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Liquidity and Regulation of Sovereign Bond Markets after the Great Recession

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Abstract

This research investigates some aspects of the structure of European sovereign bond secondary market. Eruopean government bonds are standard financial instruments, traded in highly transparent markets. A good functioning of these markets provides an essential supportive environment for the primary market, by which Sovereign entities issue their bonds among investors. During the last decade, many factors have potentially affected the bond market's structure: the US and UK financial crisis, the European sovereign crisis, the deflation and the non-standard monetary policies of ECB and other central banks, new regulatory frameworks for financial markets and banks (e.g., MIFID II and MIFIR).

Looking at the period of the European debt crisis, the pricing in financial markets of sovereign credit risk has been a central topic for empirical research. In the first chapter, we study the links between credit default swaps (CDS) and bond spreads, the differences in the set of relevant determinants, the price discovery of sovereign credit risk and the impact of the entry into force of the European ban on *naked CDS*, approved by European authorities to contrast speculative activity against national public debts.

Secondly, we focus on the Italian case. The wholesale secondary market of its securities is MTS. We provide an extensive study on the evolution of the microstructural liquidity conditions over the last decade. In order to investigate different dimensions of the market liquidity (quoting, trading and resiliency), we propose an analysis on several liquidity measures. The large set of measures on a unique dataset provides a complete view of the market structure, market makers' behavior and price takers' preferences. This analysis clearly highlights trends, causes and timing of structural variations in market liquidity in the last decade.

Lastly, since MTS Italy is the secondary market that operates under the *specialist system*, the last chapter investigates some peculiar aspects of the incentives that probably affect specialists' behavior. Differently from other markets, the Italian Treasury monitors the performance of specialists on MTS, in order to push them to provide high level of liquidity. Monitoring rules represent a sort of soft regulation applied on Italian government bond market. We investigate whether these rules and the correspondent public ranking system effectively affect market makers in their quoting decisions and, consequently, the liquidity conditions of order books. To the best of our knowledge, this is one of the very first studies to statistically assess the impact of this regime on specialists' quoting preferences.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

European sovereign debt securities are standard financial instruments, traded in highly transparent markets. A good functioning of these markets provides an essential supportive environment for the primary market, by which the Sovereign entities issue their bonds among investors.

European governments, to achieve the minimization of national borrowing cost, have faced the challenges of sustainable development in sovereign bond markets' structure and regulatory innovations. The current dissertation touches some of these aspects with an empirical perspective.

During the last decade, many factors have potentially affected the bond market's structure: the US and UK financial crisis, the European sovereign crisis, the deflation and the non-standard monetary policies of ECB and other central banks, new regulatory frameworks for financial markets and intermediaries (e.g., MIFID II and MIFIR).

During the sovereign debt crisis, credit default swaps (CDS) played a central role in the pricing of sovereign credit risk. CDS are contracts whereby one party guarantees to a bond holder the repayment of principal if the issuer of the bond (the *reference entity*) incurs in a specified credit event (e.g., it does not reimburse the capital). In exchange for such protection, the *CDS buyer* ensures a constant payment over time, the CDS spread. Thus CDS are equivalent of insurance contracts, exchangeable in financial markets.

This instrument was also suitable for *speculative* transactions. This term is used to indicate a trading strategy employed to realize in the short run a gain generated by strong changes in the value of the products purchased or sold. CDS was also used to amplify investors' bets on the sovereign credit risk pricing. In order to limit the use of this instrument for speculative purposes, on 26 March 2012 the European Commission has approved a regulation that bans the opportunity to buy CDS if the investor does not really own a position exposed to the credit risk of a particular reference entity (*naked CDS*). In this way, they have tried to limit the use of CDS at a mere use for hedging or insurance purposes. This legislation became effective from 1 November 2012. The aim of the second chapter is to investigate the link between the credit risk priced in the sovereign bond and in the CDS markets. In more detail, we study how the set of relevant drivers of these two instruments and the price discovery mechanism of sovereign credit risk have been affected by the introduction of the European ban on naked CDS.

The third and fourth chapters focus on the Italian case. Italy has the second largest public debt among European countries. The wholesale trading market of its securities is MTS. It was introduced in 1988 by the Italian Treasury and it was the first electronic market for government bonds in Europe. Currently, it is the electronic platform with the highest trading market share of Italian government bonds. As mentioned above, the good functioning of this market guarantees a lower liquidity premium, demanded by investors on Italian government bonds, and facilitates allocation in the primary market. A large number of studies on the liquidity conditions on MTS domestic platform are conducted recently (Girardi and Impenna (2013), Pelizzon et al. (2014), Cafiso (2015), Pelizzon et al. (2016), Scheneider et al. (2016), Corradin and Maddaloni (2017)). In the third chapter we provide an extensive study on the evolution of the liquidity microstructure conditions over the last decade. In order to investigate different dimensions of the market liquidity (quoting, trading and resiliency), we propose an analysis on 45 liquidity measures. We select some of these measures among those described in Coluzzi et al. (2008) and we put forward some new measures. The large set of measures on a unique dataset provides a complete view of the market structure, market makers' behavior and price takers' preferences. This analysis clearly highlights the main trends and the timing of structural variations in market liquidity during the last decade.

Lastly, since MTS Italy is the a secondary market that operates under the *specialist system*, the fourth chapter investigates some peculiar features of the incentives that probably affect specialists' quoting decisions. Differently from other markets, the Italian Treasury monitors the performance of specialists, in order to incentivize them to provide high level of liquidity. Monitoring rules represent a sort of soft regulation applied on Italian government bond market. We investigate whether these rules and the correspondent public ranking system, through its explicit and implicit incentives, effectively affects market makers in their quoting decisions and, consequently, the liquidity conditions of order books. To the best of our knowledge, this is one of the very first studies to statistically assess the impact of this regime on specialists' quoting preferences.

The empirical analysis, based on diff-in-diff approach, employs the changes in monitoring rules between 2015 and 2016. These have decreased the minimum size that has to be quoted by specialists on BTPs with residual maturity longer than 10 years from 5mm to 2mm. Results clearly identify the decisive role of monitoring and public ranking regimes in specialists' quoting behavior. A combination of a positive effect on tightness of bid-ask spreads and no negative depletion of quoted depth in the order book is found, globally leading to better liquidity conditions. These results are reconciled with traditional microstructure models taking into account the positive effects of a public ranking system. Furthermore, this analysis definitely highlights a heterogeneous impact among market makers, suggesting these operators are differently exposed to the potential benefits of a ranking system. These results provide important implications for policy makers in the design of financial markets and suggest that traditional microstructure models and empirical studies can be enhanced by taking into account incentives provided by the ranking regime, when it exists.

Chapter 2

Government Bond-SCDS links in the Eurozone (2008-2015)

2.1 Introduction

In recent years, the debt sustainability of advanced countries has become one of the main concern in financial markets. Creditworthiness deterioration has been related to the dynamic of governments' budget deficits, the rising debt burdens, the increasing political uncertainty and the decline in financial markets stability. Therefore, hedging activity on sovereign credit risk has become a critical component for market participants. Among different strategies in portfolio management, CDS was undoubtedly used by market operators to manage their exposures to sovereign credit risk. CDS are contracts whereby one party guarantees to a bond holder the principal repayment as well as the interest payments in case the issuer of the bond (the *reference entity*) defaults or experiences another credit event. Against such protection, the *CDS buyer* ensures a constant payment over time, the *CDS spread*. Apparently, this swap is very similar to a credit insurance contract. As Duffie (1999) pointed out, from a theoretical no-arbitrage condition, CDS spread should be replicated by a portfolio that is long on the bond and short on an appropriate risk-free rate. In perfect market conditions, the portfolio return, composed by a government bond and a loan at risk-free rate, should be the only extra-yield that the investor requires in facing the credit risk of bond issuer: $\textit{CDS Spread}_t = \textit{Bond Yield}_t - \textit{Risk free rate}_t$, that is $\textit{CDS Spread}_t = \textit{Bond Spread}_t$. However, this instrument could be also used for speculative transactions (Barclays (2010), Che and Rajiv (2010)), amplifying investors bets on sovereign credit risk.

In order to limit the use of this instrument for speculative purposes, on 26 March 2012 the European Commission (henceforth EC) has approved a regulation that bans the possibility to buy CDS if the investor does not really own a position exposed to credit risk of the reference entity (*naked CDS*). In this way, EC has limited the trading on CDS at a mere use for hedging or insurance purposes. This legislation has become effective from 1 November 2012.

The aim of this work is to investigate the interconnections between bond spread and CDS spread in a wide sample of Eurozone countries. In particular, the study, considering a very long period, that runs from the Lehman default in September 2008 to the end of June 2015, firstly analyzes the relevant determinants of the two assets, highlighting differences between peripheral and core countries and investigating the evolution of the differences between the two drivers' sets over the period 2008-2015. Secondly, we investigate whether the cointegration condition and the leading role in the pricing mechanism of sovereign credit risk, played alternatively by the cash or the derivative market, actively modify the set of key drivers of the bond or CDS. Lastly, this paper tries to verify whether the EU restriction has effectively affected the links and the equilibrium between bond and CDS. To the best of our knowledge, no previous research assesses the impact of European ban on naked CDS. In this paper, we explain in more detail this reform and we study the evolution of the price discovery mechanism of sovereign credit risk and the variations in the set of relevant drivers of these two assets through both static and dynamic models. These two steps are two sides of the same coin: the European ban could have affected the leading role in the pricing of credit risk and, consequently, the relevant drivers in determining the sovereign cost of financing. The main contributions of this paper are to analyze a very long period (2008-2015), to offer a new view on the links and on the long-run equilibrium between CDS and bond markets using both static and dynamic models and to investigate the impact of European ban on naked CDS.

This paper is organized as follows. The next section presents the previous literature on CDS and cash bond markets relations. Then, Section 3 discusses methodology, data and the main results of the study of relevant determinants of sovereign credit risk. Section 4 investigates the pricing mechanism of sovereign credit risk. Section 5, addresses a panel var analysis on the determinants of the CDS and bond spread in order to test the dynamic relation between the two assets. Section 6 discusses the introduction of the European ban on naked CDS and on bonds' short selling and verifies the impact of the entry into force on the price discovery mechanism and on the set of relevant variables. Concluding remarks are offered in Section 7.

2.2 Related literature

In recent years, literature on the links between bonds and CDS has greatly expanded, since CDS have grown in efficiency, in trading volume and in information contribution on credit risk. As mentioned above, from a no-arbitrage condition, CDS and bond markets should be in equilibrium: CDS spread should be equal to the difference between the bond yield and a correspondent risk free rate (Duffie (1999)). In the short term, this relation can be expected to have deviations, while - from economic theory - it should not be expected to have substantial differences in the medium or in the long term. Many researchers have investigated this aspect and they conclude that equilibrium condition is not always respected. Wide literature about the relation between corporate CDS and bond yield exists. We refer to Zhu (2006), Ammer and Cai (2007), Blanco et al. (2005) for the corporate case.

Focusing on the sovereign European case, some common features can be found. Clear evidences of no-cointegration before September 2008 are highlighted. Conversely, since autumn 2008 signs of cointegration can be traced. Fontana and Scheicher (2010), using the framework proposed by Johansen (1988, 1995) on a sample of ten EU countries (Austria, Belgium, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain), find no-cointegration if the period 2006-2008 is considered. After 2008, the cointegration equilibrium is respected for all the units in the sample, with a confidence level greater for the peripherals (especially Italy and Spain). Similar findings on post-Lehman crisis period are found in Carboni (2011) and in Alper et al. (2013). However, Carboni shows that it is necessary to include the spread Euribor-Eurepo to restore cointegration among the markets, which appear misaligned after the Lehman default. Palladini and Portes (2011), considering a six countries sample (Italy, Belgium, Portugal, Ireland, Greece and Austria), demonstrate that theoretical value $[1, -1]$ of the cointegrating vector is rejected, highlighting a strong short run misalignment from equilibrium condition. Delatte et al. (2012) highlight that CDS and bond spreads are not linked by a linear relationship. Arce et al. (2013) find persistent deviations between both spreads during the crisis but not before.

Given the analysis on the equilibrium conditions, it might be interesting to understand in which market the price is formed when new information is received. There are several ways to estimate in which market price discovery occurs. The choice to use some metrics as opposed to others depends on the level of market cointegration. Fontana and Scheicher (2010), using VEC model and the corresponding Gonzalo-Granger measure, show clear evidence of CDS supremacy in price discovery process since the outbreak of financial crisis. In addition, this supremacy is stronger during periods of stress and turbulence for government yields of weak economies: during financial turmoil, the CDS market led with more force the cash market, being able to cause in the latter strong destabilizing conditions. The same conclusions can be found in Palladini and Portes (2011), in Carboni (2011), in Delatta et al. (2012) and in Alper et al. (2013). IMF (2013) carried out the analysis with Hasbrouck statistic estimated from a panel VEC model. They find a leading role of the derivative product during the hardest part of the crisis.

As mentioned above, the further question is about the determinants of CDS and bond prices, to test whether the two sets of relevant drivers are systematically different. About this issue, the literature is wide. Subrahmanyam et al. (2014) provide a complete review of existing studies about drivers of sovereign CDS (henceforth SCDS). Synthetically, according to Subrahmanyam, three main categories of determinants can be identified: structural ones (risk-free rate, public debt and idiosyncratic volatility of assets), those related to liquidity conditions and those that approximate the conditions in international financial markets (i.e., market volatility and the degree of risk aversion by investors).

With respect to bond yields, focusing on the European case, D'Agostino and Ehrmann (2014) and Matei (2013) provide a general review of studies on the relevant drivers of government bond spreads. The results reveal that fiscal fundamentals (mainly public debt and GDP growth rate) as well as international risks, liquidity risk and the risk of the crisis' transmission among Eurozone member States are likely to put substantial upward pressures on sovereign bond yields.

This literature is only a starting point for our analysis. As a matter of fact, the aim of this paper is to investigate the relevant differences between the drivers set of bond and CDS prices and whether these differences have varied over the period 2008-2015. On this subject, only few papers exist. Fontana and Scheicher (2016) reproduce a panel analysis on CDS and bond spreads, with weekly data between June 2006 and June 2010. They find that bond spreads are driven more than CDS by country-specific factors (e.g., Debt/GDP) and that before the crisis, market prices were less linked to fundamental determinants (*wake up call* phenomenon). The *wake up call* and the mis-pricing of the sovereign default risk in the pre-crisis period are also pointed out in Cipollini et al. (2015). Two years before, Alper et al. (2013) analyze data in the period 2008-2010 on CDS and RAS (Related Asset Swap on government bonds). Proposing a division of drivers between *global&financial* and *Country-specific* fiscal factors, they find CDS spreads are more responsive to new information on the fiscal side. This is particularly evident if the same analysis is performed splitting the sample between *core* and *weak* economies. Lastly, they argue that CDS market provides better signals on credit risk during periods of stress. IMF in its Global Financial Stability Report of the April 2013, using standard panel regression on 33 countries during 2008-2012, states the derivative and the cash markets reflect economic fundamentals and other relevant market factors in a similar fashion. As Arce et al. (2013) and Fontana and Scheicher (2016), they perform a panel analysis on the determinants of the basis between CDS and bond spreads.

2.3 The determinants of sovereign credit risk

The first step of the analysis investigates the relevant drivers on bond and CDS spreads. It will be studied through a panel regression model, as previous research of ECB and IMF did (D'Agostino and Erhmann (2014), Fontana and Scheicher (2016), IMF Global Financial Stability Report (April 2013), Alper et al. (2013)). The variables used in the model are chosen among those suggested by economic theory and literature. This analysis investigates whether the credit risk pricing in the two markets (cash and derivatives) is driven by the same set of country-specific and macroeconomic variables. Lastly, as other studies have investigated (e.g., Fontana and Scheicher (2016), Alper et al. (2013), we study the set of relevant drivers of the basis. It is defined as the difference between CDS spread and bond spread and this part of study verifies which variables lead the pricing differences between the two assets.

2.3.1 Methodology and data

The analysis of determinants is carried out through a standard panel regression model with individual and time fixed effects, using monthly level data on ten European countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain). In appendix .1.4 we show the results of Hausman test for the correct specification in using unit fixed effects and the outcome of the tests to verify the required time fixed effects dummies. From our sample, we exclude countries whose activity was limited in the primary and secondary cash markets. For this reason, we do not consider Luxembourg, Malta and Cyprus. In the case of Greece and Slovenia, the reasons are quite different. We collect data for Greece until May 2010, when the Prime Minister Papandreou asked the EU partners to activate the fiscal support mechanism. Because of this, the activity in the Greek government bond market became rarefied and it does not permit us to consider Greece within the sample. However, if we consider Greece until May 2010, the results of the econometric analysis are not substantial affected. In the case of Slovenia, the market data are available starting from 2012. For this reason we include it only in the final part of the sample and we verify that it does not influence our conclusions.

The sample period runs from 15 September 2008 to 30 June 2015. We choose the Lehman default as starting point of our analysis because previous literature has pointed out a structural variation in the level of cointegration between the two assets after the autumn 2008. Credit risk should be priced both in the government bond market and in the derivative SCDS market. Under efficient conditions, a new information on the creditworthiness of an issuer should affect the bond prices and the corresponding cost of protection. However, markets are not fully efficient and, as a result, there is a disequilibrium between cash and derivative assets. These imbalances result in partial misaligned movements in the two markets, offering arbitrage opportunities. Recalling that $CDS\ Spread_t = Bond\ Spread_t$ from economic theory, this condition has been repeatedly studied in the literature and the persistence of disequilibrium between the two markets has been pointed out. In this part of the analysis, we study whether the two assets are linked to different sets of relevant variables.

In our analysis, the *bond spread* is obtained by subtracting to the ten-year bond yield the Euro ten-year swap rate, as a proxy of participants' preferred measure of the risk-free rate with the same maturity. This choice, used in other studies in the literature (Alper et al.

(2013), Fontana and Scheicher (2010)), makes the use of the German Bund yield unnecessary as a proxy for risk-free rate. It provides two advantages. First, it allows to use Germany as a unit in the sample. The second benefit is that the spread obtained for each country is not directly distorted by the dynamic of the German data. The 5y *CDS spread* is expressed in basis points, as percentage on the notional value protected. A price increase should represent deterioration in the reference entity creditworthiness. For all countries, the two variables are positively correlated. The first tensions appeared after the Lehman default. Then, up to 2010, the level has decreased. However, the strongest widening occurred from the beginning of 2010, when the dramatic conditions of Greek public budget manifested itself. Following the summer 2012, a normalization period, in which spreads and volatility return to lower levels, started. Lastly, as explained above, the basis is defined as the difference between CDS spread and bond spread.

The basic panel model is represented by the following specifications:

$$\begin{aligned}
\textit{Bond Spread}_{it} =& a_0 + \beta_1 \textit{Bond Liq}_{it} + \beta_2 \textit{Euribor3m}_t + \beta_3 \textit{Global Aversion Risk}_t + \\
& + \beta_4 \textit{Eqindex SXXP}_{it} + \beta_5 \textit{EVZ}_t + \beta_6 \textit{VsParty}_t + \beta_7 \textit{Debt GDP}_{it} + \\
& + \beta_8 \textit{GDP Growth}_{it} + \beta_9 \textit{Inflation Expectations} + \\
& + \beta_{10} \textit{CDS net am dynamic} + \beta_{11} \textit{Specialness} + \alpha_i + d_t + \varepsilon_{it} \\
\textit{CDS Spread}_{it} =& a_0 + \beta_1 \textit{CDS Liq}_{it} + \beta_2 \textit{Euribor3m}_t + \beta_3 \textit{Global Aversion Risk}_t + \\
& + \beta_4 \textit{Eqindex SXXP}_{it} + \beta_5 \textit{EVZ}_t + \beta_6 \textit{VsParty}_t + \beta_7 \textit{Debt GDP}_{it} + \\
& + \beta_8 \textit{GDP Growth}_{it} + \beta_9 \textit{Inflation Expectations} + \\
& + \beta_{10} \textit{CDS net am dynamic} + \alpha_i + d_t + \mu_{it} \\
\textit{Basis}_{it} =& a_0 + \beta_1 \textit{Euribor3m}_t + \beta_2 \textit{Global Aversion Risk}_t + \\
& + \beta_3 \textit{Eqindex SXXP}_{it} + \beta_4 \textit{EVZ}_t + \beta_5 \textit{VsParty}_t + \beta_6 \textit{Debt GDP}_{it} + \\
& + \beta_7 \textit{GDP Growth}_{it} + \beta_8 \textit{Inflation Expectations} + \\
& + \beta_9 \textit{CDS net am dynamic} + \beta_{10} \textit{Specialness} + \alpha_i + d_t + \nu_{it}
\end{aligned} \tag{2.1}$$

The use of monthly averages and interpolations rather than closing prices of each month avoids some distortions and provides less volatile and biased data. Appendix .1.3 shows details on data manipulation, descriptive statistics of time series and the output of the test on the stationarity conditions.

As robustness check, in order to verify whether coefficients are different across more homogeneous countries, we split the sample between core and peripherals (Italy, Spain, Portugal and Ireland).

The explanatory variables that have been used in the panel models are the following: liquidity measure of the asset (bond or CDS), Euribor 3 months, a global risk aversion indicator, idiosyncratic volatility, EVZ, counterparty risk proxy, debt level, GDP growth, European inflation expectations, CDS net amount to gross amount ratio. Only in the bond specification, it is also considered a proxy about the specialness in the repo market[1] of securities of each issuer, a key determinant pointed out in Fontana and Scheicher (2016). These variables can be divided into country-specific factors and variables common to the countries in the sample.

In the bond and CDS specifications, the *liquidity measure* has been calculated as the difference of the bid-ask prices in percentage on the mid-price. The idiosyncratic volatility is measured as the difference of the realized volatility on monthly based of the national main stock index (FTSE MIB - Italy, IBEX - Spain, DAX - Germany, CAC - France, PSI20 - Portugal, AEX - The Netherlands, ATX - Austria, BEL20 - Belgium, HEX - Finland, ISEQ - Ireland) and the volatility of the European SXXP. The first fiscal variable is the debt outstanding (the national debt/Gdp ratio); the second fiscal variable is the Gdp growth QoQ. The latter could explain some aspects that are not caught by the Debt/GDP variable. These aspects concern the debt sustainability and they help to have a forward looking on the country fiscal condition.

Regarding liquidity measures two distinct trends can be seen: a) with regards to bond spreads, liquidity strains can be identified after 2010, in particular in peripherals case (studied in Pelizzon et al. (2016) and in Badaoui et al. (2016)); b) in the CDS case, many countries show a U-shape pace during the whole period, with highest level of liquidity during the period 2011-2012.

DTCC (Depository Trust and Clearing Corporation) provides the CDS net amount, defined as *the maximum possible net funds transfers between net sellers of protection and net buyers that could be required upon the occurrence of a credit event relating to a particular reference entity*. As the definition suggests, net amount allows to know the size of the ef-

[1] A repurchase agreement (repo) is a form of short-term borrowing for dealers in government securities. For the party selling the security and agreeing to repurchase it in the future, is a repo. For the party on the other end of the transaction, it is a reverse repurchase agreement. Repo market allows investors to implicitly finance its buying and market makers to short-sell the bond in the cash market.

fective protection which floats on the market, that is the size of the exchange of protection from the seller to the buyer if a credit event occurs. In our model, we use the *net to gross amount ratio* to understand whether the variation in the effective open positions in credit risk hedging plays a role in bond and CDS pricing. Lastly, specialness in the repo markets is defined as the difference between each country Repo Funds Rate (RFR) and the European repo rate. These data are provided by NEX Data and are calculated from trades, executed on either the BrokerTec or the MTS electronic platforms, that use sovereign government bonds as collateral. NEX provides data about RFR Euro, RFR Germany, RFR France, RFR Italy, RFR Spain, RFR Netherlands and RFR Belgium. So far, the country-specific variables have been explained.

The second set of variables is composed by the common factors across countries. These are representative of macroeconomic and international phenomena that the previous literature has found to be influential on bond and CDS spreads.

Euribor 3-month is the short-term risk-free rate. During this period, the rate has decreased from a level of about 3% from current zero level, reflecting the monetary policy in Eurozone.

The global risk aversion is constructed as the difference between the VIX index and the same measure of volatility on the Euostoxx Index. In this way, this variable should replicate the net level of non-EU risk aversion.

The EVZ variable (Euro Currency Volatility Index) is an index on the expectations of the exchange rate €/$. It is produced by the CBOE and it is constructed in a very similar way to the VIX. EVZ measures the market expectations of 30-day volatility of the €/$ exchange rate by applying the VIX methodology to options on the Currency Shares Euro Trust. *A priori*, we expect to have an effect in CDS specification because the derivative product provides USD protection on a EUR capital.

The inflation expectations are measured by the 5-year/5-year swap rate, the benchmark market expectations as explained in Schulz and Stapf (2014).

The counterparty risk is approximated through a synthetic index. It has been constructed as the average of the CDS spreads written on twelve major investment banks (Bank of America, Citigroup, Credit Suisse, HSBC, Royal Bank of Scotland, Barclays, Deutsche Bank, Goldman Sachs, JP Morgan, Morgan Stanley, Nomura and UBS). They represent the group of investment banks that act as market makers on the government bonds issued by the countries in the sample. Also in this case, one should expect a greater effect in the derivative specification since CDS is more exposed to counterparty risk, being a derivative contract.

2.3.2 Results

Regression results are summarized in Table 2.1. In appendix .1.4, the test on the autocorrelation of residuals is presented. The outcome of these tests rejects the null hypothesis of presence of a unit root. Starting from the bond specification, it is positively influenced by bid-ask spread, the idiosyncratic volatility, the counterparty risk proxy and the cds net volume dynamic. The fiscal dynamic, represented by GDP growth, negatively affects the dependent variable: better economic conditions reduces sovereign financing cost. Also the uncertainty on €/$ exchange rate plays a role, with negative sign. As pointed out in Fontana and Scheicher (2016), the specialness in the repo market affects negatively the bond spread. Higher the specialness, lower the yield of the bond. Bond spread is not affected by the level of debt/GDP ratio, the risk-free rate and other financial and macroeconomic factors.

Looking at the CDS specification, it is linked to international risk aversion and gdp dynamic. Differently from bond specification, liquidity, idiosyncratic volatility, exchange rate risk, counterparty risk proxy and cds net volume dynamic do not play any role in CDS pricing. Lastly, adjusted R^2 is quite different between the two regressions. The explained variance in the bond specification is 0.746, that is higher than in the CDS case (0.475).

A first important evidence of the basic model is that the sets of explanatory drivers of the two spreads are different and these seem to be complementary. Excluding gdp growth, each relevant driver in bond specification loses its causal effect in the cds model and vice-versa. From this part of analysis, one can conclude bond spread seems to be more informative and stronger linked to fiscal, credit risk and macro-financial variables.

Looking at the basis specification, we find it is positively related to Euribor 3m and exchange rate risk. As expected, since the protection of CDS is in $, uncertainty in the exchange rate determines higher CDS premia versus a more stable euro-denominated government bond. Conversely, higher international risk aversion and a worsening of debt-to-gdp ratio affect negatively the basis. A negative impact on these variables causes a higher repricing in bond spread leading to a widening of the basis.

Subsequently, the same analysis is developed separately for core and peripheral coun-

	(1)								
	Bond	CDS	Basis	Bond		CDS		Basis	
				Peripheral	Core	Peripheral	Core	Peripheral	Core
Liquidity	1.129***	0.078		1.002***	0.249	-0.091	-0.003		
	(0.066)	*(0.055)*		*(0.031)*	*(0.161)*	*(0.219)*	*(0.012)*		
Euribor 3m	0.318	0.259	0.152*	0.455	-0.007	0.778**	0.156	0.171	0.141
	(0.173)	*(0.204)*	*(0.068)*	*(0.307)*	*(0.081)*	*(0.153)*	*(0.228)*	*(0.101)*	*(0.097)*
International risk aversion	-0.04	-0.358**	-0.120***	-0.157	0.023	-0.52	-0.017	0.154	0.124
	(0.049)	*(0.137)*	*(0.024)*	*(0.070)*	*(0.024)*	*(0.241)*	*(0.016)*	*(0.492)*	*(0.553)*
Idiosyncratic vol	0.042**	0.017	-0.001	0.059*	0.008	0.014	0.02		
	(0.014)	*(0.021)*	*(0.006)*	*(0.021)*	*(0.008)*	*(0.032)*	*(0.012)*	*(0.008)*	*(0.007)*
Evz	-0.191***	-0.037	0.036*	-0.217**	-0.058**	0.029	-0.066	0.021	0.047
	(0.038)	*(0.060)*	*(0.020)*	*(0.044)*	*(0.015)*	*(0.094)*	*(0.061)*	*(0.032)*	*(0.049)*
Counterparty risk proxy	0.537**	0.52	0.091	1.075*	0.346***	0.916	0.671***	0.011	0.004
	(0.225)	*(0.313)*	*(0.078)*	*(0.448)*	*(0.074)*	*(0.484)*	*(0.122)*	*(0.028)*	*(0.003)*
Debtp Gdp	0.003	0.021	-0.012***	-0.023	-0.005	0.015	0.008	-0.005	-0.010
	(0.012)	*(0.012)*	*(0.002)*	*(0.011)*	*(0.015)*	*(0.028)*	*(0.012)*	*(0.004)*	*(0.007)*
Gdp growth	-0.215**	-0.501*	-0.025	-0.165*	-0.005	-0.353	-0.004	-0.037	-0.006
	(0.070)	*(0.260)*	*(0.020)*	*(0.069)*	*(0.038)*	*(0.407)*	*(0.060)*	*(0.023)*	*(0.043)*
Inflation expectations	-0.026	0.162	-0.082	-0.238	0.048	0.101	-0.171	-0.716*	-0.015
	(0.150)	*(0.185)*	*(0.069)*	*(0.121)*	*(0.049)*	*(0.301)*	*(0.097)*	*(0.291)*	*(0.323)*
Cds net volume dynamic	4.800*	0.917	-0.015	-1.721	-0.118	-6.907	1.224	0.560	0.092
	(2.598)	*(4.860)*	*(0.1.007)*	*(4.050)*	*(1.048)*	*(8.886)*	*(2.004)*	*(2.080)*	*(0.062)*
Repo	-4.313***		0.098	-0.165	-1.374			0.416	0.030
	(0.649)		*(0.366)*	*(1.506)*	*(1.311)*			*(0.901)*	*(0.621)*
Constant	0.025	-3.828*	0.648	3.803**	0.443	-2.81	0.04	-1.953	-1.739
	(1.288)	*(2.010)*	*(0.361)*	*(1.057)*	*(1.369)*	*(5.269)*	*(1.454)*	*(1.486)*	*(1.259)*
Observations	800	800	800	320	480	320	480	320	480
Adjusted R^2	0.746	0.475	0.724	0.851	0.291	0.692	0.681	0.620	0.781

Table 2.1: **Panel regression results**. The table presents the results from panel regression with time and individual fixed effects defined in the model 2.1. Under each coefficient, robust standard errors to heteroskedasticity and within-panel correlation in the idiosyncratic error term are reported. The basic model is estimated on the entire period. The peripheral sample is composed by Italy, Spain, Portugal and Ireland. Germany, France, The Netherlands, Belgium, Austria and Finland are considered as core countries.

tries. It reveals some important differences between the two subsamples. Peripheral bond spread has as significant drivers the liquidity measure (positive sign), the counterparty risk proxy (positive sign), the €/$ uncertainty (negative sign), the gdp growth (negative sign) and the idiosyncratic volatility (positive sign). Conversely, in core sample only the counterparty risk measure and the exchange rate risk affect the bond price levels. About the stronger effect of counterparty risk proxy in the peripherals' subsample, one possible explanation could be the existence of steadier interconnections between the default risk of the main financial institutions and the stability conditions of weak European countries. Also in the CDS specifications there are some important differences in the set of relevant drivers. Euribor 3m is a relevant factor only in peripherals sample, whereas the counterparty risk leads only CDS pricing. We do not find any relevant relation between basis and the set of explanatory variables. Only in the *peripheral* specification, we find a negative relation between inflation expectations and basis. As expected, higher inflation leads to a stronger repricing (higher yield) of the fundamental value of the fixed income product with respect the CDS, that should be a pure credit risk product. It is possible to conclude that bond spread in the peripheral countries specification is the dependent variable with the high links with the selected explanatory variables.

To summarize, this econometric analysis has allowed to verify that: *a*) the drivers sets of CDS and bond spread are strongly different, in particular if the analysis is divided into unit subsamples; *b*) bond spreads are more linked to country specific and fiscal variables of our estimation model; *c*) Peripherals' bonds show the high links with our selected explanatory variables; *d*) as in previous literature, *flight to liquidity* and *flight to quality* phenomena have been found.

2.4 The price discovery of sovereign credit risk

In this section we study the price discovery mechanism of sovereign credit risk. After studying the differences in the set of relevant drivers, we analyze which asset leads the price action of credit spread. In this section, we propose a similar path of previous studies (Palladini (2012), Carboni (2011), Fontana and Scheicher (2010), Alper et al. (2013)). We separately analyze the relation between the two assets for each sovereign entity, in order to verify whether in the Eurozone countries a heterogeneity exists in the leading role of CDS or bond spread.

2.4.1 Methodology and data

For our analysis, we collect weekly data from Bloomberg®on the ten European countries of the sample. We prefer to use weekly observations in order to limit problems of non-normality and heteroschedasticity of data. Firstly, the stationarity condition of the time series will be analyzed. After this preliminary step, the level of cointegration of the two markets will be studied. Lastly, the measures, that suggest the market in which the price discovery process takes place, will be examined: these measures are different if the two markets are cointegrated or if they are not.

Firstly, we study the stationarity condition of the two variables. As proposed by Elliot, Rothenberg and Stock (1996), a modified version of the Dickey-Fuller test has been used. After the integration analysis, the cointegration test has been conducted. The economic theory suggests that the bond and CDS spreads, combined in a linear combination ($z_t = CDS\ Spread_t - Bond\ Spread_t$), produce a stationary process. Formally, the variables y_t in a process of K-dimension are cointegrated of order (d,b), shortly $y_t \sim CI(d,b)$, if all y_t components are $I(d)$ and a linear combination $z_t := \beta' y_t$, with $\beta = (\beta_1, \dots, \beta_K)' \neq 0$ such that z_t is $I(d-b)$, exists. A process consisting of cointegrated variables is called cointegrated process. These processes were introduced by C. Granger (1981) and Engle e Granger (1987). To carry out the cointegration analysis there are several strategies. The method suggested by Johansen (1988, 1995) has been used. This test is essentially a multivariate Dickey-Fuller test that determines the number of cointegration equation by calculating the likelihood ratio statistics for each added cointegration equation in a sequence of nested models.

Finally, the price discovery process analysis has been developed. Two different paths have been followed depending on whether the two markets reveal or not cointegration evidences. In the case of no cointegration, the Granger causality test (Granger (1969), Granger (1981)) has been used to investigate the price discovery process. Formally, defining a common VAR model $y_t = A(L)y_{t-1} + B(L)x_{t-1} + \varepsilon_{1t}$ and $x_t = C(L)y_{t-1} + D(L)x_{t-1} + \varepsilon_{2t}$ (with $A(L), B(L), C(L)$ and $D(L)$ are matrix polynomials in the lag operator L), the variable x

causes in the sense of Granger the variable y iff:

$$X\ GC\ Y \leftrightarrow E(y_t|y_{t-1},y_{t-2},\dots,x_{t-1},x_{t-2},\dots) \neq E(y_t|y_{t-1},y_{t-2},\dots,)$$

.

Otherwise, the Gonzalo-Granger statistic has been applied. Define a bivariate Vector Error Correction Model (VECM):

$$\begin{cases} \Delta CDS_t = \lambda_1(Z_{t-1}) + \sum_{j=1}^{p} \alpha_{1j}\Delta CDS_{t-j} + \sum_{j=1}^{q} \beta_{1j}\Delta Bond\ Spread_{t-j} + \varepsilon_{1t} \\ \Delta Bond\ Spread_t = \lambda_2(Z_{t-1}) + \sum_{j=1}^{p} \alpha_{2j}\Delta CDS_{t-j} + \sum_{j=1}^{q} \beta_{2j}\Delta Bond\ Spread_{t-j} + \varepsilon_{2t} \\ Z_t = CDS_{t-1} - \alpha_0 - \alpha_1 Bond\ Spread_{t-1} \end{cases} \tag{2.2}$$

Price discovery process is driven by the CDS product if λ_2 is significant. In contrast, the bond spread leads if λ_1 is significant. If both λ_1 and λ_2 are significant, then both markets contribute to price discovery. However, the supremacy of one market or the other one can be measured by the ratio that Gonzalo and Granger suggested: $GG = \frac{\lambda_2}{\lambda_2 - \lambda_1}$. Values close to one or greater signal that the derivative market leads. Values close to zero or negative indicate the supremacy of the cash market.

Following the above-mentioned procedure, the analysis is carried out separately for each country.

2.4.2 Results

As mentioned above, the augmented Dickey-Fuller test in the GLS version has been used to test the stationarity conditions of the series. The output confirms the non-stationarity of the series in levels. Conversely, performing the same analysis on the differentiated time series, it is possible to conclude that these series are stationary (more details on the test are shown in Appendix .2.1). Then, we proceed with the cointegration analysis of the two markets. It is carried out through the Johansen procedure. In Table 2.2, the cointegration analysis for each country is summarized.

Table 2.2 shows the trace statistic of Johansen test, depending on the specification used. In the last column the logic output is reported. The final output is determined following these steps: I) starting from model 1, trace statistic in the first column is compared with

Country	Model 1		Model 2		Cointegration
	rank=0	rank=1	rank=0	rank=1	
Italy	24.25	5.98	24.16	5.98	Y
Spain	21.55	5.80	21.30	5.78	Y
Germany	29.27	4.97	29.07	483	Y
France	21.66	2.75	21.49	2.75	Y
Portugal	21.26	2.03	21.09	2.03	Y
The Netherlands	24.03	6.62	23.89	6.52	Y
Austria	24.03	5.89	23.98	5.89	Y
Belgium	16.65	2.43	16.63	2.43	N
Finland	22.18	5.75	22.09	5.75	Y
Ireland	11.63	1.41	11.59	1.40	N

Table 2.2: **Cointegration analysis**. This table presents the trace statistic of Johansen test on two different specifications of an ECM. It could be represented as: $\Delta y_t = \alpha(\beta y_{t-1} + \mu + \rho t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \gamma + \tau t + \varepsilon_t$, where μ and ρt are the constant term and the trend in the cointegrating vector, γ and τt are the constant term and the trend in ECM. Posing restrictions on these terms, it is possible to define different specifications. In particular, Model 1 has the following restrictions: $\rho = 0, \tau = 0$ and $\gamma = 0$. Model 2 has the following restriction: $\rho = 0$ and $\tau = 0$. For each model, the first column provides the statistic with the null hypothesis of no cointegration (that is the cointegrating vector has rank equal zero). The second column shows the statistic with the null hypothesis of cointegration (that is the cointegrating vector has rank equal one). For model 1, the 10% critical values are for rank=0 17,85, for rank=1 7,52. For model 2, the 10% critical values are 13,33 for rank=0 and 2,69 for rank=1.

the corresponding critical value. If the null hypothesis is accepted, the two markets are not cointegrated. If the null hypothesis is rejected, the analysis continues with the step no.2; II) looking at the model 2, the trace statistic of no cointegration hypothesis is compared with the corresponding critical value. Also in this case, if the null hypothesis is accepted, the two markets are not cointegrated. If it is rejected, the hypothesis testing continues with the step no.3; III) back to the model 1, the trace statistic in the second column is compared with the critical value. If the null hypothesis is accepted, then the two markets are cointegrated. Otherwise the analysis continues with the next step; IV) the value of the second column of the second model is compared with its critical value, if the H_0 is accepted, then the two markets are cointegrated. If it is rejected, then we conclude that the two variables have to be stationary and a VAR model in levels should be estimated in order to analyze the price discovery process.

From the output analysis, the main results could be summarized as follow. First, according to the the theoretical predictions, we have found that the majority of the countries in the sample have the two markets cointegrated. During the entire period considered, only Belgium and Ireland show a different condition betwe CDS and bond spread. However, it could suggest that there were some differences between core and peripheral countries since the evidence that the two markets move together is more evident in the weak countries group.

Country	Coint.	Test Price Discovery		Output
		H0: Bond does not lead (p value)	H0: CDS does not lead (p value)	
Italy	Y	0.476	0.001	CDS
Spain	Y	0.247	0.001	CDS
Germany	Y	0.001	0.004	Bond and CDS
France	Y	0.216	0.001	CDS
Portugal	Y	0.905	0.001	CDS
The Netherlands	Y	0.005	0.001	Bond and CDS
Austria	Y	0.513	0.001	CDS
Belgium	N	0.002	0.001	Bond and CDS
Finland	Y	0.114	0.001	CDS
Ireland	N	0.001	0.002	Bond and CDS

Table 2.3: **Price discovery outcome**. The table presents the *p-values* of two null hypotheses: I) *bond spread does not lead price discovery* (the first column); II) *CDS spread does not lead price discovery* (the second column). The test is performed separately for each country in the sample and in three different subperiods (I period: September 2008 - May 2010. II period: June 2010 - October 2012. III period: November 2012 - June 2015).

About price discovery analysis, presented in Table 2.3, other important results emerge. CDS has a leading role in creditworthiness price discovery for the whole group of countries. For some countries CDS leads alone the pricing mechanism (Italy, Spain, France, Portugal, Austria and Finland) whereas there are not countries on which the credit risk pricing is uniquely led by the bond spread. Also from this analysis, some signs of a difference between core and peripherals countries seems to exist, with a more relevant role of CDS in the latter group of sovereign entities.

2.5 Panel var analysis

2.5.1 Methodology and data

To examine more accurately the relation between CDS and bond spread, taking into account the potential dynamic interdependencies, we estimate a panel VAR model. For a wide review of panel var models in the macro and financial research fields we refer to Canova and Ciccarelli (2013). Although it is known that when analyzing the transmission of shocks across the financial markets of different countries, static interdependencies are probably sufficient if data are monthly (Canova and Ciccarelli 2013), we decide to estimate a panel var model since these models are unique in their ability to model dynamic interdependencies, cross sectional heterogeneities and account for evolving pattern of transmission. We consider a two-variables panel VAR with country-specific fixed effects represented by the following system of linear equations:

$$Y_{i,t} = A_1 Y_{i,t-1} + ... + A_p Y_{i,t-p} + BX_{i,t-1} + \mu_i + \varepsilon_{i,t} \tag{2.3}$$

where $Y_{i,t}$is the vector of dependent variables (CDS and bond spread), $X_{i,t}$ is the vector of those exogenous covariates employed in the model 2.1, μ_i and $\varepsilon_{i,t}$ are vectors of country fixed effects and idiosyncratic errors respectively. The estimation is based on GMM for dynamic panels with unit fixed effects. All variables are in level and data frequency is monthly. The lag length is set to one based on the usual information criteria.

2.5.2 Results

Table 2.4 presents the estimation of the panel var model of equation 2.3. In appendix .3 the analysis of the stability condition of the estimates are reported. First, we find similar results of those got in the static specification. The liquidity risk affects significantly both the bond and the CDS spread. The bond spread is significantly and positively related to the idiosyncratic volatility, the counterparty risk and the dynamic of net exposure on CDS. Differently from the static model, we find a wider set of relevant drivers in the CDS specification. In these panel var estimations, in addition to the liquidity risk, also the risk free short term and the idiosyncratic volatility positively affect the credit premium priced by the derivative asset.

In order to evaluate the role of the lagged variables in the estimated model, we discuss our main results in the form of impulse response functions. Figure 6 shows the two combinations of IRFs to evaluate the cross impact of shocks between bond and CDS spread (the four combinations of IRF of the estimated model are presented in Appendix). Bootstrapped 95% confidence intervals are based on 500 replications.

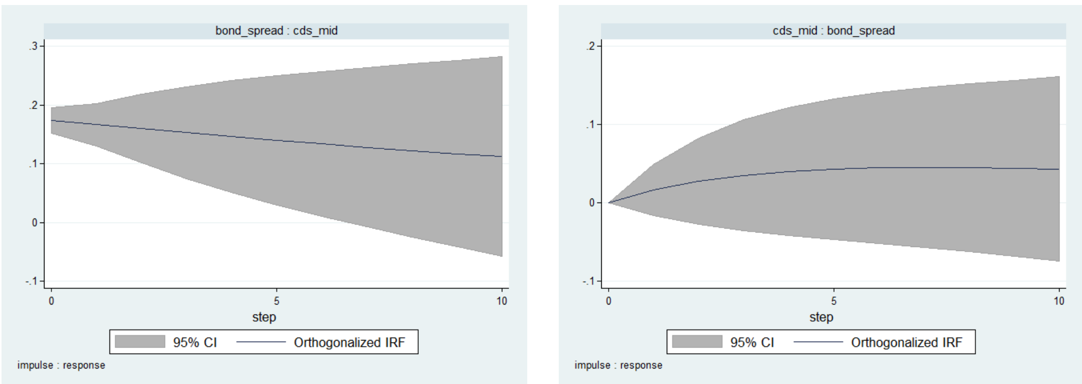

Figure 2.1: Impulse Response Fuction - Panel Var

A shock of 1% in the bond spread immediately increases the level of credit risk pricing in the CDS of more than 0.15 basis points. The impact of this shock is found to be persistent up to 6 lags. On the contrary, a shock in the CDS spread does not affect the pricing of bond spread, nor immediately nor in the lagged periods. As explained above, this analysis covers the whole period considered. Up to here, we do not verify whether unstable relations exist between CDS and bond spread. For this reason, in next sections we study whether a variation in these relations has appeared after the entry into force of the ban on *naked CDS*.

	Bond Spread	Cds Spread
Bond spread (L1)	0.918***	0.125
	(0.068)	*(0.079)*
CDS Spread (L1)	0.057	0.768***
	(0.063)	*(0.085)*
Liquidity	0.071***	0.158*
	(0.005)	*(0.085)*
Euribor 3m	0.049	0.483***
	(0.135)	*(0.215)*
International risk aversion	0.003	0.008
	(0.007)	*(0.009)*
Idiosyncratic vol	0.007**	0.011**
	(0.003)	*(0.005)*
Evz	0.044	0.039
	(0.035)	*(0.056)*
Counterparty risk proxy	0.188*	0.069
	(0.107)	*(0.161)*
Debt Gdp	0.003	-0.021
	(0.008)	*(0.013)*
Gdp growth	-0.030	0.092
	(0.046)	*(0.070)*
Inflation expectations	0.030	-0.231*
	(0.079)	*(0.129)*
Cds net volume dynamic	1.036**	0.104
	(0.414)	*(0.685)*
Repo	-1.022*	-1.050
	(0.607)	*0.818*
Observations	780	
Adjusted R^2	0.803	

Table 2.4: **Panel Var model**. The table presents the results from panel var regression defined in equation 2.3. Under each coefficient, robust standard errors are reported.

2.6 The role of European regulation on naked CDS and on short selling restrictions

In this section, we investigate whether the European ban on naked CDS and short selling restriction on sovereign debt's securities, that entered into force in November 2012, has played any role in affecting the relation between the cash and the derivative markets. Firstly, we briefly describe the timeline, the setup and the main characteristics of the law. Then, we replicate the analysis of the previous sections splitting the time period into two subsamples defined by the entry into force of the new regulation.

2.6.1 The ban: the timeline and the setup

During the European sovereign debt crisis, policy makers were concerned about some trading strategies, carried out by investors, that were destabilizing the bond markets. EC wanted to regulate the bonds short selling[2], without having at the time of placement, the certainty of availability of the securities at maturity and the contracts with naked CDS positions[3]. These strategies were used by those who wanted to have a short position on bonds for a simple choice of investment or, worse, those who wanted to push the market in that direction to profit from it.

The debate, which had been developed during 2010-2012 period, had been turned on whether to restrict the practices described above. The central issue was whether the costs of a ban outweigh the benefits, in particular if the restriction can lead to a collapse of liquidity in the derivative market. The costs arise because in the market would remain buyers of CDS for hedging purposes and sellers of protection. However, the latter, not being able to buy

[2]Short selling is the sale, carried out in respect to one or more third-parties, of securities not owned directly by the seller. The short seller, not being in possession of the bond, must borrow it from a broker and, within a certain deadline, he buys back to return it. Usually, interests shall be paid annually to the broker in relation to the duration of the short sale. Short seller benefits if the stock price has a bearish trend. In fact, if after the sale of the asset at the price P_1, the price drops to P_2 ($< P_1$), the bearish, being able to buy back the asset at a price P_2 to return it to the broker, has a gain equal to the difference between P_1 and P_2 and the interest paid. For the short seller, this is the direct effect, but there is another indirect effect for him. In fact, the signal that is sent to the market through a massive sale of a security could represent a negative expectation on asset price. If other investors decide to follow the bearish strategy, it can lead to a downward spiral that amplifies the negative trend of the securities. Therefore, the importance of limiting the contagion effect on government bonds is a determinant aspect to restore stability in the markets.

[3]The purchase of CDS by a buyer that is not actually exposed to the credit risk of the corresponding reference entity. This type of contract is called *naked CDS* in the sense that it is devoid of the real need to cover an effective credit risk exposure of the protection buyer.

naked CDS to cover the risk assumed, would not be able to remain in the CDS market and to continue to offer the sale of the contract. So, there would have been the need to provide exemptions to the ban, for example for market makers. In addition, this would have caused a problem in the proxy-hedging activities for investors. Conversely, the benefits were related to the conditions of the global financial markets. In particular, the Eurozone would have benefited from a more stable cash market, leader in the price discovery process of credit quality and less subject to the derivative market fluctuations.

The discussions about the introduction of this ban started in the spring of 2010, when Greek crisis started and CDS prices, written on Hellenic Republic, reached unprecedented levels. The timeline of the events, until the entry into force of the ban, is the following: on June 15th 2010, for the first time, the EU Parliament calls for a permanent ban on naked SCDS; on September 15th 2010, the EU Commission tables a draft Regulation on the transparency in short selling and SCDS buying[4]; on December 7th 2010, the European Council starts to discuss the draft regulation[5]; on May 17th 2011, The European Council agrees to ban temporary uncovered short selling of bonds and on naked CDS buying; on 15th November 2011, the European Parliament adopts the draft regulation during a Plenary session; on 14th March 2012, the European Parliament and the European Council approve the final version of the Regulation[6] on naked CDS and bonds short selling.

The regulation is composed by nine chapters and 48 articles. The third chapter contains the gist of the trading activities restrictions: Art. 13 explains the ban on uncovered short sales in sovereign debt and Art. 14 on uncovered sovereign CDS. In the case of bond's short selling restriction, the regulation, that is applied to debt issued by all 30 EEA Countries, including their agencies and their regional, local, and municipal governments, allows a person, that short sells a sovereign security, to do it if: he has borrowed the securities, he has entered into an agreement to borrow the securities, he has an arrangement with a third party under which the latter has confirmed that the security has been located and has taken measures so that the person has a reasonable expectation that settlement can be effected when due. Thus, the EU Authorities require that the investor, that short sales, has a reasonable expectation

[4]Source: http://europa.eu/rapid/press-release_IP-10-1126_en.htm?locale=en .

[5]There was not unanimous consensus on the regulation effectiveness and importance. Moreover, the competences, distributed among European Institutions, were under discussion.

[6]Regulation (UE) n. 236/20120 of the European Parliament and of the Council on short selling and certain aspects of credit default swaps.

to own the availability of security to maturity. Moreover, according to the norm, there is the possibility to suspend these constraints if liquidity conditions reach a certain minimum threshold, below which the costs on market efficiency would be excessive.

The naked SCDS ban, that is applied to all market participants, including those outside the EEA, allows the investors to buy protection referencing EEA sovereign debt only if they hold the issuer's debt or if they have exposures that are "meaningfully" correlated with the sovereign reference entity. Also in this case, there is the possibility for the authorities to suspend this restriction in limited and renewable time windows. To meet the "correlation" exemption, the hedged exposure must be referred to an entity in the same Country, and the amount of protection bought must be proportional to the delta-adjusted size of the exposure. As IMF (2013, p. 16) has explained, the correlation criteria can be satisfied by a quantitative or qualitative test or by an analytic proof (e.g., by showing that the exposure is to an entity whose fortunes are significantly dependent on the relevant sovereign). The quantitative test is satisfied if the adjusted Pearson's correlation coefficient between the value of the exposure and the referenced sovereign debt over the previous 12 months is at least 70%. The exemptions are collected in the two articles 16 and 17. Transactions that do not meet these constraints are permitted only if they are related to market-making activities and primary-dealer operations. This choice is due, as in the case of suspensions, to prevent a dramatic fall in the liquidity conditions of the cash and derivative products. As explained in the previous paragraph, a decision to prevent market makers from operating freely on the CDS market, would provoke strong inefficiencies on derivative products, raising their price and decreasing liquidity. The result would have been a static market, very inefficient.

In next paragraphs, results from the empirical analysis are shown.

2.6.2 The ban's effect on the determinants

The analysis is carried out through two modified versions of the standard panel regression models defined in equation 2.1. In the first version, we add an additive dummy D_{it} to the basic models. The dummy D_{it} assumes value 1 for observations after November 2012, the entry into force of the new legislation.

$$Y_{it} = a_0 + \lambda_1(D_{it}) + \sum_{j=1}^{11} \beta_j X_{it} + \alpha_i + d_t + \varepsilon_{it} \tag{2.4}$$

In the second modified version, we employ the dummy in a multiplicative way in order to estimate the contribution in determining the impact of the new regulation on each driver in the sovereign credit risk pricing:

$$Y_{it} = a_0 + \sum_{j=1}^{11} \beta_j X_{it} + \sum_{j=1}^{11} \gamma_j (D_{it} X_{it}) + \alpha_i + d_t + \varepsilon_{it} \tag{2.5}$$

As in the previous section, we estimate models on the three dependent variables: *bond spread*, *CDS spread* and *basis*. Regression results are shown in Table 2.5. Starting from the first modified model, important results derive from the estimated coefficients of the dummy variable on the three specifications. As one could expect, the entry into force of the ban has influenced negatively the CDS premia and positively the bond spread: the ban, *ceteris paribus*, has limited the speculative activity of buyers of naked-CDS (a lower buying activity causes a reduction of the credit risk price) and probably has moved this activity on the cash market, that causes higher bond spreads. These results are in line with predictions of Capponi and Larsson (2013). In their model, they find the ban should only exclude the market moderately pessimistic investors and it induces the most pessimistic to implement their strategy on the short side of the bond market. Lastly, the combination of these effects determines a negative impact on the basis.

Looking at the results of the second model, in the case of the bond specification, the introduction of the ban strengths the link with microstructure liquidity, brings out the negative relation with risk-free rate and the positive effect with inflation expectations (in line with the expected relation for an asset typically used by investors for carry trades[7]) and reinforces the link with the fiscal dynamic, that seems not to be priced in period of financial and sovereign debt crises. At the same time, the most important result from the CDS specification is the strong and positive relation that has emerged with the CDS net volume after November 2012. The higher the net open positions on CDS, the higher premium an investor pays in order to hedge its sovereign credit exposure. This relation did not exist in the previous period, indicating that the ban on naked CDS helps to link the net demand of protection, without the speculative component, with the correspondent price. The results from the basis specification confirm those got from the previous section and it represents the combination

[7] A trading strategy that involves borrowing at a low interest rate and investing in an asset that provides a higher rate of return. Typically, the borrowing cost is linked to risk-free rate and to inflation expectations.

	(2)			(3)					
	Bond	CDS	Basis	Bond		CDS		Basis	
				Ban=0	Ban=1	Ban=0	Ban=1	Ban=0	Ban=1
Liquidity	1.129***	0.078		1.036***	0.538**	0.031	-0.080		
	(0.066)	*(0.055)*		*(0.082)*	*(0.182)*	*(0.032)*	*(0.059)*		
Euribor 3m	0.357	1.084*	0.426***	-0.149	-1.336**	0.709**	-2.741*	0.274***	-0.226
	(0.243)	(0.516)	(0.114)	(0.115)	(0.475)	(0.307)	(1.391)	(0.056)	(0.255)
International risk aversion	-0.089***	-0.105*	-0.030**	0.015	-0.021	-0.187*	0.188*	-0.0887***	0.0839***
	(0.024)	(0.047)	(0.010)	(0.024)	(0.033)	(0.091)	(0.097)	(0.023)	(0.022)
Idiosyncratic vol	0.042**	0.017	-0.001	0.042**	0.009	0.032**	-0.003	0.003	-0.011
	(0.014)	(0.021)	(0.006)	(0.016)	(0.016)	(0.011)	(0.050)	(0.006)	(0.007)
Evz	-0.194**	-0.399*	-0.085***	0.035	-0.101	-0.015	0.012	0.027**	0.004
	(0.063)	(0.182)	(0.024)	(0.031)	(0.061)	(0.017)	(0.040)	(0.009)	(0.010)
Counterparty risk proxy	0.675**	0.912**	0.208***	-0.313*	0.927**	0.234	0.135	0.135*	-0.232
	(0.265)	(0.403)	(0.050)	(0.141)	(0.313)	(0.249)	(0.564)	(0.069)	(0.170)
Debtp Gdp	0.003	0.021	-0.012***	0.017	0.000	0.048*	-0.023	-0.007***	-0.004
	(0.012)	(0.012)	(0.002)	(0.010)	(0.006)	(0.022)	(0.015)	(0.002)	(0.003)
Gdp growth	-0.215**	-0.501*	-0.025	-0.086	-0.363***	-0.155	-0.356	0.048**	0.041
	(0.070)	(0.260)	(0.020)	(0.095)	(0.078)	(0.230)	(0.239)	(0.018)	(0.038)
Inflation expectations	0.265*	-0.574**	-0.359***	-0.313	0.794*	-0.167	0.437	-0.119	0.079
	(0.142)	(0.206)	(0.050)	(0.235)	(0.364)	(0.275)	(0.350)	(0.071)	(0.059)
Cds net volume dynamic	4.800*	0.917	-0.015	0.610	6.481	-4.299	27.910**	-0.539	4.534
	(2.598)	(4.860)	(1.007)	(2.209)	(7.949)	(4.242)	(10.310)	(0.693)	(2.839)
Repo	-4.313***		0.098	-4.738***	-0.933			0.153	-3.474***
	(0.649)		(0.366)	(0.772)	(3.677)			(0.265)	(0.797)
Dummy Ban	1.050**	-1.055**	-0.463***						
	(0.353)	(0.419)	(0.109)						
Constant	-1.577	3.399**	3.246***	0.220	-2.806	-2.781	-0.392	0.493	0.334
	(0.981)	(1.324)	(0.462)	(1.084)	(1.668)	(2.158)	(2.594)	(0.510)	(0.697)
Observations	800	800	800	800		800		800	
Adjusted R^2	0.746	0.475	0.724	0.759		0.550		0.653	

Table 2.5: **The role of European restrictions on naked-CDS and bonds' short-selling**. The table presents the results from panel regression defined in models 2.4 and 2.5, where the dummy variable assumes value 1 for observations after November 2012. Under each coefficient, robust standard errors to heteroskedasticity and within-panel correlation in the idiosyncratic error term are reported. The dependent variables are *bond spread*, *CDS spread* and the *basis*.

of the results got from bond and CDS specifications.

2.6.3 The price discovery of sovereign credit risk

The second part of the analysis concerns the study of the evolution during these years of the cointegration of the two markets and the contribution in the price discovery process of credit risk. Developing an analysis separately for each country and splitting the time span in several periods, different results could be found among units. Differently from previous studies (Palladini (2012), Carboni (2011), Fontana and Scheicher (2010), Alper et al. (2013)) in this section we split our very long period in three different sub-periods in order to investigate whether the European ban has affected in some ways the links between the two assets.

We follow the procedure described in section 2.4. The three periods are defined as: a) the financial crisis post Lehman default from September 2008 to May 2010, b) the European sovereign debt crisis before introduction of the EU ban from June 2010 to October 2012, c) the normalization period from November 2012 to June 2015.

The first step of the analysis is the study of cointegration of the two markets (the preliminary check on the stationarity condition are shown in Appendix .2.1). It is carried out through the Johansen procedure. In Table 2.6, the cointegration analysis for each country is summarized.

Table 2.6 shows the trace statistic of Johansen test, depending on the specification used. In the last column the logic output is reported. The final output is determined following the steps described in section 2.4.2.

From the output analysis, the main results in the three different periods could be summarized as follow. In the first period, according to the main findings in the previous literature, we have found that the majority of peripheral countries (italy, Spain and Portugal) and some core countries (the Netherlands, Finland and Austria) had the two markets cointegrated. In the Germany, France and Belgium cases we accept the null hypothesis of no-cointegration. However, it could suggest that there were some differences between core and peripheral countries since the evidence that the two markets move together is more evident in the weak countries group. In the second period, the cointegration condition was lost. Only Germany and Finland show the two markets in the long-run equilibrium. Other countries have not

Country	Period	Model 1		Model 2		Cointegration
		rank=0	rank=1	rank=0	rank=1	
Italy	I	19.76	6.68	17.42	6.64	Y
	II	14.86	3.04	14.04	2.76	N
	III	9.53	3.22	7.01	2.72	N
Spain	I	19.2	1.18	15.59	0.11	Y
	II	9.24	3.83	8.08	2.79	N
	III	11.84	3.99	7.82	3.45	N
Germany	I	16.83	3.74	15.38	3.72	N
	II	28.13	2.55	28.05	2.54	Y
	III	8.64	1.12	8.07	0.55	N
France	I	14.57	1.68	12.17	1.35	N
	II	11.39	1.1	11.19	1.06	N
	III	9.89	2.48	8.79	1.39	N
Portugal	I	18.01	1.3	14.15	0.47	Y
	II	7.07	1.42	5.66	1.31	N
	III	17.69	6.06	14.28	4.21	Y
The Netherlands	I	18.38	3.33	17.93	3.33	Y
	II	16.7	1.88	16.68	1.87	N
	III	8.85	1.17	7.84	0.26	N
Austria	I	23.75	5.74	23.35	5.56	Y
	II	15.58	1.25	15.43	1.11	N
	III	10.11	3.32	9.83	3.07	N
Belgium	I	14.82	1.97	12.61	0.39	N
	II	14.48	1.77	10.39	0.77	N
	III	6.13	2.42	4.49	1.62	N
Finland	I	20.14	3.86	20.77	4.71	Y
	II	18.03	2.13	18.00	2.10	Y
	III	8.64	2.45	6.37	1.72	N
Ireland	I	18.97	8.39	17.60	8.16	N
	II	10.83	4.34	10.69	4.33	N
	III	18.50	7.15	13.55	3.16	N

Table 2.6: **Cointegration analysis**. This table presents the trace statistic of Johansen test on two different specifications of an ECM. It could be represented as: $\Delta y_t = \alpha(\beta y_{t-1} + \mu + \rho t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \gamma + \tau t + \varepsilon_t$, where μ and ρt are the constant term and the trend in the cointegrating vector, γ and τt are the constant term and the trend in ECM. Posing restrictions on these terms, it is possible to define different specifications. In particular, Model 1 has the following restrictions: $\rho = 0, \tau = 0$ and $\gamma = 0$. Model 2 has the following restriction: $\rho = 0$ and $\tau = 0$. For each model, the first column provides the statistic with the null hypothesis of no cointegration (that is the cointegrating vector has rank equal zero). The second column shows the statistic with the null hypothesis of cointegration (that is the cointegrating vector has rank equal one). For model 1, the 10% critical values are for rank=0 17,85, for rank=1 7,52. For model 2, the 10% critical values are 13,33 for rank=0 and 2,69 for rank=1.

cointegration evidences. In particular, in the peripherals case, the long-run equilibrium does not hold clearly, signaling that an unstable relation exists between the two markets. In the last period considered, excepting Portugal, the whole sample continues to show signs of no cointegration. The entry into force of the EU ban seems not to affect the long-run equilibrium condition between the two markets.

Country	Period	Coint.	Test Price Discovery		Output
			H0: Bond does not lead (p value)	**H0: CDS does not lead (p value)**	
	I	Yes	0.147	0.001	CDS
Italy	II	No	0.384	0.007	CDS
	III	No	0.001	0.489	Bond
	I	Yes	0.217	0.001	CDS
Spain	II	No	0.001	0.489	Bond
	III	No	0.001	0.263	Bond
	I	No	0.018	0.096	Bond and CDS
Germany	II	Yes	0.001	0.081	Bond
	III	No	0.021	0.839	Bond
	I	No	0.023	0.208	Bond
France	II	No	0.001	0.001	Bond and CDS
	III	No	0.013	0.318	Bond
	I	Yes	0.099	0.001	CDS
Portugal	II	No	0.006	0.001	Bond and CDS
	III	Yes	0.271	0.108	Bond and CDS
	I	Yes	0.020	0.001	CDS
The Netherlands	II	No	0.006	0.024	Bond and CDS
	III	No	0.048	0.086	Bond
	I	Yes	0.952	0.001	CDS
Austria	II	No	0.024	0.043	Bond and CDS
	III	No	0.255	0.689	-
	I	No	0.006	0.001	Bond and CDS
Belgium	II	No	0.008	0.043	Bond and CDS
	III	No	0.409	0.180	-
	I	Yes	0.137	0.001	CDS
Finland	II	Yes	0.893	0.001	CDS
	III	No	0.422	0.959	-
	I	No	0.062	0.001	Bond and CDS
Ireland	II	No	0.001	0.199	Bond
	III	No	0.004	0.021	Bond and CDS

Table 2.7: **Price discovery outcome**. The table presents the *p-values* of two null hypotheses: I) *bond spread does not lead price discovery* (the first column); II) *CDS spread does not lead price discovery* (the second column). The test is performed separately for each country in the sample and in three different subperiods (I period: September 2008 - May 2010. II period: June 2010 - October 2012. III period: November 2012 - June 2015).

About price discovery analysis, presented in Table 2.7, other important results emerge. During periods I and II, CDS had a leading role in creditworthiness price discovery. In the first period, the null hypothesis of *CDS no role* is rejected in nine countries. In the second period, CDS contributes in the credit risk pricing in seven countries. Conversely, the contribution of bond spread seems to be limited. During the hardest part of sovereign debt crisis (second period), only in Spain, Ireland and Germany, the cash market led price discovery without CDS interference. Looking at the third period, after the introduction of the European ban, in the whole sample the cash became the leading instrument in signaling the reference entity credit risk while CDS lose (except in Portugal and Ireland cases) its relevant role.

To summarize, it is possible to conclude that there have been three phenomena during the entire time span considered: I) before the spring 2010, during the international financial crisis, the peripherals CDS market assumed a leading role in the credit risk pricing; II) during European debt crisis, CDS market contributed significantly in the price discovery; III) after 2012, the government bond supremacy has been reestablished.

2.6.4 Panel var analysis

Lastly, we conclude the analysis verifying whether any relevant differences exist in the dynamic panel var estimations if these are computed on two period subsamples: before and post entry into force of the ban on *naked CDS*.

The results of regressions of the pre-ban period are quite different to those obtained from the specification based on the entire period of section 2.5 and from those of the post-ban's entry into force. The pre-ban period shows the same relation and magnitude between the counterparty risk and repo specialness with the government bond spread. However, differently from other models, the pre-ban estimates also highlight a strong relation between the risk of default of global investment banks and CDS spread. This relation, as economic theory would suggest, is stronger than that with the cash spread (-0.433 vs -0.240). A second important difference is related to the significance of the uncertainty about the currency. Also in this case the impact is higher for the pricing of credit risk through CDS spread since this asset is idiosyncratically exposed to the currency volatility. Looking at the estimates of the post-entry into force ban, these highlight weaker links between the selected drivers set and our endogenous variables, in particular in the case of CDS specification. It is interesting to note the negative and significant relation that appears in this period between the cash spread and the international risk aversion. It means that, after the entry into force of the ban on short selling, the whole sector of European government bonds are employed by investors as a risk-less asset.

Figure 2.2 shows the cross IRFs between bond and CDS spread estimated separately in the two sub-periods. Firstly, the results got from this analysis is very similar to those got in the section 2.5. As a matter of fact, we find that in both sub-periods, only the bond spread determine a relevant lagged impact on the CDS variable. In this sense the entry into force of the ban seems to not affect the relation between CDS and bond spread. Secondly, the sub-periods analysis highlights a stronger impact of bond spread on CDS before November 2012. In the first period, a shock of 1% in the cash spread immediately increases the level of the CDS spread of almost 0.50 basis points and this impact becomes statistically neglectable after the third period. In the second period the relation is weaker: the impact is near 0.15 basis points meanwhile, as in the first period, it persists up to the third lag.

Pre naked CDS ban | Post naked CDS ban

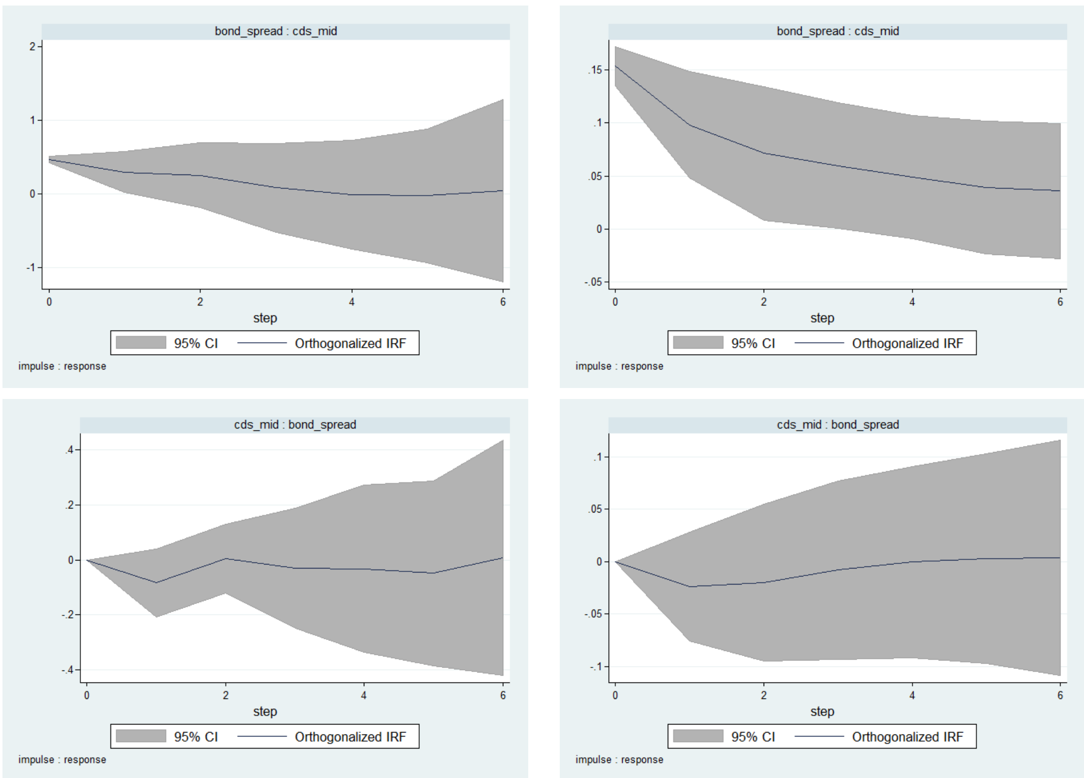

Figure 2.2: Impulse Response Fuction - Panel Var. Pre and post Ban

	Before naked CDS Ban		(Post naked CDS Ban)	
	Bond Spread	Cds Spread	Bond Spread	Cds Spread
Bond spread (L1)	0.968***	0.244	1.009***	0.754
	0.155	0.222	0.376	1.119
CDS Spread (L1)	0.063	0.876***	-0.159	0.033
	0.074	0.092	0.425	1.276
Liquidity	0.015	0.078	0.106	0.069
	0.163	0.235	0.188	0.168
Euribor 3m	-0.137	-0.077	-0.422	1.106
	0.165	0.278	1.056	3.380
International risk aversion	0.028	0.021	-0.022**	-0.011
	0.040	0.064	0.009	0.025
Idiosyncratic vol	0.005	0.002	0.003	-0.016
	0.006	0.009	0.017	0.051
Evz	0.062*	0.098*	-0.008	0.042
	0.032	0.053	0.039	0.109
Counterparty risk proxy	-0.240***	-0.433***	0.141	0.792
	0.082	0.117	0.399	1.315
Debt Gdp	0.005	0.009	-0.001	-0.012
	0.012	0.019	0.010	0.030
Gdp growth	-0.062	-0.102	0.036	0.269
	0.088	0.141	0.148	0.460
Inflation expectations	0.096	0.144	0.122	0.135
	0.195	0.313	0.078	0.253
Cds net volume dynamic	-1.651	-2.689	-0.507	-0.345
	2.250	3.523	1.875	0.578
Repo	-1.186**	-1.398	-1.422*	-1.034
	0.596	1.218	0.741	6.277
Observations	470		300	
Adjusted R^2	0.793		0.846	

Table 2.8: **Panel Var model**. The table presents the results from panel var regression defined in equation 2.3. Under each coefficient, robust standard errors are reported.

2.7 Concluding remarks

This research has studied some aspects of CDS and government bond, on which an econometric analysis has been proposed in order to analyze the relations and the pricing equilibrium between the two markets in a sample of Eurozone countries. The results are partly consistent with the previous literature, but they also contribute to highlight some new features on the relation between these two assets.

We show that the relevant drivers' sets in defining CDS and bond prices are partially different and they seem to be complementary. This difference is also clear if the core and peripheral countries are analyzed separately. According to previous literature, phenomena of *flight to liquidity* and *flight to quality* have been observed in the results of our models. These results are confirmed by the estimates of a dynamic panel model.

With regards to price discovery process, in last years strong heterogeneity among Eurozone countries exists. Until 2012 in Italy, Spain and Portugal, credit risk pricing seems to take place in the derivative market. Conversely, during the 2010-2012 period in Germany and France cases the bond market had the leading role. This result is crucial for the European economic policy. As a matter of fact, if the bond market is driven by the CDS, which is driven by factors not exclusively related to the creditworthiness conditions of the sovereign reference entity, then CDS price dynamic could affect the sovereign financing costs and this is not bearable for weak countries.

The European legislative intervention, which has prohibited the naked CDS purchase and bond's short selling, has helped restore a more stable relationship between CDS and government bonds. In the peripherals countries, it is clear that the bond market returned to be the lead market during and after the spring of 2012. In that period, the Eurozone has been politically and economically eventful. In particular, on 26 July 2012, Mario Draghi established that the ECB was ready to guarantee as lender of last resort the Eurozone and, on 6 September 2012, the ECB approved the rules for the purchases on the secondary market of government bonds with a maximum maturity of three years (OMT plan). Moreover, on 9 march 2012, Greece announced that its debt restructuring plan was accepted by the large majority of bondholders. The ISDA Committee declared a triggering credit event occurred, but due to technical features in settlement auction, CDS instrument did not fully protect the face value of the originals bonds. Certainly, also these facts affected market participants' confidence in using CDS instrument, limiting its signaling power in sovereign credit risk.

The study suggests that the new EU regulation was a critical aspect to understand what happened during 2012. The summer 2011 was characterized by equally strong pressures on peripherals bonds spreads, but at that time, the bond market suffered from the leading role of the CDS spreads and not vice versa. Thus, the EU regulation has helped reduce the destabilizing role of the CDS, probably shifting part of the investors' activity from CDS to bond and determining a negative impact on the basis.

Now, the question is whether the market participants have come up with another portfolio and trading strategies to hedge sovereign credit risk. One of these strategies involves the use of futures written on government bonds. Trading volume of futures on 10y Italian btps, that has been introduced in the market since 2009, has grown a lot in recent years. An investor, who desires to hedge its risk on Italy, could short a futures. But there is a risk for Italy: among peripheral countries, only the Italian futures, and correspondent options, are traded on the market. For this reason, this instrument may reflect the economic fundamentals of other weak countries, biasing the judgment and the pricing of the Italian fiscal conditions. However, from October 2015, the futures on Spanish bonos have been introduced, limiting this distortion effect. Because of that, futures market is probably the new market on which research works and regulators will have to focus their attention (Pelizzon et al., 2014), however taking care of the strong differences with CDS market (i.e., high level of transparency, different regulatory environment), in order to avoid the destabilization of the European bond market.

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Chapter 3

An analysis of long-term evolution of the Italian government bond wholesale secondary market liquidity

3.1 Introduction

This chapter investigates the evolution of the market liquidity in the Italian platform of MTS markets. The aim of this part of the thesis is to provide a basic description of the institutional features of MTS market (the secondary wholesale platform of Italian government bonds) and a wide analysis of the evolution of the microstructure liquidity conditions of this electronic trading platform. The analysis does not investigate any causal effect of the liquidity conditions with other financial variable, but it is just a wide introduction for the topic of the next chapter.

MTS was introduced in 1988 by the Italian Treasury and it was the first electronic market for government bonds in Europe. In 1997 it was privatized and it began expansion across other public debt issuers. In 1998 MTS became a *Regulated market* owned by the private sector. However, according to several second tier regulations (e.g., Ministry decrees), the set of rules according to which the Italian platform for wholesale trading in government bonds works is laid down by the Italian Treasury, while the supervision is under the control of Bank of Italy and Consob.

Currently MTS Italy is the domestic trading platform of Italian government bonds of

MTS markets. It is defined as a *wholesale* secondary market, implying only banks and institutional intermediaries may be admitted as dealers and participate on their own account (or on behalf of institutional investors but as a direct counterpart). As the other MTS markets, the Italian platform is a quote-driven electronic order book market. It means that participants are divided into two groups, namely: market makers and market takers. The role of market makers is to provide liquidity continuously, quoting two proposals (bid and ask prices) that are aggregated in the order book for each bond. The other participants, acting as price taker, can buy and sell a certain amount of a bond, hitting the proposals with a market order.

As discussed in the previous chapter, the microstructure liquidity is one of the key drivers that affects sovereign bond yield. Solid market structure reduces the liquidity risk for market participants, leading to lower bond yields. The Italian case offers a good case-study to investigate the evolution in the last decade of the liquidity conditions on one of the most important and largest European government bond market. During these years, many factors have potentially affected the market's microstructure: the US and UK financial crises, the European sovereign debt crisis, the deflation and the non-standard monetary policies of ECB and other central banks, new regulatory frameworks for financial markets and banks (e.g., MIFID II). Investigating the evolution of different measures of market liquidity may help to understand which factors have played a relevant role in affecting the market structure and market makers' resiliency.

The remainder of the chapter is organized as follows. The next section presents the dataset and the methodology. Then, empirical results are shown. Lastly, comprehensive comments on the evolution of liquidity conditions are presented.

3.2 Methodology and data

This section provides some technical notes about methodology and data employed in the analysis. In order to investigate different dimensions of the market liquidity (quoting, trading, market makers' resiliency), we propose an analysis on six liquidity measures that are commonly used by academics and practitioners. The analysis has been conducted on several other liquidity measures, but we have selected those more informative. In appendix .4.2 the analysis on the whole set of measures is presented. For an interesting review of liquidity measures on MTS for the Italian government bonds see Coluzzi et al. (2008). In their paper, they also discuss the link between each measure with the theoretical market structure model. In order to link our sample of liquidity measures with the theoretical framework, in paragraph 3.2.1 we introduce each measure with a discussion about its contribution in rapresenting some specific features of the microstructural liquidity. However, the large set of measures on a unique dataset provides a complete view of the market structure, market makers' preferences and price takers' behaviors.

Our dataset covers both trading and quoting activity on MTS Italy in the period that runs from February 1, 2006 to April 30, 2017. For the trading side, it covers all the transactions on the MTS platform of each trading day on the BTP 10 year benchmark. The informations available for each deal include the sign, the time, the price and the traded quantity. About the quoting activity, the dataset contains all the snapshots between 9.00am and 5.00pm at a five-minute frequency of the quoting book of the BTP 10 year benchmark. In our analysis, the benchmark contract corresponds with the BTP on-the-run[1] from the settlement date of the second auction (in order to consider only bonds with a large enough outstanding volume).

Before computing liquidity measures, a filter to the quoting dataset has been applied in order to exclude outliers and stub quotes[2]. For each snapshot and for each market side (bid and ask) the first step is to exclude quotes far more than 200 tick prices from the best price. Secondly, the Thompson's Tau method is applied on quotes on an hourly basis, in order to aggregate a larger number of observations (quotes of twelve snapshots) and to improve test precision. Stub quotes cover the 0.08% of the dataset.

As mentioned above, six liquidity measures are computed. The measures employed in the analysis of the quoting activity describe the evolution of different dimensions of market liquidity, namely: *tightness* that measures how far transaction prices diverge from mid-market prices; *depth* that is the quantity available for trade on each side of the book; *breadth* that indicates how wide the order book is. These measures are computed for each snapshot of the sample and then are aggregated on a daily basis. Appendix .4.1 shows the details of data manipulation in order to get daily time-series. Looking at the trading, the analysis investigates the *investors' activity* through measures on traded volumes and on block trades, defined as trades that has the original order greater than a threshold (in this case, 15mm). Lastly, *resiliency* provides a measure of how much prices move in response to a trade. In

[1] It is the most recently issued BTP of a particular maturity. The opposite is off-the-run, which refers to a bond that has been issued before the most recent issue and are still outstanding.

[2] Order placed well off the range where the fair market price is likely to lie.

order to investigate this dimension, we employ measures on the price impact of block trades. For trading and resiliency measures, the daily series are computed (see appendix .4.1 for details about data manipulation).

In order to analyze the evolution of the market microstructure, the Bai and Perron test (Bai and Perron 1998, 2003) is employed on each liquidity measure. This test allows us to verify whether and when a structural change occurred on the time series. The underlying assumption of this test is that the level of liquidity fluctuates around a stable mean in absence of structural changes. If a structural change shifts the long-run mean towards a different level, this test detects the dates when the changes occur. The advantage of this test is that it does not require *a priori* knowledge of the number and the timing of the breaks.

In next section, the results of test applied to the six liquidity measures are presented. For each measure, the name, the definition, the graphical outcome and the identified breaks are shown. Each graph shows the liquidity measure (blue line) and the output of Bai and Perron test (red line): the horizontal segment is the estimated mean for each sub-period, jumps of red line identify structural breaks. The break dates are estimated by the Bai and Perron approach with 5 percent significance level and are also shown in each table.

The test is applied on the entire sample and on three different sub-periods: Jan 2006 - Apr 2010, the US and UK financial crises; May 2010 - Dec 2012, the European sovereign debt crisis; Jan 2012 - Apr 2017, the normalization period. In each figure, four dates are highlighted through vertical green lines: September 15th, 2008, the Lehman default; April 27th, 2010, Standard & Poor's downgrades Greek bonds to *junk* bonds; July 26th, 2012, *whatever it takes* Draghi's speech; March 9th, 2015, ECB's public sector purchase programme starts. The results got from the empirical analysis are shown in section 3.3. In the last section, comprehensive comments are presented.

3.2.1 Liquidity measures of a *pure specialist* limit order book.

As said before, MTS is a wholesale inter-dealer market, implying that individuals cannot access to it. Market participants can be distinguished into two categories: market makers (or *specialists*) and market takers. For each bond, the former quote continuously and immediately executable two proposals: the bid price (and quantity) on which market takers may sell a certain amount of bond and the ask price (and quantity) on which market participants may buy the bond. The quoting book of each bond is the aggregation of the proposals of each specialist. Figure 3.1 shows how the aggregation works. The first figure shows the quoting book with the proposals of a single market maker: a bid proposal of 5 millions (mm) at 99.90 and an ask proposal of 8mm at 100.10. Since these are the unique proposals in the book, these are the best prices available for the investors.The second figure shows the quoting book when a new market maker adds her proposals. In this example, she decides to show a bid and ask quotes of 5mm at 99.90 and 100.11, respectively. Lastly, the proposals of the third market maker (bid quote of 5mm at 99.95 and ask quote of 5mm at 100.15) modify the best bid prices since, from the market taker's perspective, it is better to sell at 99.95 than 99.90. When a market participant sends a market order, this is executed according to price priority and time priority. These features of the platform make MTS a limit order book market, under the *specialists* system.

One market maker

Level	Bid		Ask	
	Q_b	P_b	P_a	Q_a
1	5mm	99.90	100.10	8mm
2				
3				
...				

Two market makers

Level	Bid		Ask	
	Q_b	P_b	P_a	Q_a
1	10mm	99.90	100.10	8mm
2			100.11	5mm
3				
...				

Three market makers

Level	Bid		Ask	
	Q_b	P_b	P_a	Q_a
1	5mm	99.95	100.10	8mm
2	10mm	99.90	100.11	5mm
3			100.15	5mm
...				

Figure 3.1: **An example of a quoting book**. The first figure shows the quoting book with the proposals of a single market maker. The second and the third figures show how the aggregation of proposals of multiple market makers works.

These three examples of a quoting book show different conditions of microstructure liquidity. The first book, with the proposals of just one market maker, has a bid-ask spread of 20 price ticks. It means that investors have to pay 10 price ticks, with respect the theoretical mid fair price, in order to execute an order of a limited quantity (5mm or 8mm). Instead, it is quite intuitive that the quoting book with three active market makers shows better microstructure conditions: the best bid-ask spread is reduced to 15 price ticks, the tradable quantities for the final investors are 15mm on the bid side and 18mm on the ask side.

On MTS, during the period of this analysis the number of market makers really active in their quoting activity is close to twenty (Mormando, 2017), this means that the study of the structure of quoting book of MTS is closely linked to the quoting choices of this restricted group of market operators.

Each market maker sets her proposal defining the two prices (P_b and P_a) and the correspondent quantities (Q_b and Q_a). Their quoting decisions is the result of an optimization problem. Their proposals (the combination of P_b, P_a, Q_b and Q_a) should compensate market makers for their immediacy of transaction and for other costs that they implicitly and explicitly face: operation costs, participation costs, transaction costs, asymmetric information, imperfect competition, inventory control costs, funding constraints and search. Vayanos and Wang (2012) provide an exhaustive survey on theoretical work and empirical literature on these imperfections. Among implicit costs, the existing literature extensively studies asymmetric information costs (Copeland and Galai (1983), Glosten and Milgrom (1985), Kyle (1985), Easley and O'Hara (1987), Admati and Pflederer (1988), Foster and Viswanathan (1990)) and inventory control costs (Garman (1976), Stoll (1978), Amihud and Mendelson (1980), Ho and Stoll (1981, 1983)) . Asymmetric information costs arise when some investors are better informed about the true value of the asset. If market makers are not able to distinguish these investors, they set their proposals taking into account the risk of dealing with a better informed investor. The inventory control costs arises when imbalances of buying and selling flows increase. Market maker, setting their quotes, should consider the risk in holding inventory that may deviate from their desired position and causing losses if prices move against. If they already own a significant long (or short) position, they set the bid and ask prices and quantities in order to facilitate the turnover of the position. Lastly, quoted prices and quantities are used as substitutes by market makers: a narrow bid-ask spread induces small depth quotes whereas large depth quotes induce a wide bid-ask spread.

In next section we propose the structural breaks analysis of a restricted group of liquidity measures. The six liquidity measures, we present, are: *volume-weighted bid-ask spread, ratio between the bid (ask) quoted depth on the three best bid (ask prices) and the total quoted quantity, standard deviation of bid (ask) prices, slope of bid (ask) proposals, daily total volume traded, the price impact* of a selling (buying) trade of 15mm on the volume weighted bid (ask) prices after 15 minutes the deal is executed.

Each of these measures has a strict link with the microstructure models. The *volume-weighted bid-ask spread* is a *synthetic* measure of the global bid-ask spread of the quoting book on which twenty operators contemporaneously quote. It measures how wide the bid ask spread is set by operators in order to compensate the risks that they face in the market making activity. The *ratio of the quoted quantities on the three best prices and the total depth* is a simple measure of the amount of available depth for investors to deal on the bond and measures the concentration of market makers' quotes in the top level of the book. The higher is the ratio, the higher is the homogeneity among *specialists* in quoting their proposals in the top prices. The *standard deviation* of the prices is a measure of dispersion and heterogeneity among market makers in valuating the fair price of the bond and in solving their quoting optimization problem. If the standard deviation of prices is zero, it means that all the players quote the same prices, indicating a full agreement about the fundamental value of the asset and the correspondent risks. The *slope* is defined as the ratio between the absolute difference between the best and the worst quotes (on the bid side) and the difference between total depth and best size (on the bid side). Ginebri et al. (2008) explain this measure computes how far from best price a dealer has to depart if he wants to trade 100mm. The smaller the slope, the more liquid the market is. The *daily total volume* highlights the size of the trading activity on the platform. Lastly, the *price impact* is a measure of resiliency of market makers. After an investor sends a market order and fills the proposals on the book, market makers may interpret the market order as an information about the value of the bond (if they believe the filler is an informed trader). The quoting reaction (that is the price impact) highlights the resiliency of market makers in keeping intact the levels of liquidity offered before the deal. The lower the price impact, the higher is the resiliency of *specialists* and the microstructure liquidity. In next section we present the results and comments of our analysis.

3.3 Structural Breaks

3.3.1 Volume weighted bid-ask spread (VWBA)

Dimension: Quoting.

Definition: Difference between volume weighted ask price and volume weighted bid price.

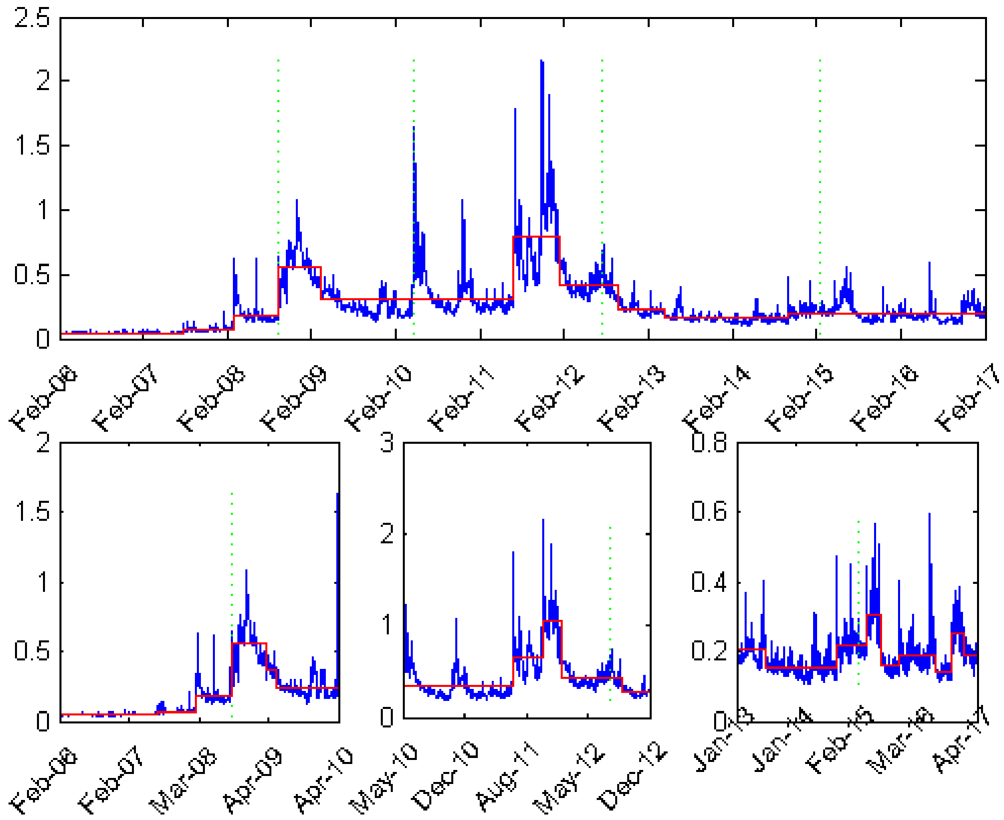

Figure 3.2: Bai and Perron test - Volume weighted bid-ask spread (bps)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Mar-08	Sep-08	Mar-09	Jul-11	Jan-12	Oct-12	Apr-13	Oct-14
I Per	5	Jul-07	Feb-08	Sep-08	Mar-09	May-09				
II Per	4	Jul-11	Nov-11	Jan-12	Sep-12					
III Per	8	Jul-13	Oct-14	May-15	Aug-15	Dec-15	Jul-16	Nov-16	Jan-17	

Table 3.1: Bai and Perron test - Volume weighted bid-ask spread

3.3.2 3 best bid quoted depth (V3B)

Dimension: Quoting.

Definition: Sum of the volumes quoted on the three best bid prices.

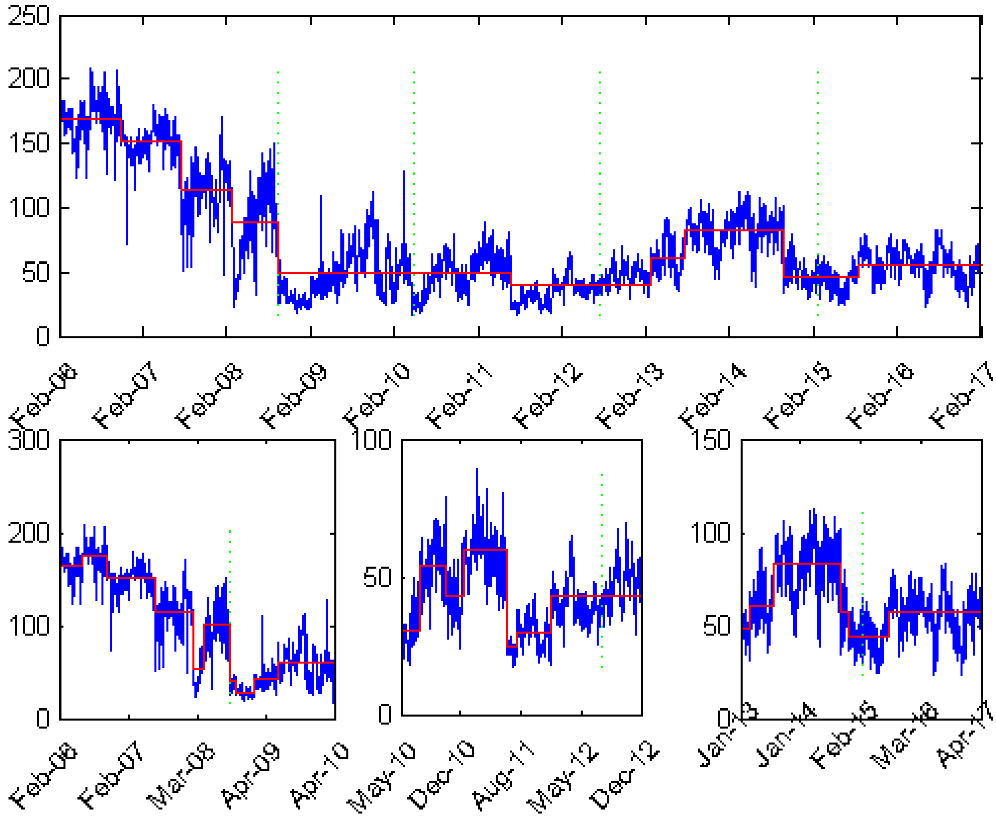

Figure 3.3: Bai and Perron test - 3 best bid quoted depth (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Nov-06	Jul-07	Feb-08	Sep-08	Jul-11	Mar-13	Aug-13	Oct-14	Aug-15
I Per	9	Jun-06	Nov-06	Jul-07	Feb-08	Apr-08	Sep-08	Oct-08	Feb-09	Jun-09
II Per	6	Jul-10	Nov-10	Jan-11	Jul-11	Aug-11	Jan-12			
III Per	5	Mar-13	Aug-13	Oct-14	Dec-14	Aug-15				

Table 3.2: Bai and Perron test - 3 best bid quoted depth

3.3.3 3 best ask quoted depth (V3A)

Dimension: Quoting.

Definition: Sum of the volumes quoted on the three best ask prices.

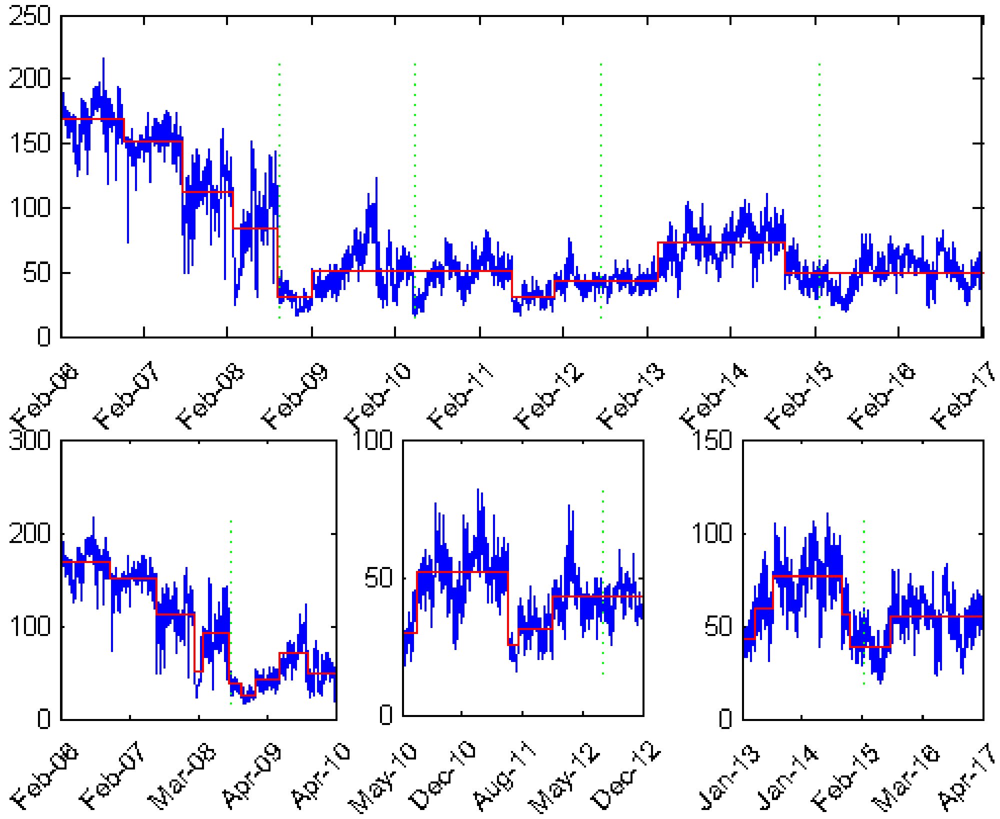

Figure 3.4: Bai and Perron test - 3 best ask quoted depth (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Nov-06	Jul-07	Feb-08	Sep-08	Feb-09	Jul-11	Jan-12	Apr-13	Oct-14
I Per	9	Nov-06	Jul-07	Feb-08	Apr-08	Sep-08	Nov-08	Feb-09	Jun-09	Nov-09
II Per	4	Jun-10	Jul-11	Aug-11	Jan-12					
III Per	5	Apr-13	Jul-13	Oct-14	Dec-14	Aug-15				

Table 3.3: Bai and Perron test - 3 best ask quoted depth

3.3.4 Standard deviation bid prices (SDB)

Dimension: Quoting.

Definition: Standard deviation of bid prices, weighted for correspondent quoted depth.

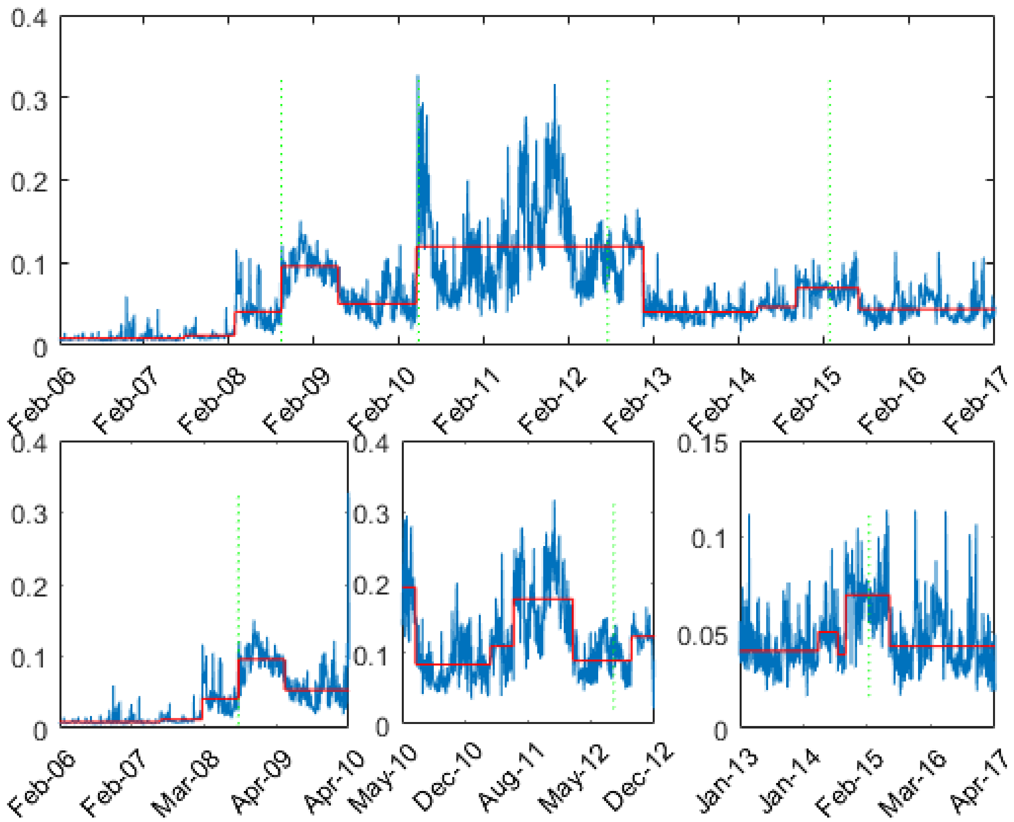

Figure 3.5: Bai and Perron test - Standard deviation bid prices

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Feb-08	Sep-08	May-09	Apr-10	Dec-12	May-14	Oct-14	Jul-15
I Per	4	Jul-07	Mar-08	Sep-08	May-09					
II Per	5	Jun-10	Apr-11	Jul-11	Feb-12	Oct-12				
III Per	4	May-14	Aug-14	Oct-14	Jul-15					

Table 3.4: Bai and Perron test - Standard deviation bid prices

3.3.5 Standard deviation ask prices (SDA)

Dimension: Quoting.

Definition: Standard deviation of ask prices, weighted for correspondent quoted depth.

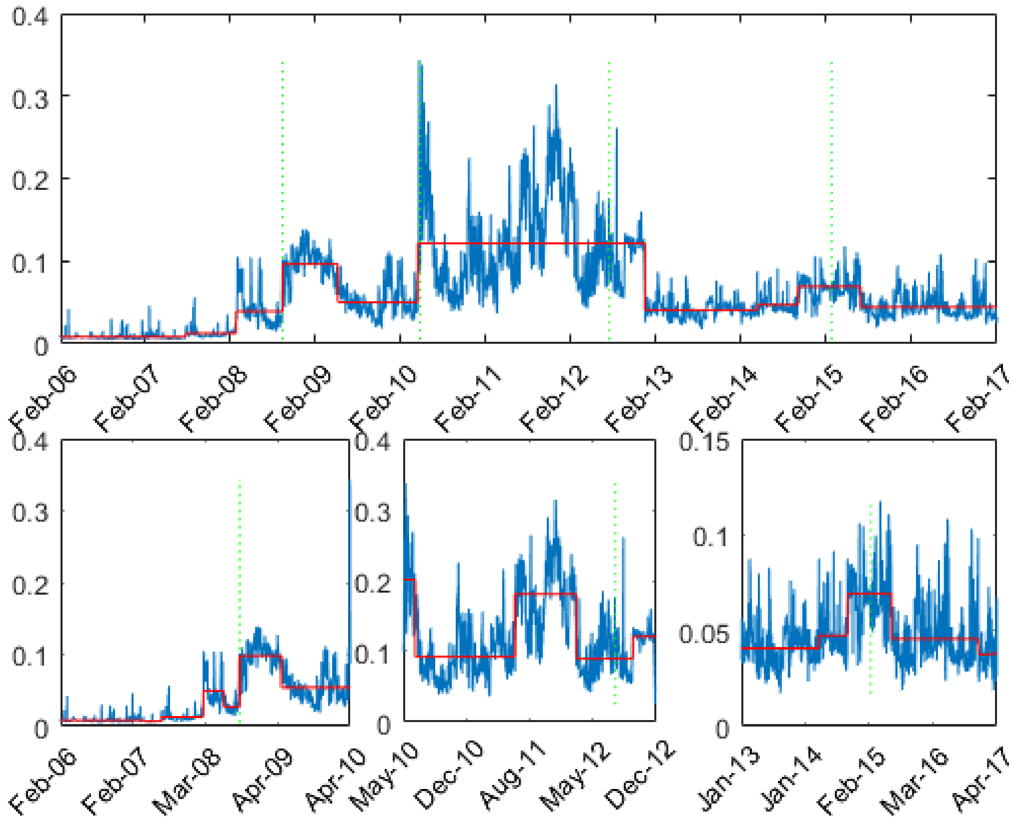

Figure 3.6: Bai and Perron test - Standard deviation ask prices

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Feb-08	Sep-08	May-09	Apr-10	Dec-12	Apr-14	Oct-14	Jul-15
I Per	6	Apr-07	Jul-07	Mar-08	Jun-08	Aug-08	Apr-09			
II Per	4	Jun-10	Jul-11	Feb-12	Oct-12					
III Per	4	Apr-14	Oct-14	Jul-15	Jan-17					

Table 3.5: Bai and Perron test - Standard deviation ask prices

3.3.6 Slope bid (SLB)

Dimension: Quoting.

Definition: Slope is the ratio between the absolute difference between the best and the worst quotes (on the bid side) and the difference between total depth and best size (on the bid side).

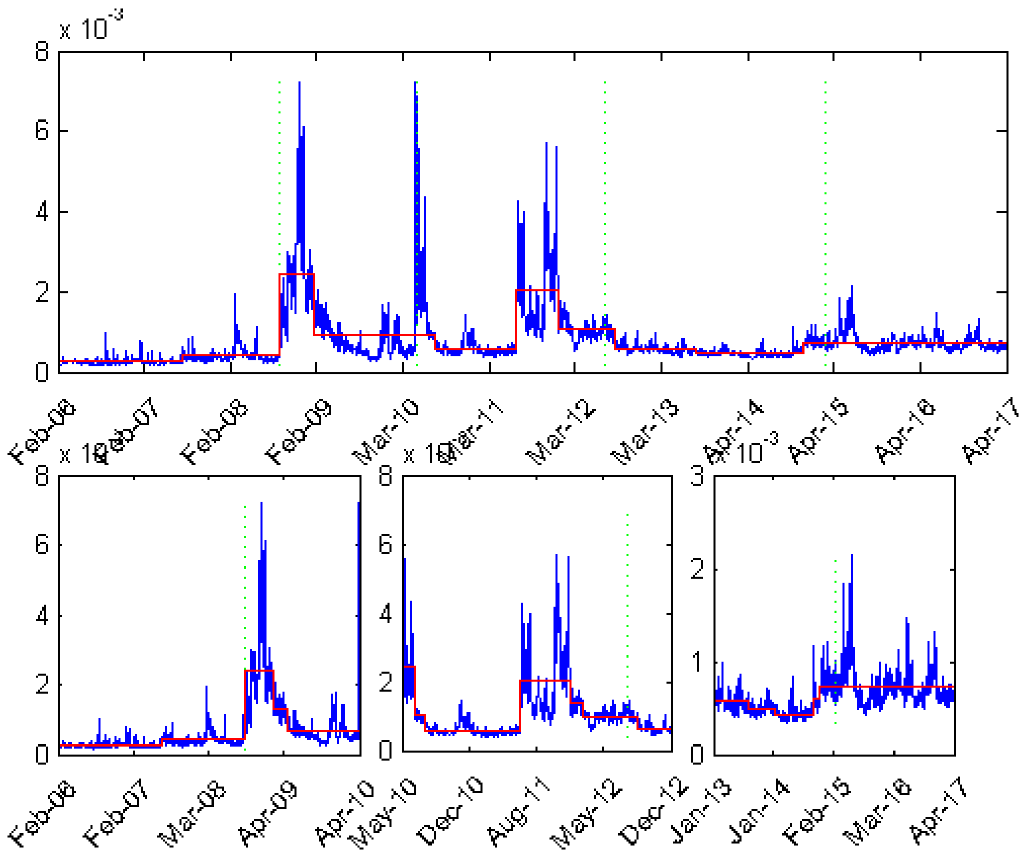

Figure 3.7: Bai and Perron test - Slope bid

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Sep-08	Feb-09	Jul-10	Jul-11	Jan-12	Sep-12	Aug-13	Nov-14
I Per	4	Jul-07	Sep-08	Feb-09	Apr-08					
II Per	6	Jun-10	Jul-10	Jul-11	Jan-12	Feb-12	Sep-12			
III Per	4	Aug-13	Feb-14	Oct-14	Nov-14					

Table 3.6: Bai and Perron test - Slope bid

3.3.7 Slope ask (SLA)

Dimension: Quoting.

Definition: Slope is the ratio between the absolute difference between the best and the worst quotes (on the ask side) and the difference between total depth and best size (on the ask side).

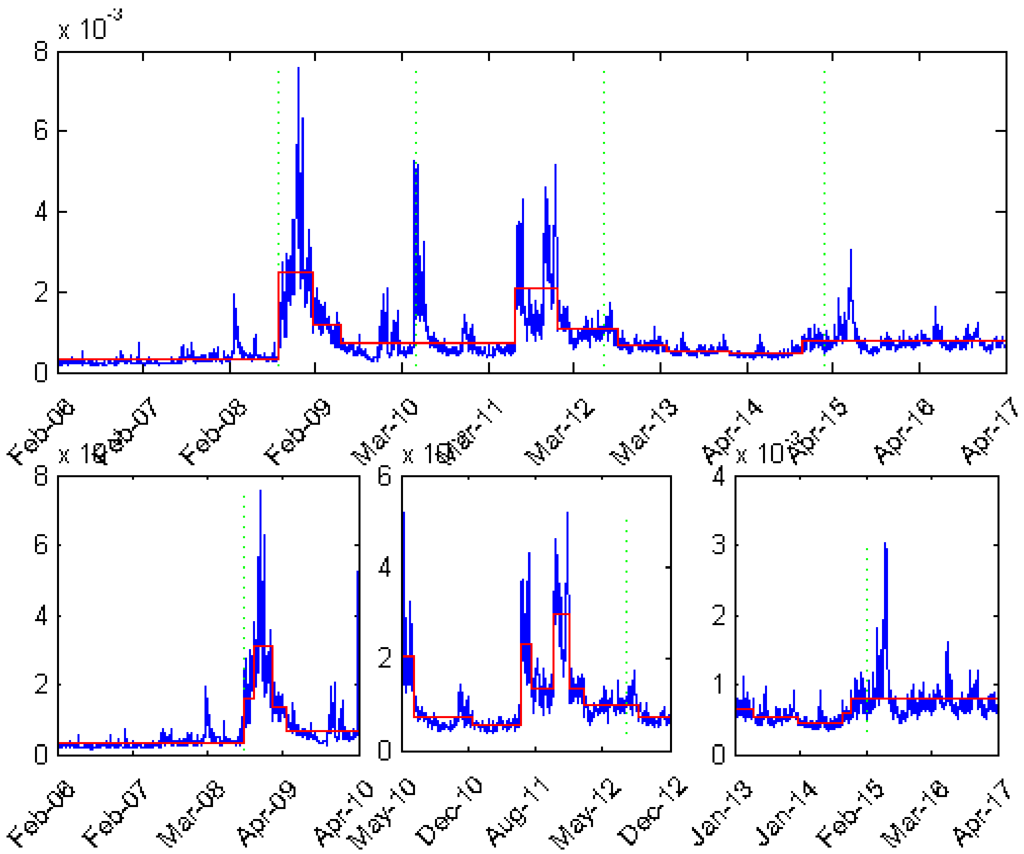

Figure 3.8: Bai and Perron test - Slope ask

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Sep-08	Feb-09	Jun-09	Jul-11	Jan-12	Sep-12	Apr-13	Jan-14	Nov-14
I Per	4	Sep-08	Nov-08	Feb-09	Apr-09					
II Per	8	Jun-10	Jan-11	Jul-11	Aug-11	Nov-11	Jan-12	Feb-12	Sep-12	
III Per	4	Apr-13	Jan-14	Oct-14	Nov-14					

Table 3.7: Bai and Perron test - Slope ask

3.3.8 Total traded volumes (VT)

Dimension: Trading.

Definition: Total trading volumes.

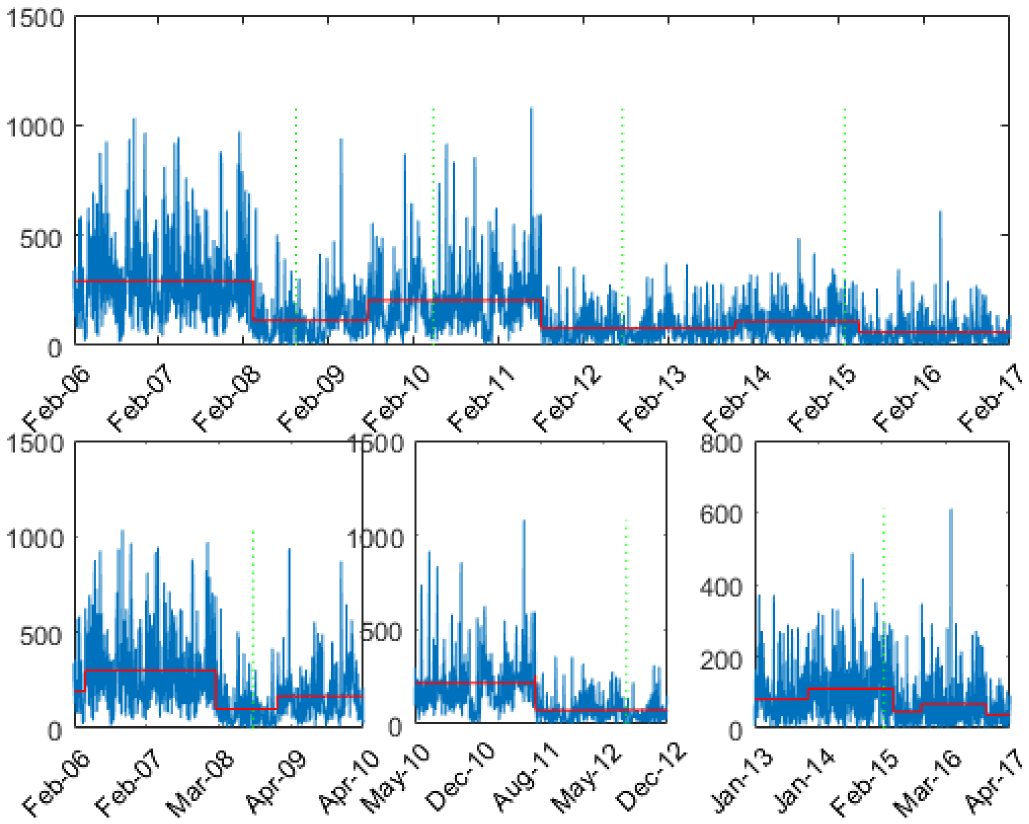

Figure 3.9: Bai and Perron test - Total traded volumes (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	5	Mar-08	Jul-09	Aug-11	Nov-13	May-15				
I Per	3	Apr-06	Feb-08	Jan-09						
II Per	1	Aug-11								
III Per	4	Nov-13	May-15	Oct-15	Nov-16					

Table 3.8: Bai and Perron test - Total traded volumes

3.3.9 Price impact on volume weighted bid (PIVWB)

Dimension: Resiliency.

Definition: Impact of selling trades greater of 15mm on the volume weighted bid prices after 15 minutes the deal execution.

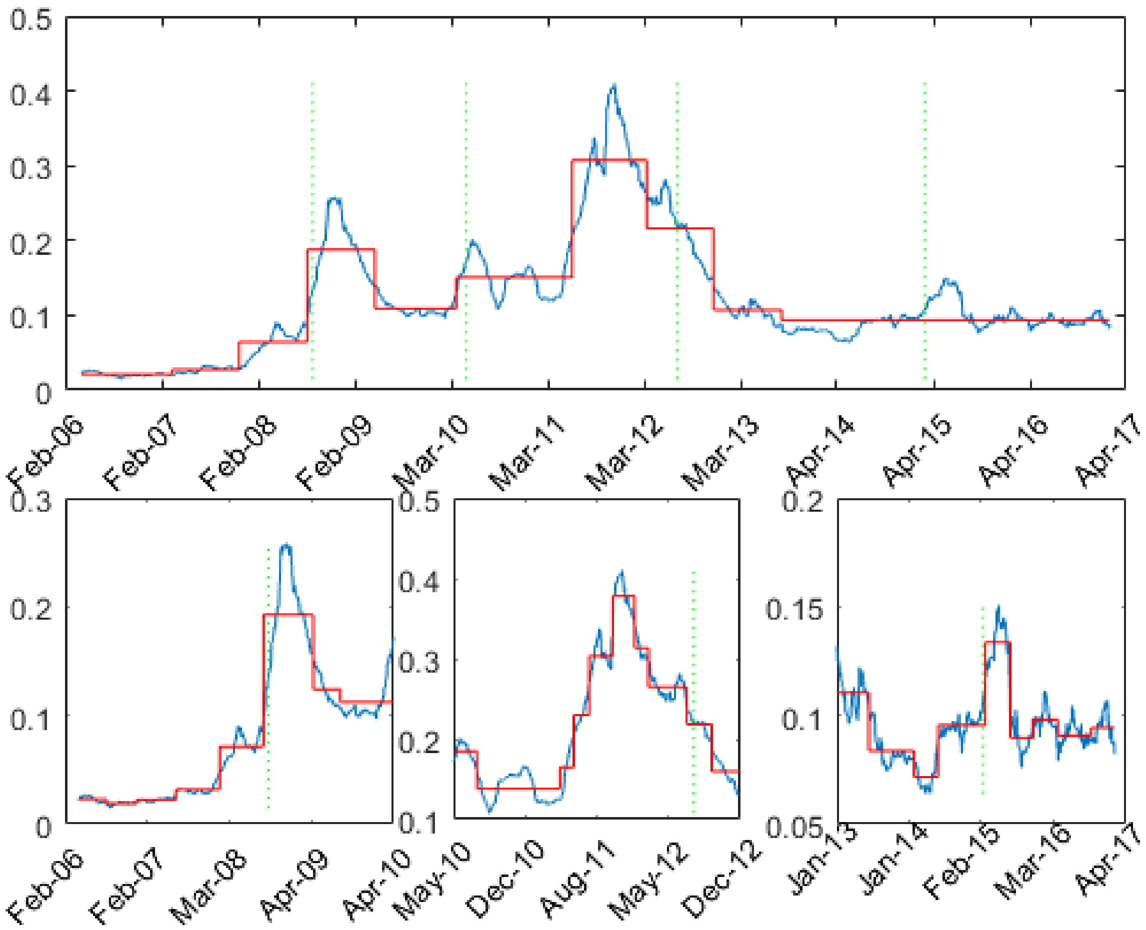

Figure 3.10: Bai and Perron test - Price impact on volume weighted bid (price ticks)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Mar-07	Dec-07	Aug-08	May-09	Mar-10	Jun-11	Mar-12	Dec-12	Sep-13
I Per	7	Aug-06	Jan-07	Jul-07	Jan-08	Aug-08	Apr-09	Aug-09		
II Per	9	Jul-10	Apr-11	Jun-11	Aug-11	Oct-11	Jan-12	Feb-12	Jul-12	Sep-12
III Per	8	Jun-13	Feb-14	Jul-14	Mar-15	Aug-15	Dec-15	Apr-16	Oct-16	

Table 3.9: Bai and Perron test - Price impact on volume weighted bid

3.3.10 Price impact on volume weighted ask (PIVWA)

Dimension: Resiliency.

Definition: Impact of buying trades greater of 15mm on the volume weighted ask prices after 15 minutes the deal execution.

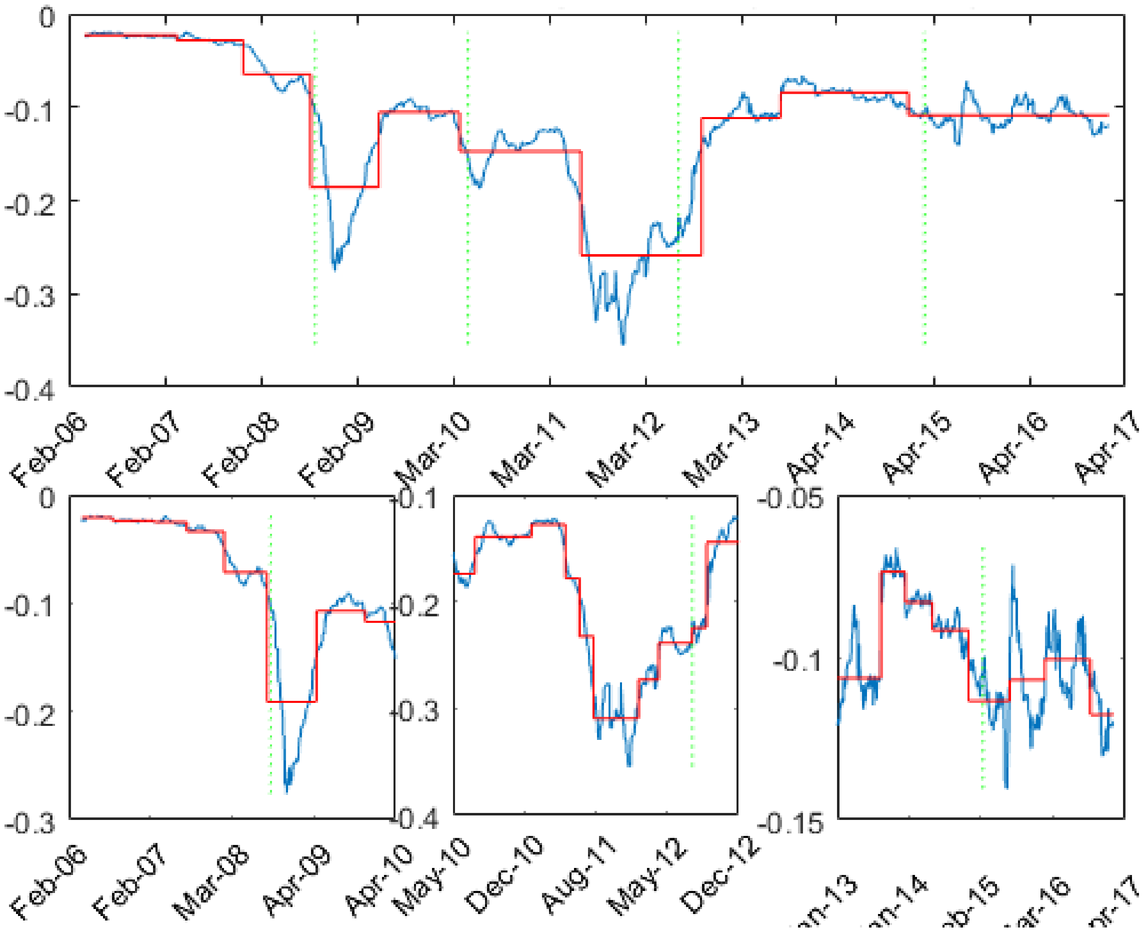

Figure 3.11: Bai and Perron test - Price impact on volume weighted ask (price ticks)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Mar-07	Dec-07	Aug-08	May-09	Mar-10	Jul-11	Oct-12	Aug-13	Jan-15
I Per	7	Aug-06	Mar-07	Aug-07	Feb-08	Aug-08	Jul-09	Dec-09		
II Per	9	Jul-10	Jan-11	May-11	Jul-11	Aug-11	Jan-12	Apr-12	Jul-12	Sep-12
III Per	7	Aug-13	Jan-14	Jun-14	Dec-14	Aug-15	Feb-16	Oct-16		

Table 3.10: Bai and Perron test - Price impact on volume weighted ask

3.4 Concluding remarks

In this section we provide final comments about the analysis conducted on this large set of liquidity measures (in appendix .4.2, the same analysis is performed on 35 liquidity measures).

Week	Number of measures with a break	Sign	US-UK financial crisis	EU peripheral credit risk - non IT	Italian credit risk	Global markets volatility
July 23, 2007	18	-	Yes	No	No	No
February 25, 2008	21	-	Yes	No	No	No
September 08, 2008	13	-	Yes	No	No	No
September 15, 2008	24	-	Yes	No	No	No
July 20, 2009	12	+	Yes	No	No	No
April 12, 2010	14	-	No	Yes	No	No
July 04, 2011	20	-	No	No	Yes	No
January 02, 2012	14	-	No	No	Yes	No
September 10, 2012	18	-	No	Yes	No	No
October 13, 2014	25	-	No	No	No	Yes
August 31, 2015	13	-	No	No	No	Yes

Table 3.11: Summary of the weeks with the highest number of measures with a structural break

Table 3.11 summarizes the weeks in correspondence of which structural breaks occurred more frequently in the whole sample of measures, indicating the sign of the variation and the link with the macroeconomic event that caused the switch in the liquidity regime. The first important result is that the structural changes in the market microstructure are only partially related to the Italian sovereign credit risk. Although structural breaks are found in correspondence of July 2011 and January 2012, the other relevant dates that collect a high number of breaks among several liquidity measures are not strictly related to Italian creditworthiness. The first depletion of market liquidity occurred in 2007-2008 due to the UK and US financial crisis. The recovery path was interrupted by the Greek and the subsequent Eurozone sovereign debt crisisi. The positive trend of the last years has been hit by episodic negative events, like the sell-off in the world fixed income market of October 2014. The fact that several measures show that the high levels of liquidity eroded permanently and reached its lowest historical levels during the spring 2008, after the outbreak of US financial crisis, makes clear that in the last decade the first and main reason of the erosion of market quality has been the US and UK financial crisis.

Secondly, a strong asymmetry between structural changes in case of liquidity's depletion or liquidity's strengthening exists. A decline in liquidity occurred through negative shock depicted in strong and violent downside in the liquidity measures (e.g., during Lehman's default in September 2008). Conversely, positive evolution of liquidity conditions take place through slow moving and gradual recovery (e.g., period post European debt crisis). For this reason, Table 3.11 shows nine weeks in which a negative breaks occurred versus only one week with a positive sign of the break. Negative events in financial markets are clearly identifiable and this causes a concentration of negative breaks in several measures in days close to the date of these events. On the other side, the slow moving recovery unlikely identifies structural breaks close to single dates in several liquidity measures.

Lastly, since the analysis of each measure is conducted separately for the two sides of the market (bid and ask), we note a strong homogeneity in the evolution of each pair of measures. Graphically, each pair of measures moves in a very similar way. Analytically, a large number of breaks is identified simultaneously both in the bid and ask sides. This result confirm the idea that market makers act in a symmetric way in their quoting behaviors.

Looking in more detail the dynamic of each measure, we firstly analyze a rather standard liquidity measure such as *volume-weighted bid-ask spread*. This is a measure more informative than the *best bid-ask spread*, since its implicit multidimensional nature combines prices and the correspondent quantities. The Bai and Perron test detects the two strongest and negative breaks during the US and UK financial turmoil (September 2008) and the European sovereign debt crisis (July 2011). Although the measure reached its daily highest values during summer 2011, the persistence of the negative liquidity depletion is very similar in these two periods: in both cases, the Bai and Perron test detects a relevant positive restoration of liquidity after seven months from the previous negative event.

Secondly, we consider a couple of measures, namely the *ratios between the bid (ask) quoted depth on the three best bid (ask) prices and the total quoted quantity*. When the ratio is near to one, it means that all market makers quote their proposals in the top prices of the book. When this ratio decreases, it represents a liquidity depletion in the depth of the quoting book in the top prices. Looking at the results, the two measures do not highlight any significant difference between the two sides of the quoting book. Both measures show that the lowest average level of 35% is reached in correspondence of the Lehman default and it remains stable until 2013. Differently from the previous measure, these ratios show clearly that the liquidity in the top positions eroded permanently in march 2008. The recovery path has started in march 2013. During these five years, breaks in the liquidity conditions show up only when the analysis by sub-periods is carried on.

We then consider the *standard deviation of bid (ask) prices*, weighted for their correspondent quoted quantities. These measures show how the dispersion of the quoted prices has evolved during these years. Also in this case, no significant differences between the bid and ask sides has emerged. From the analysis of these measures, it is clear the spillover effect of the Greek bonds' tensions on the Italian government bond market. As a matter of fact, these measures reached the highest value in correspondence of the outbreak of the Greek sovereign debt crisis, in spring 2010.

The measure that we present for the trading activity is the daily traded volumes. The measure' dynamic shows two permanent depletions of the liquidity: the first during the financial turmoil of 2008, the second in correspondence of the Italian sovereign debt crisis.

Moving to multidimensional measures, the *slope* of the quoting book and the *price impact* are analyzed. These measures have reached their highest value respectively during the financial crisis of 2007-2008 and during the Italian debt crisis. Looking at the dynamic of the slope, differently from other distressed periods (i.e., spring 2010, 2011-2012), the recovery path after its negative jump during the 2008-2009 period has been longer (even longer if it is compared with the other post-liquidity depletion periods). Lastly, the price impact is the only measure of those in the sample that has reached the highest value (indicating a negative evolution of market liquidity) during the Italian debt crisis with the strongest negative jump in correspondence of June 2011.

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Chapter 4

Market-Making and Monitoring Rules on the Italian Sovereign Bond Market

4.1 Introduction

In recent years, the debate about the restructuring of the regulatory framework of financial markets has increased significantly. In Europe, the structure and the design of Government bond markets are one of the main concerns of regulators and policy makers. Studies, linked to the European sovereign debt crisis, have clearly highlighted that market microstructure and liquidity risk are crucial components that affect sovereign borrowing cost, especially during periods of distress and turbulence (D'Agostino and Ehrmann (2014)).

For sovereign issuers, a good functioning of the secondary market provides an essential supportive environment for the primary market, by which the sovereign entities issue their bonds among investors. A good design of secondary market implies a reduction of liquidity risk and the correspondent premium demanded by investors, leading to lower bond yield and sovereign debt cost.

In the European case, the government bonds secondary markets operate under the *market making system*. Market participants are divided into two groups: market makers and market takers. Market makers face quoting obligations: they quote continuously the bid price (on which market takers can sell the bond) and the ask price (on which market takers can buy the bond). Thus market makers offer market liquidity and they are subject to several regulations on pre and post-transparency, on capital and organizational requirements.

Looking at the Italian case, MTS Italy is the secondary wholesale market of the Italian government bonds[1]. It is defined as a *wholesale* secondary market, implying only banks and institutional intermediaries may be admitted as dealers. Among market makers on MTS Italy, a group of selected dealers act as *specialists* of Italian public debt, facing, other than quoting obligations on MTS, other duties in terms of activity in the primary and in the repo markets. These operators benefit from some privileges, explicitly defined by the Specialists' Decree of Italian Ministry of Economy and Finance (henceforth MEF or Italian Treasury). In order to verify the compliance on their duties and obligations, the Italian Treasury monitors continuously their activity on primary and secondary markets. At the end of each year, based on the overall evaluation, the MEF calculates the final ranking and publishes the first five specialists. Monitoring rules and the public ranking regime are employed by the Italian Treasury in order to push specialists to compete in the liquidity provision. These operators are so subject to both market makers' obligations and specialists' duties defined by the MEF.

The contribution of the present study is threefold. First, it highlights that liquidity conditions are affected by monitoring rules, not only due to their compulsory nature, but also through the incentives linked to the correspondent ranking system. For instance, these incentives could be related to higher reputation among financial investors. The analysis employs the changes in monitoring criteria occurred between 2015 and 2016 on BTPs with residual maturity longer than 10 years. These changes are suitable for this analysis since these affect only a restricted number of BTPs, determining both temporal and units discontinuities that are opportunely employed in the econometric analysis. The results suggest that empirical research on MTS Italy[2] should take into consideration whether changing in the ranking system occurred during the period considered.

Second, this study suggests how traditional market microstructure models could handle this new source of market externality. The basic idea is that specialists are exposed heterogeneously to the benefits of being in the top positions of the final ranking. Direct and explicit benefits derived from higher probability to be selected by the Italian Treasury as lead managers of syndicated issuances or as dealers in bilateral operations. Other implicit benefits

[1] MTS Italy is the most important electronic market for Italian government bonds since it has the highest market share in terms of trading activity among electronic platforms (Consob - biannual bulletin June 2017).

[2] A large number of studies on the liquidity conditions on MTS domestic platforms are conducted recently (Girardi and Impenna (2013), Pelizzon et al. (2014), Cafiso (2015), Pelizzon et al. (2016), Scheneider et al. (2016), Corradin and Maddaloni (2017)).

may be essentially related to the higher reputation among investors and these benefits vary among specialists. The ranking signals the quality of execution services of these investment banks: reaching the top positions, specialists signal their compliance in providing a good liquidity service in government bonds, an asset class characterized by high competition and low profitability, in order to increase fidelity of their clients for execution in other asset classes. However, this heterogeneity could be related to several other reasons. Further research could investigate why some banks are more exposed than others to potential benefits of ranking regime.

Third, these results significantly contribute on the debate about the restructuring of markets design, highlighting that monitoring and ranking regimes may increase market competition, globally leading to better market quality.

The paper is organized as follows. The next section presents the literature related to market microstructure models, regulatory changes, the correspondent impact on market makers' behavior and a review of studies on liquidity conditions in MTS markets. Then, Section 4.3 presents MTS Italy platform, the specialists' evaluation criteria, the ranking system laid down by the Italian Treasury and the first testable prediction. Sections 4.4 discuss methodologies, data and the main results of the econometric analyses on the first prediction. Section 4.5 formally assesses the second prediction about the heterogeneous response of different market makers to the new market rules. Sections 4.6 and 4.7 present other robustness checks of the basic analyses. Concluding remarks are offered in Section 4.8.

4.2 Related literature

Market microstructure models examine the process by which institutional market rules, investors demands and traders' heterogeneity interact and are translated into transactions and price variations. Market makers play a crucial role in this process: they stand ready to buy and sell a particular amount of an asset on a continuous basis at a publicly quoted price. If v_t is the public fair value of a risky asset at a some point in the time t, market makers set the bid price b_{vt} ($< v_t$), on which investors are able to sell the asset, and the ask price a_{vt} ($> v_t$), on which investors can buy the asset. The bid-ask spread should compensate market makers for their immediacy of transaction and for other costs that they implicitly and explicitly face: operation costs, participation costs, transaction costs, asymmetric information, imperfect competition, inventory control costs, funding constraints and search. Vayanos and Wang (2012) provide an exhaustive survey on theoretical work and empirical literature on these imperfections. Among implicit costs, the existing literature extensively studies asymmetric information costs and inventory control costs. Asymmetric information costs arise when some investors are better informed about the true value of the asset. If market makers are not able to distinguish these investors, they set bid and ask prices taking into account the risk of dealing with a better informed investor.

Several studies have focused on those costs and proposed different models (information-based models) that try to explain how asymmetric information on the real value of the asset affects the bid-ask spread. Among these models, two different classes can be distinguished: strategic models and sequential trading models. The common idea is that a trade reveals something about the agent's private information. Kyle (1985) proposed the first strategic model. The basic idea of this model is that the better informed trader trades strategically maximizing its trading profits before the information becomes common knowledge. This model considers the existence of a single informed trader. Holden and Subrahamanyam (1992) propose a similar multi-period auction model but characterized by multiple noncompetitive agents. In contrast with Kyle results, they find that even just two informed traders cause an immediacy in private information incorporation in asset price. Some other basic assumptions of the original Kyle's framework have been relaxed in other papers: Admati and Pflederer (1988) introduce endogenous patterns in buy and sell volumes that induce buyers and sellers to trade in different periods mitigating the adverse selection problem, Foster and Viswanathan (1990) argue that, since prices are an important source of information both for informed and uninformed traders, also uninformed traders could act strategically in the market.

The sequential trade models focus on the basic idea that, in a quote driven market with heterogeneously informed traders, the bid-ask spread is linked to the probability structure of the market participants. Among these model, Copeland and Galai (1983) and Glosten and Milgrom (1985) propose the first models in this direction. Looking at the basic assumptions, the market maker is risk neutral and sets quotes in a competitive way (zero profit condition is respected). Since the market maker losses on dealing with informed traders, she quotes higher bid-ask spread. The adverse selection problem implies that there is an increasing and positive effect of the fraction of informed traders on the bid-ask spreads. Easley and O'Hara

(1987) incorporate in the model also the trade size and the different effect of a small or large trade in signaling the quality of information. Better informed trader faces a trade-off. In order to maximize their profits, they could trade a large size but in this way they send a higher quality signal on the information. Based on these models, several studies discuss when crashes in financial markets arise with the inability of the market maker in playing its crucial role in stabilizing the market. Romer (1993) argues that crashes may arise when traders are uncertain about the precision of information of other traders.

The second implicit cost that a market maker faces is the inventory-control cost. This cost arises when imbalances of buying and selling flows increase. Market maker, setting their bid-ask spread, should consider the risk in holding inventory that may deviate from their desired position and causing losses if prices move against. If they already own a significant long (or short) position, they set the bid and ask prices in order to facilitate the turnover of the position. Garman (1976) proposes a model in which he assumes that the market maker has to face the Gambler's Ruin problem since dealer capital is finite and the probability that inventories become greater than the capital is equal 1 for some finite time T. As Madhavan (2000) explains, this simple model well highlights the relation between market making activity, inventories and dealer capital structure. Inadequate capitalization could cause an increase in price volatility due to inventories control: if market maker already owns a relevant position (suppose long), after an heavy selling flow, she could be reluctant in increasing her long position, leading to a deterioration in the bid side of the market, a compression in the ask side and an increase in market volatility. Stoll (1978), Amihud and Mendelson (1980), Ho and Stoll (1981) propose a model of a monopolistic specialist that sets the markup on the fair price of the asset depending on monopoly power, volatility and inventory control costs. Ho and Stoll (1983) relax the assumption of monopolistic market maker and analyze the equilibrium condition under multiple specialists in a competitive framework. In their paper, authors conclude that market volatility is affected not only by uncertainty about the returns on their inventories, but also by uncertainty about the arrival of transactions.

Differently from previous literature that limits the specialist' choice to the bid and ask prices in order to compensate several implicit and explicit costs, Kavajecz (1998) proposes the first model in which a specialist chooses prices and depths jointly in order to maximize her profits. He found that prices and depths are used as substitutes: a narrow bid-ask spread induces small depth quotes whereas large depth quotes induce a wide bid-ask spread. These depths quotes are not, however, the familiar depth parameter discussed in the Kyle (1985) paper, rather they are quantities that specialists post in real time that announce the number of shares available at the posted price (Kavajecz, 1998). Kavajecz (1999) and Caglio and Kavajecz (2006) link the specialist's choice of quoted depth and tightness of her bid-ask spread in order to face the adverse selection risk. Specifically, they found that specialists decide to reduce their exposure risk, reducing their quoted size, when they face an increase in the amount of adverse selection or in price uncertainty. These works are the main references for our study since it focuses on the opportunity for specialists, provided by the new monitoring rules, to manage both prices and quantities in their quoting proposals.

The second strands of literature refers to the empirical analyses on the impact of changes in quoting obligations on market makers' behavior. Only few of these changes affect directly the obligation on the minimum quantity set by market makers. McInish, Van Ness and Van Ness (1998) have examined how the change in the Actual Size Rule (ASR) affected Nasdaq market quality. They find a negative impact on the quoted depth and a positive effect on the number of small quotes in the 10 days after the implementation of the new rule. Porter et al. (2006) investigate the link between the ASR change and periods of market stress. They find that ASR may significantly reduce market quality under times of financial distress. Chung and Zhao (2006), employing both cross sectional and intertemporal analyses on Nasdaq stocks, find that dealers post large depths when their quotes are at the inside[3] and frequently quote the minimum required depth when they are not at the inside, leading to a negative intertemporal correlation between dealer spread and depth.

Other previous studies of the spread-depth interaction focus on specialist quotes on the NYSE. However, our paper differs from these studies since the MTS setup is substantial different from equity markets. The main difference in the market structure is that in MTS, only the group of market makers quotes simultaneously the whole group of Italian government bonds, while in NYSE each stock has just one specialist that faces the quoting obligation and acts competitively with limit orders of other investors. Gozluklu et al. (2015), employing a dataset on Borsa Italiana, investigate how market quality has been affected by the reduction of the minimum trade unit (MTU). They find a substantial improvement of liquidity driven by the reduction in adverse selection and by the increase in retail trading. However, Go-

[3] Inside quote represents the best bid or ask prices of the quoting book. The inside quote is the prices at which market order will be executed.

zluklu setup and other previous studies on the reduction of MTU (e.g., Amihud et al., 1999) differ from this paper since our focus is on quoting obligation and not on the opportunity to increase liquidity with low entry barriers in stocks trading.

In addition, a wide literature exists on the effect of other regulatory changes in financial markets. For instance, the effects of changing the minimum tick size draws considerable attention. The tick size is the minimum price movement of a trading instrument. Harris (1994) hypothesizes that a smaller tick size is likely to cause a reduction in the bid-ask spread since to the removal of the artificial ceiling allows investors to place limit orders at prices which were previously unavailable. Empirical studies, applied in different markets, confirm these hypotheses (Goldstein and Kavajecz (2000), Chung and Chuwonganant (2004), Ahn and al. (2007), Buti et al. (2013), Lepone and Wong (2017)). Other studies assess the impact of ban on stub quoting that should narrow volume weighted bid-ask spread and reduce the price impact leading to better liquidity conditions. Findings of Egginton and al. (2016) are consistent with these hypotheses. These studies differ from our paper since the rule changes concern different characteristics of the market design and because, as mentioned above, other important structural differences exist between MTS and equity markets.

Finally, this paper is related to the literature on MTS market, one of the most important electronic trading platforms of European government bonds with a peculiar organizational setup. As discussed above, this market differs substantially from equity markets. Cheung at al. (2005) provide a first extensive description of the European bond market and investigate some aspects of the microstructure of MTS markets, as the link between Euro MTS and domestic platforms. Coluzzi et al. (2008) analyze the microstructure liquidity evolution on MTS Italy employing a wide set of different liquidity measures. Later, Darbha and Dufour (2013b) review the microstructure of Euro area government bond market, including the high number of studies linked to the European sovereign bond crisis. Pelizzon et al. (2016) study the evolution of liquidity measures during the Euro-zone crisis in the MTS Italy, highlighting the links with sovereign risk and ECB's intervention through LTRO and OMT programs. Pelizzon et al. (2014) investigate the links between the cash (MTS) market and the correspondent futures market (Eurex) in price discovery and in liquidity discovery processes. Paiardini (2015) studies how economic news are incorporated in MTS markets. Cafiso (2015) investigates the connections between primary and secondary markets, employing data on the Italian case. Scheneider et al. (2016), employing a dataset that runs from

2011 to 2015, study the spillover effects of shocks in liquidity conditions among different segments of BTPs.

MTS provides also a platform to execute repos on government bonds[4]. Since market makers face order imbalances and manage scarcity risk, a good functioning of repo market is crucial in order to guarantee high level of liquidity in the cash market. Corradin and Maddaloni (2017) study how supply and demand shocks (e.g., ECB's intervention) affect the specialness of Italian government bonds.

4.3 Institutional details

4.3.1 MTS Italy market structure

MTS was introduced in 1988 by the Italian Treasury and it was the first electronic market for government bonds in Europe. In 1997 it was privatized and it began expansion across other public debt issuers. The main reason for the launch of MTS was to create a supportive environment for the big changes that were ongoing in the primary market, namely the evolution in the placement technique of government bond from a system of firm sale to a predetermined group of banks to an auction based system, where all market players can participate and bid competitively for the amount of bonds announced by the issuer. In 1998 MTS has become a *Regulated market* owned by the private sector. However, according to several second tier regulations (e.g., Ministry decrees), the set of rules according to which the market for wholesale trading in government bonds works is laid down by the Italian Treasury, while the supervision is under the control of Bank of Italy and Consob.

The Italian Treasury issued two main regulations in 1999 and 2009 that reaffirmed MTS as a pure interdealer platform with market making obligations, high levels of transparency both pre trade and post trade, even before MIFID 2 requirements. These decrees also set down the rules for specialists. These measures, to create an efficient secondary market, were adopted within the general framework of public debt management policy, aimed at achieving a structural minimization of funding cost, increasing liquidity for government bonds through an electronic system which makes transactions very easy to be executed, providing a clear picture of market conditions for the market participants by means of a

[4] Miglietta et al. (2015) documents that the market share of MTS repo platform is close to 90% .

continuous "on screen" availability of bid-ask prices, helping the issuer in the placement of specific bonds offered at auctions (Iacovoni, 2017).

Currently MTS Italy is the domestic trading platform of Italian government bonds of MTS markets. It is defined as a wholesale secondary market, implying that only banks and institutional intermediaries are admitted as dealers and participate on their own account (or on behalf of institutional investors but as a direct counterpart).

As the other MTS markets, the Italian platform is a quote-driven electronic order book market. Participants are divided into two groups: market makers and market takers. As discussed above, the role of market makers is to provide liquidity continuously, quoting two proposals (bid and ask prices) that are aggregated in the order book for each bond. Other participants, acting as price taker, can buy and sell a certain amount of a bond, hitting the proposals with a market order. Other important features of MTS markets are that the proposals are anonymous (the counterpart is revealed only if at least one of the two dealers settles bilaterally) and market makers are not forced to show the maximum quantity they are willing to trade. Market maker could show only a partial amount of its proposal, maintaining the priority for the entire size of the proposals (both disclosed and undisclosed quantities)[5]. However the undisclosed size has to be at least equal to the minimum lot size (2mm), defined by MTS market rules.

4.3.2 Evaluation criteria of Specialists in Italian Government bonds

In 1994, the Italian Treasury introduced a new category of operators: specialists. Originally, this group was composed by selected primary dealers operating in MTS Italy. The aim was to enhancing the demand at auctions, the liquidity conditions in the secondary markets and assisting the Treasury with advice on debt management policy issue (IMF Guidelines for Public Debt Management, 2001). From 1994, the list of specialists has been modified several times: when a new specialist arrives (e.g., Barclays in September 2004, Nomura and HSBC in January 2005) or an old one decides to limit her participation in Italian sovereign bonds activity (e.g., UBS in July 2018). Note that specialists are necessarily market makers in MTS Italy, the contrary is not always true. However, as the next sections will show, the

[5]Buti and Rindi (2013) find that operators have a strong incentive to choose a quantity very closed to the minimum size since they face exposure costs that arise when agents, submitting large orders, run the risk of being undercut by aggressive traders.

market share as fillers[6] in MTS Italy of the whole group of specialists is very high, more than 90%, indicating that the liquidity provided by market makers, that are not specialists, is negligible.

The Italian Treasury clearly explains in its decrees (e.g., *Selection and evaluation of Specialists in Government Bonds Decree*) which privileges are provided for banks that act as specialist in its government bond market. The Ministry guarantees to the whole group of specialists exclusive access to reserved reopenings of government bond auctions[7], to the selection of lead managers of syndicated issuances, of dealers for bilateral buyback operations and for derivative transactions. In order to verify the compliance of specialists on their duties, the Italian Treasury monitors continuously their activities on primary and secondary markets. At the end of each year, based on the overall evaluation, the Italian Treasury calculates the final ranking and publishes the first five specialists on the Italian Public Debt website.

In its evaluation criteria, the Italian Treasury defines general principles, specifies the requirements which need to be fulfilled by each specialist (e.g., the allocation on an annual basis of a share no less than 3% of the total volume issued by the Treasury) and lists the specific criteria for monitoring specialists' activities, with formulas and practical informations. The Ministry monitors that specialists efficiently and continuously participate in the placement auctions, in the secondary markets, in the repo market and contribute to the management of public debt through advisory and research activity.

With respect the activity on the secondary market, the Italian Treasury defines that each specialist has to contribute to the efficiency of the market and an orderly execution of trading[8] and determines the criteria to evaluate specialists so as to establish the contribution to the efficient functioning of the trading venues.

[6]As mentioned above, market makers set their quotes defining prices and quantities that they are willing to trade. When a price taker (the *aggressor*) decides to hit the proposals in the quoting book, the counterparts of the deals are market makers that act as *fillers*.

[7]Reserved reopenings give to the Specialists the right to buy predetermined additional quantities of the issued bond at the price settled at the auction. The application deadline is fixed at 3.30 p.m. of the business day following the auction. Thus it represents a free call option on the issued bond. We refer to Coluzzi C. (2011) for an extensive discussion on the value of this option for specialists.

[8]Specialists Evaluation Criteria Decree Year 2018 , Article 3.

Specialists evaluation criteria - year 2015

Looking at the 2015 criteria, the most important criteria on the primary market activity, in terms of contribution for the ranking (33 points), is the Primary Quantitative Indicator. Each specialist is assigned a score in proportion to the share in the primary market allocation. The score begins to be assigned with the allocation of a share of at least 3% up to a maximum level of 6%. The score assigned to each specialist is given by: $(Q_s\text{-}3\%)*33/(6\% - 3\%)$, where Q_s is the specialist's share in the primary market.

Looking at the criteria on the secondary market, the Treasury defines four indicators: the quotation quality index (QQI), the traded volumes (TV), the number of bonds traded as filler (NBTF) and the large in size contract (LSC).

The QQI is an indicator based on high frequency snapshots, made on each market day, on the order book of each bond for each specialist. For each snapshot, the ranking of the specialist in the order book of the bond with respect the best ranked specialist (both for the bid and ask sides) is recorded. To calculate this indicator only proposals associated with visible quantities equal to 5mm are considered. For each bond, the average ranking of the specialist is calculated relative to the market day. To calculate the average ranking, each position in the order book is weighted with increasing coefficients that are in proportion to the position in the order book with respect to the best price, in order to reward more those dealers that continuously show the best prices both for the bid and the ask sides. Thus QQI measures the contribution of each specialist in narrowing the best bid-ask spread. The higher is the contribution, the lower is QQI. At the end of the year, the specialist with the lowest QQI is assigned 8 points. The other specialists are rescaled with respect to the best one.

The TV index measures the market share of trading activity of each specialist in MTS Italy. The parameter is calculated with two subsequent weightings, the first takes into account the type of bond traded (BOT, CTZ, BTP, CCT), the second discriminates the volumes traded as filler (weight equal to 1) or volume traded as aggressor (weight equal to 0.50). The best specialist is assigned a score of 8 points.

NBTF measures the ability of each specialist to trade, as filler, the highest possible number of bonds on MTS. To the best Specialist are assigned 4 points and a score between 0 and 4 is proportionally assigned to the other specialists.

Lastly, LSC measures the contribution of each specialist to provide size to contracts traded as filler. All contracts larger than or equal to a threshold size are selected. The threshold size, for each class of BTPs, is defined by averaging the size of contracts traded during the observation period within that class. Then the Treasury calculates the share of each Specialist as filler. The specialist with the highest indicator is given a score of 2 points.

Other indicators refer to the activity in the repo market, in the buyback or exchanges transactions and in evaluating the organizational structure. The full list of criteria, coefficients of QQI and weights of TV are presented in Appendix .5. The total maximum score is 100 points and specialists compete for the first five positions, in order to be published in the final ranking[9]

Changes in evaluation criteria - year 2016

Every year, the Italian Treasury may modify monitoring and ranking criteria. As explained in the introduction, this paper employs the changes between 2015 and 2016 on criteria of the secondary market in order to verify whether and how market liquidity is affected by the ranking rules. As a matter of fact, the changes in the criteria for 2016 ranking modified some important features only in the segment of BTPs with residual maturity longer than 10 years, providing a quasi natural experiment to be employed for statistical purpose.

The Treasury has changed several times monitoring rules, but these changes are different from those occurred in the past: in most cases, rules were modified homogeneously among bond segments (i.e., introducing new criteria applied to the whole group of bonds); actually the changes of 2016 determined both temporal and units discontinuities. Therefore, the variation between 2015 and 2016 is suitable to detect the causal effect of monitoring rules on liquidity conditions.

Before explaining in details the new rules, the timeline of the events is presented. On 20 November 2015, the Italian Treasury invited specialists to communicate their proposals for potential changes to be introduced in the 2016. On 9 December, the Treasury, collected specialists' comments, discussed with them its definitive proposal on how to modify the monitoring rules for 2016. On 15 December, the Treasury formally confirmed the set of

[9]Note that, although the rules about mandatory exclusion from the list of specialists are clearly listed in the MEF's decrees, in the last decade no case of exclusion has occurred. Conversely, cases of banks that voluntarily decide to suspend their activity as specialist occurred several times. In this sense, there is not a competition to comply the minimum compulsory conditions set by the Italian Treasury, actually if banks compete for the ranking, they do that to be published in the five top positions.

changes for the new year. Lastly, on 4 January (the first trading day of the year), the new regulation has entered into force.

The changes with respect to 2015 were mainly designed to push market makers to provide higher liquidity in the group of BTPs with residual maturity longer than 10 years. With respect the quoting and trading activities on MTS, the Italian Treasury modified in two ways the calculation of the four indicators of secondary market. Firstly, the minimum size required for the evaluation of QQI on nominal BTP with maturity longer than 10 years was removed and became 2mm, the minimum required size defined by MTS rules. Secondly, in order to offset the potential negative impact of this change on the depth of the quoting book, the Treasury doubled the weight for this group of BTPs in calculating QQI, NBTF and LSC indicators and increased the weights of these BTPs in calculating the trading volume share of each specialist in the secondary markets (TV index)[10]. In this way, specialists face a trade-off in choosing their quoted depth: if they reduce to 2mm their proposals, then they benefit from lower quoting risks but they also reduce their expected scores in the final ranking.

With the new monitoring rules (the list of other changes is provided in the Appendix .6.), the Italian Treasury aimed at incentivizing market makers to narrow their bid-ask spread in the longer maturity BTPs group, allowing them to reduce their quoted quantities. However, modifying also the weights on TV, NBTF and LSC indices, each specialist should set its quoted prices and depths in order to maximize her expected returns from market making activity and her expected score for the final ranking.

Prediction n. 1

In the light of the previous discussion, we can summarize the following testable empirical prediction.

Prediction 1: Ranking system, acting on market makers' quoting decisions, affects positively the conditions of market liquidity.

Monitoring rules and ranking system may affect quoting preferences of market makers. In a *pure specialists* market, as the previous chapter has explained, the quoting book aggregates only specialists' proposals. Since ranking system increases competition among

[10]The new weights are shown in Appendix .6

specialists, the final effect is a positive impact on aggregated liquidity conditions. In the empirical application, we use the changes between 2015 and 2016 to assess whether a variation in the monitoring criteria affects the microstructural liquidity offered by specialists. Since the dataset does not provide information at the individual market maker level, the focus is on the structure of the quoting books. However, the book is just the aggregation of the proposals provided by market makers; employing suitable liquidity measures, one may infer on the aggregated market makers' quoting decisions.

4.3.3 Appraisal of the activity of Primary Dealers in the Eurozone countries

Lastly, this section provides a brief discussion about evaluation criteria of Primary Dealers (henceforth PD) employed by the Debt Management Offices (henceforth DMO) of other Eurozone countries[11]. In particular, in this section, the differences with the Italian case are highlighted. Let's recall that MTS Italy is the only eligible trading platform and PDs are publicly ranked at the end of each year. The combination of these two characteristics makes MTS Italy the most suitable case to study the impact of incentives linked to a public ranking regime in the market makers' quoting choices.

Austria uses a broad range of criteria to measure PDs' performance on primary and secondary markets, turnover statistics with real money investors and other qualitative factors. Looking at the secondary market activity, Austria does not prescribe specific platform eligibility criteria and does not have a firm quoting obligation. Austria leaves the selection of a platform to its PDs, that have to submit daily data on their quoting and trading activities that are matched with data provided on voluntary basis by all major platforms. The final ranking's top ten dealers are made public in the DMO's website in December.

Belgium appraises the activity of the PDs in the primary and secondary markets according to various quantitative and qualitative. Since April 2014, Belgium have selected three trading platforms (MTS Belgium, Eurex, Icap BrokerTec) on which PDs can comply with their quoting obligation. The system guarantees an high level of flexibility: each PD can select daily at its discretion the platform on which it complies with its quoting obligation;

[11] For an extensive discussion on all European national public debt frameworks, I refer to the *European Primary Dealers Handbook*, publicly available on AFME website.

moreover, the selected platform may be different for different securities. The appraisal is communicated to each Primary Dealer individually.

Finland's evaluation system is based on an internal scorecard model that takes into account various areas of services. Looking at the market making obligations, the Finnish Treasury selects four eligible platforms (BGC, Eurex, MTS, BrokerTec) on which PDs are forced to provide two-way proposals for all securities with minimum quantity and maximum spread obligations. The scorecard rankings are not public.

France measures the PDs' performance through an overall assessment on primary, secondary, repo and strips markets. The selected trading platforms on which PDs are evaluated are MTS France and ICAP/Brokertec. The main criteria on the evaluation of the secondary market activity is the market share wighted for different segments (maturity and the nature of security). Quarterly, the *Agence France Tresor* informs each PD of its position on the primary and secondary markets.

Germany does not have any PD system and corresponding ranking regime. However, there are still rules that apply to the *Bund Issues Auction Group*, a group of investment banks to whom the direct participation in the auctions is guaranteed. Starting from 2015, the members of the *Bund Issues Auction Group* provide to the Finance Agency on a voluntary basis the trading activity in the secondary market.

In the Irish case, Primary Dealers are required to quote two-side proposals for benchmark bonds on any recognized electronic platform such as MTS, BGC Partners and BrokerTec. Monthly, each PD declares on which platform it decides to quote in line with its obligations and then the National Treasury Management Agency monitors its activity in the selected venue. The ranking of PDs, based on an all-encompassing basis, is not made public.

The Dutch State Treasury Agency (DSTA) has selected four platforms (ICAP, MTS, Eurex Bonds, BGC Brokers) in order to outline a multi-platform environment on which each PD may select a single venue to fulfill its quotation obligations. The assessment criteria for appraising the PD activity are based on the market share in the primary and secondary selected markets, the fulfillment of their quotation obligations and the support in the promotion and development of products related to dutch public securities. Three times a year, the DSTA publishes the top five positions of PDs ranking.

Also in the Portuguese case, a multi-platform environment has been established. Portugal has set a compliance ratio of at least 80% for PDs' quoting obligation on MTS for each entire calendar month and other quoting obligations weighted by daily volatility in designated platforms (BGC eSpeed, MTS, BrokerTec). No information about public ranking are found.

Lastly, Spain identifies SENAF (that does not impose any quoting obligations) and MTS Spain (that imposes obligations to market makers not registered as PDs) as two authorized electronic trading platforms. Spanish Government requires PDs to quote in one platform at least 5 hours the benchmark bonds and a strip basket. Each PD can quote part of the securities on one platform and part on the other. Annually, the Spanish Treasury publicly ranks the five most active primary dealers.

In the light of this discussion, one can conclude the Italian case is the most suitable framework to analyze how these ranking systems may affect market makers' choices: quoting obligations are applied to a single eligible trading platform (MTS Italy) and annually the first five positions of the ranking are published. The former feature helps the analysis limiting confounding effects and any potential endogeneity problems, since each market maker might have unobservable preferences about the trading venue[12] on which comply its quoting obligations. On the other side, the Italian ranking regime, characterized by a clear assessment, may boost competition among specialists and it provides high implicit benefits (e.g., reputation) due to its public nature.

4.4 The causal effect of changes in monitoring rules on market liquidity

This section discusses econometric strategies to estimate the effect of monitoring rules and ranking systems on liquidity conditions of the quoting book (*Prediction 1*). The analysis employs the changes in evaluation criteria between 2015 and 2016. In practice, an analysis on individual level cannot be performed but, since the order book is the direct aggregation of the proposals of specialists, the paper estimates the causal effect of the new market rules on a set of liquidity measures of the quoting book. The changes in specialists' evaluating criteria entered into force from 4th January 2016 and affected some market making features and obligations in the segments of BTPs with residual maturity longer than 10 years. The impact of the regulatory switch on liquidity measures is investigated using a standard panel

[12]Regulated markets and multilateral trading systems.

regression model with individual and time fixed effects.

4.4.1 Data and methodology

The analysis considers the period that runs from 1st September 2015 to 29th April 2016 and selects bonds that, in line with the regulatory variation, were closed to the threshold of 10 years as residual maturity. These bonds are those included in two classes of BTPs defined by the Treasury for TV index around the 10-year maturity: seven bonds with residual maturity between seven to ten years (the control group that has not been affected by rules' change)[13] and eight bonds with residual maturity between ten to fifteen years (the treatment group)[14]. This specific classification is defined by the Italian Treasury to evaluate the specialist's activity in the primary and the secondary markets, with the aim to aggregate different bonds in more homogeneous classes (see Table 71 in Appendix .4.2). Boehmer et al. (2015) suggest that, analyzing regulatory experiments, the fundamental assumption that the control group is unaffected may not hold in financial markets, due to potential existence of spillover effects. However, in this framework no indirect and spillover effects should exist, since minimum obligations in the control group are unchanged and no rational behavior could explain different quoting preferences in these bonds.

The period that has been considered is suitable for the analysis for several reasons. First, as explained in section 4.3.2, the changes in monitoring rules between 2015 - 2016, affecting a restricted number of bonds, are appropriate to highlight the role of ranking system in influencing market makers' behaviors. During this period, the other relevant regulatory features remained unchanged. Note that, even if other regulatory changes or structural variations occurred in that period, these should impact differently the two segments of BTPs since the empirical analysis is conducted to find any significant difference between these two groups.

Second, since BTPs with maturity longer than 7 years and smaller than 15 years are selected, the paper discusses and controls whether any market factors could lead to divergence between these two groups. Looking at the spread between the yield of the BTP 10 years

[13]In more details, the control group is composed of bonds with residual maturity at 4th January 2016 lower but close to 10 years. Isin codes: IT000366655, IT0004953417, IT0005001547, IT0005045270, IT0004513641, IT0005090318, IT0005127086.

[14]The treatment group is composed of bonds with the residual maturity greater but close to 10 years. Isin codes: IT0004644735, IT0001086567, IT0001174611, IT0004889033, IT0001278511, IT0005024234, IT000144378, IT0005094088.

benchmark versus the yield of the BTP 15 years benchmark, it could help to understand how operators managed these two segments. The average spread of this period is 43.840 bps, the maximum value is 53.753 bps and the minimum value is 37.141 bps. If one looks to the annualized volatility (a financial indicator of risk and uncertainty) of this spread, computed on rolling window of 160 days (8 months), its centered value in Sep 15 - Apr 16 period is 52.823%, the maximum is 71.734% and the minimum is 51.614%. Comparing with those values computed on 2010-2017 period (respectively equal to 41.235 bps, 79.443 bps, -8.762 bps, 204.511%, 692.77%, 48.086%) confirms that the period employed in the analysis is characterized by low level of instability and uncertainty.

Moreover, since market makers intermediate the allocation of the Italian bonds among investors, some facts about the demand and supply should be previously discussed, in order to analyze whether structural variation in inventories' control cost occurred. First, the Italian Treasury follows a fully transparent calendar about auctions. Quarterly, the MEF publishes its *Quarterly Issuance Program* which announces new securities and reopenings of outstanding bonds that will be issued in the subsequent quarter. About longer BTPs, monthly the Italian Treasury supplies BTPs with 15y, 20y or 30y maturities at mid-month auction and 10y BTPs at the end of the month. In September 2015 - April 2016 period, 8 auctions both on 10y BTPs and on longer BTPs were conducted. Comparing the issued amounts through regular auctions during September 2015 - April 2016 and the average amounts of the same period during last five years (2013 - 2017), no substantial difference in the supply side can be identified. In the period 2015-2016, the issued amounts on 10y BTPs was 21.750 millions (mm) and on 15y BTPs was 5.956mm. In the same periods over the last five years, the average issued amounts on 10y BTPs has been 21.825mm and on 15y BTPs was 6.114mm[15].

Lastly, from the demand side, this period benefits from the homogeneous buying activity of ECB through its PSP program: the QE on sovereign bonds has started in March 2015 and it has been modified only at the end of the period (on March 10th, 2016, the Governing Council of ECB took the decision to reduce its reference interest rates and to increase its monthly purchases of European sovereign bonds and other corporate bonds from 60€billions to 80€billions starting from April 2016).

From a market perspective, it seems to be a good period to be analyzed with limited risks that contingent or long-run factors caused divergence in the inventories of market makers

[15]Table 75 in Appendix .4.2 presents the details of the Italian Treasury's issuance activity.

of 10 years BTPs versus 15 years BTPs. However, next paragraphs explain in more details how the analysis controls in the empirical setting for auctions and global trading activity of investors.

The following model is estimated:

$$Y_{it} = \alpha_0 + \beta change_{it} + \gamma X'_{it} + d_t + a_i + \varepsilon_{it}, \tag{4.1}$$

where $change_{it}$ is a dummy variable that assumes value one when observation is about a bond i that has maturity longer than 10 years in the 2016 year (treatment period). These observations are those referred to bonds that have been affected by the new set of market rules, implying the coefficient β represents the estimated effect of the regulatory switch on the outcome variables. Then, d_t represents time fixed effects and a_i is bond fixed effects. The model is estimated on three different outcome variables in order to verify different dimensions in the quoting response of market makers. In particular, the analysis estimates the causal effect on:

1. Bid-Ask Spread in percentage on the mid quote (BA_{it}): normalizing the absolute bid-ask spread with respect mid price allows to compare bid-ask spreads of different BTPs.

2. Total quoted quantity (Q_{it}): the average between the total depth quoted on the ask and on the buy sides.

3. Price impact of 20mm (PI_{it}): the difference between the mid price and the realizable execution price of a deal of 20mm (both on the bid and ask sides).

These outcome variables are selected among the most informative liquidity measures about the quoting activity of market makers on MTS Italy (Coluzzi et al., 2008) and these have been discussed in depth in the section 3.2.1. By employing these three measures, one can jointly infer about the choices of specialists about the level of tightness and the quoted size. In Appendix .8 descriptive statistics of each outcome variable for each bond are presented.

In order to conduct the analysis, monthly averages are employed[16]. The dataset is originally composed by the snapshots of the quoting book of each bond with a frequency of 5

[16]I have also employed weekly observations. The results confirm those with monthly data.

minutes from 9.00 am to 5.00 pm for each trading day. For each snapshot, liquidity measures are computed and then are averaged in order to get monthly observations.

The covariates employed in the model are: idiosyncratic volatility, computed as the monthly average of daily min-max quoting prices range; specialness, computed as the monthly average of daily differences between the realized repo yield and general collateral repo yields on the TomNext segment; auction, a dummy variable that assumes value one if an auction of the bond occurs in that month. As previously discussed in the section of the literature review, these control variables are selected in order to check for different factors that *a priori* may affect liquidity conditions of bonds. Volatility is the key component of the risk in providing immediacy in execution service. Specialness replicates the inventory (opportunity) cost to hold negative (positive) net position. Auction variable refers to the supply activity of the Italian Treasury.

4.4.2 Results

The estimates of the causal effect of the regulatory change on the three liquidity measures are presented in Table 4.1.

	(1)		
	BA	*Q*	*PI*
β	-0.015	0.785	-3.982
Robust SE	0.003	1.715	0.694
p-value	0.001	0.654	0.001
Covariates	yes	yes	yes
Obs	120	120	120
R^2	0.697	0.841	0.692

Table 4.1: **Panel estimates**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.1 with bond and time fixed effects with each observation defining a bond-month. The causal effect of the change in monitoring rules between 2015 and 2016 is estimated on three different liquidity measures of the quoting book: best bid-ask spread (BA), average bid and ask depths (Q) and price impact of a deal of 20mm (PI). Under each coefficient, robust standard errors (clustering at the level of individual bonds) and p-value are presented.

The estimates confirm my first predictions about the effect of the changes in monitoring rules on liquidity measures. I find a significant and negative impact on the bid-ask spread and no significant effect on the whole quoted quantities. The negative impact on the best bid-ask spread is 0.17% , equal to 17 price ticks on a bond with actual value of 100€. Price impact is significantly and negatively affected by rules' change: new rules reduce the cost of execution of a 20mm deal of 3.98 price ticks.

These results highlight that the liquidity measures are affected by the set of monitoring rules defined by the Italian Treasury. In the next sections, I provide some robustness checks in order to reinforce these results. Secondly, the combination of a narrower bid-ask spread and an unchanged total depth seems to be inconsistent with the theoretical predictions of Kavajecz (1998)[17]. In section 4.5 I put forward a possible explanation that combines the theoretical microstructure models and the role of public ranking system in pushing the competition among market makers.

4.4.3 Robustness checks

In this section, robustness checks are provided in order to test the hypothesis of selection bias time invariant before the treatment, to exclude a delayed effect of the new rules, potential seasonal effects and to assess the role of market makers that are not specialists.

Selection bias time invariant in the pre-treatment period

As a first robustness check, the hypothesis that the selection bias is constant over time in the pre-treatment period has been tested. Three diff-in-diff models are estimated considering the three couples of months in the pre-treatment period (September 2015 – October 2015, October 2015 - November 2015, November 2015 - December 2015). Estimating the following model:

$$Y_{it} = \alpha_0 + \alpha_1 D_i + \gamma X'_{it} + \alpha_2 T_t + \beta D_i T_t + \varepsilon_{it}, \tag{4.2}$$

where D_i assumes value one if the bond i has residual maturity greater than 10 years and T_t is a time dummy variable, one should expect not to find any statistical significance of β coefficient, if the selection bias is constant in pre-treatment period.

Table 4.2 shows the estimation results. As expected, the selection bias problem seems

[17] He found that prices and depths are used as substitutes: a narrow bid-ask spread induces small depth quotes whereas large depth quotes induce a wide bid-ask spread.

	Sep 15 - Oct 15			*Oct 15 - Nov 15*			*Nov 15 - Dec 15*		
	BA	*Q*	*PI*	*BA*	*Q*	*PI*	*BA*	*Q*	*PI*
β	-0.007	0.590	-1.899	0.007	2.426	1.724	0.014	1.460	4.202
SE	0.010	5.085	2.129	0.009	3.708	2.063	0.013	3.353	3.040
p-value	0.481	0.908	0.381	0.458	0.518	0.411	0.297	0.667	0.178
Obs	30	30	30	30	30	30	30	30	30
R^2	0.573	0.706	0.381	0.604	0.809	0.411	0.605	0.839	0.707

Table 4.2: **Selection bias time invariant in pre-treatment period**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.2 in the section 4.4.3. The selection bias is estimated on three different liquidity measures of the quoting book: best bid-ask spread (BA), average bid and ask depths (Q) and price impact of a deal of 20mm (PI). Under each coefficient, standard errors (without any adjustments, in order to get less conservative estimates of potential risk of selection bias time variant) and p-value are presented.

not to affect the estimates of the basic models, since β coefficients are not significant in any couple of months in the pre-treatment period. This result confirms the goodness of the design of the basic empirical setup, since in the pre-treatment period no significant difference between the two groups of BTPs is found.

Slow-acting effect

Secondly, the hypothesis that the regulatory change affects immediately market makers quoting choices without any delayed effect has been tested. Also in this case, three diff-in-diff models, considering the three couples of months in the post-treatment period (January 2016 – February 2016, February 2016 - March 2016, March 2016 - April 2016), are estimated. The models are the same of the previous robustness check and also in this case one should expect not to find any statistical significance of β coefficient.

Table 4.3 shows the results of the estimation of β coefficients. The absence of significant coefficients in the three estimated models suggests that specialists immediately react to the entry into force of new rules in January and no slow-acting effect is revealed.

The role of *market makers not specialists*

On MTS Italy, investors are divided into two groups: market makers and market takers. As mentioned above, among market makers a group of selected dealers act as *specialists*,

	Jan 16 - Feb 16			*Feb 16 - Mar 16*			*Mar 16 - Apr 16*		
	BA	*Q*	*PI*	*BA*	*Q*	*PI*	*BA*	*Q*	*PI*
β	-0.003	-1.402	-0.869	-0.003	0.749	-0.549	-0.002	0.369	-0.699
SE	0.008	4.299	1.864	0.007	5.076	1.510	0.006	5.585	1.419
p-value	0.697	0.747	0.645	0.664	0.884	0.719	0.696	0.948	0.626
Obs	30	30	30	30	30	30	30	30	30
R^2	0.498	0.762	0.659	0.465	0.676	0.698	0.444	0.617	0.677

Table 4.3: **Slow acting effect**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.2 in the section 4.4.3. The slow acting effect is estimated on three different liquidity measures of the quoting book: best bid-ask spread (BA), average bid and ask depths (Q) and price impact of a deal of 20mm (PI). Under each coefficient, standard errors (without any adjustments, in order to get less conservative estimates of slow acting effect) and p-value are presented.

facing quoting obligations that are set by the Italian Treasury. However, also a group of operators that are market makers but are not specialists exists. This presence may affect the analysis conducted in the previous section. The assumption of the basic model, that will be tested in this section, is that this group of operators, not affected by any rules' change, maintains unchanged its quoting behavior across the two groups of BTPs. Since the dataset does not allow to directly identify proposals of market makers and specialists, we introduce the analysis with some descriptive statistics and then we provide a formal test about this potential disturbance.

Firstly, some descriptive statistics on quoting books and trading activity could help to identify the dimension of this disturbance. Looking at the trading side, the market share of volumes traded as fillers[18] of these operators is 7,23% on all the segments of Italian government bonds (BOT, CTZ, CCT, BPT) and 8,44% if the sample of the fifteen bonds is considered[19]. Looking at the quoting activity, using the entire database of the 16296 observations (the snapshots of the books at 5 minute frequency in 168 trading days) on the fifteen bonds, the average number of proposals is 20.16, very close to the number of specialists. If the assumption about the constant presence in the quoting book of proposals posted by the specialists is true, this average indicates a negligible contribution of *market*

[18]Market maker quotes her proposals (a combination of prices and quantities) that can be filled by investors. If investors are looking to sell (buy) a security, market makers purchase (sell) that security. Market maker is in this respect the *filler* and the investor is the *aggressor*.

[19]Information provided directly to the author by MTS.

makers not specialists in the quoting activity. If one looks at the maximum number of quotes contemporaneously present in a snapshot, it is 28 for two bonds[20] and the average across the fifteen bonds is 26.46. Note that the difference between the maximum number of quotes and the number of specialists it is not necessarily only representative of the proposals of *market makers not specialists*. A second reason that may implicate an higher number of proposals is the possibility for specialists to post in the quoting book a second quote for each side of the market (Mormando, 2017).

In order to formally assess whether *market makers not specialists* have modified their quoting behavior, distorting our previous estimates of the causal effect between the new regulation and liquidity measures, we introduce two more liquidity measures. These measures are related to the trading volumes, linked to the quoting decisions, of the *market makers not specialist*. In more details, the *volumes traded as fillers* of the entire group of *market makers not specialists* and the correspondent *proportion calculated on the total trading activity* are used as outcome variables. Even if these are trading measures, these are strictly related to the quoting activity, the focus of the paper. As a matter of fact, the trading activity as filler (not as aggressor) is directly linked to quoting behavior: the probability that a proposal of a market maker will be hit by orders flows is function of the position of this proposal in the quoting book. Narrower the bid-ask spread, higher the probability to deal as filler.

To assess the role of this group of operators, the previous model 4.1 is estimated. From these regressions, one should expect not to find any statistical significance of β coefficient, since this group of market makers has not been affected by any regulatory modification.

As expected, β coefficient is not found significant in both specifications. It means that the group of *simple* market makers do not change their quoting behavior on BTPs with different maturities along the period considered. The result strengthens the conclusion that the causal effect estimated in section 4.4.2 is related to quoting behavior of specialists, that are affected by new monitoring and public ranking rules.

[20]The ISIN code of these two bonds are IT0005094088 and IT0005001547. The table in appendix .9 presents the details about descriptive statistics of the number of proposals in the quoting book for each bond in the sample.

	(2)	
	Vol MM	*Perc MM*
β	-12.128	-0.026
SE	8.639	0.018
p-value	0.182	0.175
Covariates	yes	yes
Obs	120	120
R^2	0.415	0.308

Table 4.4: **Panel estimates on outcome variables: VolMM and PercMM**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.1 in the section 4.4.3. The causal effect of regulatory changes is estimated on two different liquidity measures of the trading activity of market makers that are not in the group of specialists: volumes traded as filler (Vol MM) and the fraction of these volumes on the total trading volumes (Perc MM). Under each coefficient, robust standard errors (clustering at the level of individual bonds) and p-value are presented.

Is there any seasonal bias?

In previous sections, a crucial underlying assumption is that no relevant seasonal effect exists between the two groups of BTPs during the pre-treatment period (September-December) and the post-treatment period (January-April). In order to test whether this effect may invalidate the estimated causal effects of previous sections, the same analysis is conducted on the same period of one year later, from September 2016 to April 2017. Between these two years, the MEF did not modify in any relevant way the criteria on quoting and trading activity of specialists on MTS. The more significant change is the reduction of the maximum score assigned to the best specialist in the QQ Index, from 9 to 8 points. However this change, differently from the case of 2015-2016 period, has affected the entire group of BTPs. A second relevant change is linked to the decision of creating new benchmarks for the maturities of 20 years and 50 years during 2016. The MEF issued for the first time on April the new 20 years BTP benchmark and on October the new *matusalem* 50 years BTP. In 2017 criteria, the MEF has integrated the weights for the primary and secondary markets' criteria in order to take into consideration the contribution of these two new segments. However, the previous analysis is not affected by the potential disturbance of these segments since the selected group of BTPs under treatment is composed by bonds with residual maturity lower than 15 years, bonds with a maturity sufficiently far from 20 years.

2016-2017 period is suitable for the purpose to test whether any relevant seasonal effect exists also because the structure of the Italian Treasury supply and market demand seems to be unaffected by relevant shocks in the difference between the two segments. As shown in Table 75 in the Appendix .4.2, the issued amounts of 10y and 15y BTPs is close to the average of the last 5 years and to the amounts of the same period of 2015-2016. From the demand side, on 8 December 2016 Governing Council of the ECB decided that from April 2017, the net asset purchases were intended to continue at a reduced monthly pace of €60 billion until the end of December 2017. This change, that covers only marginally the period analyzed, did not provide any relevant information about differences on net purchase activity between the two groups of BTPs.

Looking at the test, this section presents the estimates of regression model 4.1, considering the 1st September 2016 - 28th April 2017 period and selecting bonds that during these 8 months were included in the two classes of BTPs around the 10y maturities: eights bonds with residual maturity between seven to ten years[21] and seven bonds with residual maturity between ten to fifteen years[22]. In the estimated model, the treatment dummy ($change_{it}$) coincides with a dummy that is equal 1 for observations of 2017 period for bonds with residual maturity longer than 10 years. The models are estimated using the three basic outcome variables (*bid ask spread, quoted quantity* and *price impact*). The expectations are to find no relevant causal effect of the dummy, since no relevant change in monitoring criteria occurred.

The Table 4.5 shows the results of the estimated models. In the three specifications, the null hypotheses of no significance of the dummy have not been rejected. These results corroborate the validity of the estimated causal effect of monitoring rules' changes on the specialists quoting behavior, suggesting that the basic estimates of table 4.1 are not distorted by any seasonal disturbance.

[21] Isin codes: IT0005001547, IT0005045270, IT0004513641, IT0005090318, IT0005127086, IT0004644735, IT0005170839, IT0001086567, IT0005210650.

[22] Isin codes: IT0001174611, IT0004889033, IT0001278511, IT0005024234, IT000144378, IT0005094088, IT0003256820.

	(1)		
	BA	*Q*	*PI*
β	0.002	2.381	0.255
Robust SE	0.002	3.230	0.505
p-value	0.474	0.473	0.622
Covariates	yes	yes	yes
Obs	120	120	120
R^2	0.855	0.599	0.826

Table 4.5: **Panel estimates on September 2016 - April 2017 period**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.1 in the section 4.4.1 with bond and time fixed effects with each observation defining a bond-month. The hypothetical seasonal effect between September-December 2016 period and January-April 2017 period is estimated on three different liquidity measures of the quoting book: best bid-ask spread (BA), average bid and ask depths (Q) and price impact of a deal of 20mm (PI). Under each coefficient, robust standard errors (clustering at the level of individual bonds) and p-values are presented.

4.5 The role of public rankings as signaling

The previous section has found that a relevant link exists between the set of monitoring rules, laid down by the Italian Treasury, and the quoting decisions of market makers. This result suggests that empirical research on MTS Italy should always take into consideration how these rules may interact with the research topic and whether any changes occur during the analyzed period.

The results presented in the previous section do not seem to be consistent with the theoretic predictions of Kavajecz (1998). In fact, I find a combination of a narrower best bid-ask spread and an unchanged total depth, whereas Kavajecz found that prices and depths are used as substitutes. However, a basic difference between Kavajecz framework and this paper is that Kavajecz studies the behavior of a generic single market makers whereas this analysis is conducted on the higher perspective of the quoting book, that in the case of MTS Italy is the strict aggregation of proposals of a selected group of market makers.

In this section I put forward a possible explanation that combines and reconciles the theoretic microstructure models and the role of public ranking system in pushing the competition among market makers. This role is not strictly related to its compulsory nature but it is linked to the strong signaling power for the investors community. In the next paragraphs I present an hint of theoretical implication of the signaling role of public ranking system and I propose an empirical application in order to formally test my prediction.

4.5.1 The role of public rankings in the microstructure models

Market microstructure models[23] assume that, in a competitive environment, the individual market maker sets her quotes in order to get at least an expected zero profit level. In these models, the market maker gains from the markup of the bid and ask prices on the asset's mid fair price, whereas the costs are mainly related to fixed components, order processing costs, inventories control costs and asymmetric information costs. However, market making activities are carried out by desks of global investment banks or financial intermediaries. These operators, in order to decide whether to provide liquidity on a specific asset, take into consideration not only the expected direct costs and benefits, but also implicit and indirect ones. In the case of the market making on the Italian sovereign bonds, specialists benefit quite homogeneously from their privileges explicitly cited by the MEF in its "Specialist Decree": exclusive access to reserved reopenings and to the selection of lead managers of syndicated issuances or in any other extraordinary transactions. However, the opportunity of being in the top positions of the public ranking system offers other potential benefits for specialists.

The signaling power of public ranking

Being in the top positions of the public ranking system offers to market operators several sources of potential returns from this positive signaling.

First, specialists, contributing in the efficiency of the secondary market, improve their reputation with the national Debt Management Office. This could lead to an higher probability to be selected as lead managers of syndicated issuances or as counterpart in bilateral transactions. From the specialist's perspective, these deals offer a good return in terms of trading revenues and commission fees. Secondly, since Ministry plays also a role as national regulator, some banks could consider positively the opportunity to strengthen the relationship with the Ministry, signaling their compliance in providing high liquidity levels in the market of Italian sovereign bonds.

[23] We refer to De Jong and Rindi (2009) for an exhaustive literature review.

Third, being in the top positions of the public ranking provides a signal on the specialist' skills and compliance in offering good execution service for buy-side or sell-side clients[24]. Thus they can use the segment of government bonds, characterized by high competition and low profitability, to increase fidelity of their customers in execution services in asset classes with low competition and high margins. Lastly, investment banks define bonuses for the trading desk or for individual traders linked, not only to the profit and loss performance, but also to the final ranking position.

Consequently and in summary, the public ranking offers a signaling for investment banks with the Debt Management Office, the community of buy-side and sell-side investors, and for traders within their organization.

The model

Using Kavejecz (1998) notation, specialist's optimization problem is to set her proposal schedule on the bond i in order to maximize profits: the specialist j posts bid and ask prices b_{ij}, a_{ij} and the quoted bid and ask quantities β_{ij}, α_{ij}. Her expected return will be $E_{ij}[\pi(b_{ij},\beta_{ij},a_{ij},\alpha_{ij})]$, facing direct and indirect costs as asymmetric information, fixed trading costs, inventory risk. In previous literature, no role for incentives deriving from the public ranking system exists. The simplest way to consider this potential benefit is to add a positive economic component in the profit maximization problem. Suppose $h_{ij}(\gamma_j,b_{ij},\beta_{ij},a_{ij},\alpha_{ij})$ is the function that describes the expected return to offer liquidity on a specific asset reaching a top position in the final ranking. Quoted prices and quantities, $b_{ij},\beta_{ij},a_{ij},\alpha_{ij}$, directly affect the individual ranking score: narrower bid-ask spread and higher quoted depth return, *ceteris paribus*, higher expected final score in the ranking. The γ_j parameter represents the individual ability to transform the final position in the public ranking in economic revenues, that are related to higher reputation among the community of financial investors, marketing activity, direct explicit privileges or cross-subsidies deriving from the execution services provided to her clients in other asset classes. This parameter is individual specific since the portfolio of clients of each investment bank, the propensity to conduct aggressively marketing activities and the interest in final ranking position could be different among market makers. The final expected return becomes $E_{ij}[\pi_{ij}()+h_{ij}()]$.

[24]The buy-side clients is the community of financial investors, proprietary desk of banks, real money, pension funds and other kind of investors. The sell-side are typically Debt Management Office of other Countries.

In the light of the above, I propose a reconciliation of the signaling of public ranking with theoretical market models.

Taking the perspective of a generic specialist and following Kavajecz (1998), after the introduction of the new set of monitoring rules of 2016, market maker may jointly narrow her quoted bid-ask spread and reduce the quoted depths. By doing that, table 4.6 summarizes the expected impact on the scores of the criteria of secondary market of a narrow bid-ask spread and lower quoted quantities. Higher the scores, higher position in the final ranking is expected by the specialist.

Variable	Variation	QQI	TV	NBTF	LSC
Q_b or Q_b	↓	=	−	=	−
Bid-Ask Spread	↓	+	+	+	+
Total		+	+/−	+	+/−

Table 4.6: **Relation between quoting variables and scores of evaluating criteria**. Taking the perspective of an individual market maker, the table shows how a reduction of quoted depth or a tighter bid-ask spread, *ceteris paribus*, affect the expected scores got from the four evaluation criteria on the secondary market.

When a market maker reduces her quoted depth, *ceteris paribus*, she reduces the expected market share in the secondary market (TV) and the contribution in increasing the traded contracts size (LSC). At the same time, the quoted quantities do not affect QQI and NBTF indicators. Conversely, narrowing the bid-ask spread, market maker increases scores in all indexes: quoting more aggressively leads market maker to lower her QQI (but higher score for the ranking) and to increase volumes traded as filler, leading to higher scores in TV, NBTF, LSC indicators.

For traditional models, only the removal of minimum quantity of 5mm in the segment of BTPs with residual maturity longer than 10 years might affect specialists' behavior (only this change modifies the set of mandatory obligations for market makers, whereas the other changes affect the implicit incentives in competing for the ranking). In fact, in these models there is no role for ranking: competition among specialists should have already led to a market equilibrium characterized by a zero expected profit for them. Relaxing the rule of the minimum quantity, market makers may solve their optimization problem, setting their optimal quantities (that can be lowered up to 2mm, the new minimum size) and prices (the bid ask spread may be reduced if they reduce their quoted quantities[25]).

Introducing potential benefits from the signaling of public ranking, the effects of the changes in monitoring rules on quoted bid-ask spread and depths could be different. Taking the perspective of a single market maker, she sets prices and quantities taking into account also the expected revenues of h_{ij}, linked to the final score in the ranking. The market maker may choose to reduce proposals' size in order to compete in tightening the bid-ask spread and to get an higher score in QQI and NBTF indicators. More precisely, looking at the Table 4.6, decreasing depths and tightening spread in response to the new rules, the total effect on QQI and NBTF criteria is strictly positive, while the effect on TV and LSC indices is uncertain. Thus market makers, in order to limit the negative impact of their quoting choices on TV and LSC indexes, are incentivized to reduce less their quantities with respect the case without the signaling from the public ranking.

In line with Kavajecz (1998) predictions, higher the propensity of a specialist to compete in narrowing the bid-ask spread, lower the quoted sizes will be. A market maker that does not compete in tightening the market, and consequently reduces her expected scores in QQI and NBTF indexes, should reduce her quantities less than a more competitive market maker (in terms of bid-ask spread) in order to limit the negative impact on TV and LSC indicators. Note that it is not of interest to formally determine the optimal strategy of each market maker in setting her quotes and quantities, the purpose of the paper is just to argue the importance of taking into account the role of the signaling power of the public ranking in evaluating market microstructure when monitoring and ranking systems exist.

Variable	Traditional models	Ranking model
Total quoted depth	↓	= / ↓
Best Bid-Ask Spread	= / ↓	↓

Table 4.7: **Changes in ranking system and microstructure models**. Taking the quoting book perspective, the table shows the effect of the variations of monitoring rules over two liquidity measures (total quoted depth and best bid-ask spread) whether ranking system is assumed to be considered or not by specialists in their quoting choices.

[25]Kavajecz, 1998.

Prediction n.2

Taking the higher perspective of the quoting book, that aggregates the proposals of the group of specialists, the effect on liquidity measures (*total depth* and *best bid-ask spread*) of the new rules under ranking and no-ranking models are summarized in Table 4.7. If ranking does not affect market makers' choices, no effect on best bid-ask spread and a reduction of quoted depth, close to difference between the two minimum quantities in the two regimes (3mm) multiplied by the number of specialists, will be found. If the positive incentives of the signaling of the public ranking are considered, a combination of high level of tightness and a smaller reduction of quoted depth should be found. This paper hypothesizes that the public ranking, through its implicit incentives and expected returns from being in the top positions of the final ranking, links monitoring rules with specialists' quoting behavior. Since these returns are heterogeneous among specialists due to the different expected reward of the signaling power of the public ranking, these benefits are individual based and vary across the market makers.

In the light of the previous discussion, I can summarize the second testable empirical prediction.

Prediction 2: Public ranking heterogeneously affects specialists.

The return from high ranking position is uncertainty and heterogeneous since each operator is differently exposed to the potential benefits of the ranking regime (e.g., higher reputation among the community of financial investors and with other sovereign DMOs, direct explicit privileges or cross-subsidies deriving from the execution services provided to customers in other asset classes).

In the following sections, the empirical application tests this prediction.

4.5.2 The empirical application

In this section, I test the second prediction and I investigate whether specialists react differently to the changes of the ranking rules. The results from the starting model suggest that few market makers have decreased their bid-ask spread, and probably have reduced also their proposals' size, in order to compete for market orders flows and for getting higher scores for the quoting indexes. However, the total effect on the quoted depth is not significant, suggesting that market makers have defined different strategies.

In order to test the second prediction, the previous model 4.1 is estimated on three new liquidity measures as outcome variables:

1. Variance of quoted prices weighting for correspondent depths in the book (VAR_{it}),
2. Volume-weighted bid-ask spread in percentage on the mid quote ($VWBA_{it}$),
3. Average quoted quantity per proposal in the two top positions of the order book ($A2B_{it}$),

Figure 4.1 shows two examples of quoting book in line with the results got from the previous section and it helps to understand which contribution in the empirical test might offer the introduction of these three liquidity measures. For each quoting book and for each side of the market, the quoted prices (*P*), the correspondent quantities (*Q*) and the number of proposals (*N*) are shown. The example of the quoting book of 2016 year assumes that only two operators have modified their quoting strategies from 2015: the most competitive market maker has reduced the quoted quantities and has narrowed the bid ask spread, whereas the less competitive increases the quoted depths in order to offset the lower expected score got from QQ index (since its proposals have moved from the third level to the fourth). The second book shows a narrower *best bid ask spread* (9 price ticks vs 15 price ticks), an unchanged *quoted depth* of €100 millions and a reduction of the *price impact* of a deal of €20 millions (7 price ticks vs 7.5 price ticks).

2015

Level	Bid			Ask		
	N	Q_b	P_b	P_a	Q_a	N
1	10	50mm	99.95	100.10	50mm	10
2	9	45mm	99.90	100.11	45mm	9
3	1	5mm	99.85	100.15	5mm	1
4						

2016

Level	Bid			Ask		
	N	Q_b	P_b	P_a	Q_a	N
1	1	3mm	99.98	100.07	3mm	1
2	9	45mm	99.95	100.10	45mm	9
3	9	45mm	99.90	100.11	45mm	9
4	1	7mm	99.85	100.15	5mm	1

Figure 4.1: **An example of quoting books**. The figure on the left shows an example of quoting book with rules of 2015, the figure on the right shows an example of how the quoting book may be modified after the changes in market rules of 2016.

I introduce the *variance* of bid (ask) prices in order to verify whether a greater prices' dispersion has occurred. Looking at the two examples, the concentration of prices in the first book is greater than the second, since the most competitive operator is now able to narrow the bid and ask prices, reducing the quoted quantities. The *volume weighted bid* *ask spread* is introduced since it is a measure of the global bid ask spread of the book. In this case, I expect to find a negative relation with the new monitoring rules, but with a lower impact with respect to the *best bid ask spread* since the response of market makers are heterogeneous, with a stronger reaction of those operators that actively compete for being in the higher prices. Lastly, the *average quoted quantity per proposal on the two top prices* is employed to test if only the most competitive operators has chosen to set their proposal schedule employing the opportunity, offered by the new set of rules, to reduce the quoted quantities in order to compete in narrowing the bid-ask spread. The result on the quoting book is that depth at the top levels apparently rarefies, actually it is new quoted volumes in higher competitive prices that were unable to be quoted with old rules.

	(1)		
	VAR	*VWBA*	*A2B*
β	0.006	-0.012	-0.830
Robust se	0.003	0.003	0.151
p-value	0.057	0.002	0.001
Covariates	yes	yes	yes
Obs	120	120	120
R^2	0.324	0.675	0.739

Table 4.8: **Panel estimates on outcome variables: VAR, VWBA, A2B**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.1 in the section 4.4.1 with bond and time fixed effects with each observation defining a bond-month. The causal effect of the change in monitoring rules between 2015 and 2016 is estimated on three different liquidity measures of the quoting book: variance of prices (VAR), volume weighted bid ask spread (VWBA), average size of proposals in the best two prices (A2B). Under each coefficient, robust standard errors (clustering at the level of individual bonds) and p-value are presented.

Table 4.8 shows the results of the estimated regressions. As expected, a significant and positive impact is found between the regulatory changes and the *variance* of prices in the order book. Conversely, a negative and significant causal effects are found between new rules and the *average depth per proposals in the top prices*. As expected, this reduction is due to the choice of the most competitive traders to quote proposals with lower depths. Lastly, a negative and significant impact is found on the *volume weighted bid ask spread*. This effect is lower than the effect on the *best bid-ask spread* measure: the rules' change has caused a tightening on the best spread of 0.15% (15 price ticks on a bond with actual value of 100€) whereas the tightening on the volume weighted global spread is found to be around 0.12% (12 price ticks). Combining these results with those found in the basic model, one can conclude that new monitoring rules have increased the competition among specialists in tightening the quoting book, signaling their compliance in the liquidity provision. At the same time, no negative sign of depth depletion in the global liquidity measures is found.

The conclusion on the heterogeneity of the impact across specialists could be enhanced by other evidences and comments got from our dataset and public rankings published in the Public Debt website. As a matter of fact, one possible alternative explanation for the results got from this section is that market makers homogeneously alternate, during a trading day, more and less aggressive quoting strategies in order to compete for trading flows and ranking.

Actually we argue that the new rules heterogeneously impact different market makers for the following reasons. Firstly, the rankings, published in the Public Debt website, show a strong persistence of few specialists in the top positions. In 2015, 2016 and 2017 rankings, the first four specialists are the same, also with the same rank (in Appendix 78 we show the rankings over the last decade): MPS Capital Services, JP Morgan, Banca Imi and Unicredit. So, there has not been a real turnover among specialists on the top positions in 2015-2016 period and the heterogeneity in the quoting preferences is a natural and inherent characteristic among operators.

Secondly, to provide a quantitative demonstration of our argument, we employ the two time series of the QQ index of the best and the median specialists in the two segment of BTPs considered in the analysis. QQI measures the contribution of each specialist in narrowing the market bid-ask spread and it is the exact representation, on a continuous basis, of its quoting strategy. To calculate the QQI of a generic specialist on a single bond, each position in the order book is weighted with decreasing coefficients that are in proportion to the position in the order book with respect to the best price, in order to reward more those dealers that continuously show the best prices both for the bid and the ask sides[26]. The higher is the contribution in tightening the bid-ask spread, the lower is the QQI index. If a specialist quotes in the best positions both bid and ask prices, its QQI assumes value zero. If he quotes in the second positions both bid and ask proposals, its QQI assumes value 10 (5+5), according to values shown in Table 70 in Appendix .5.

[26]Weights are shown in Table 70, Appendix .5

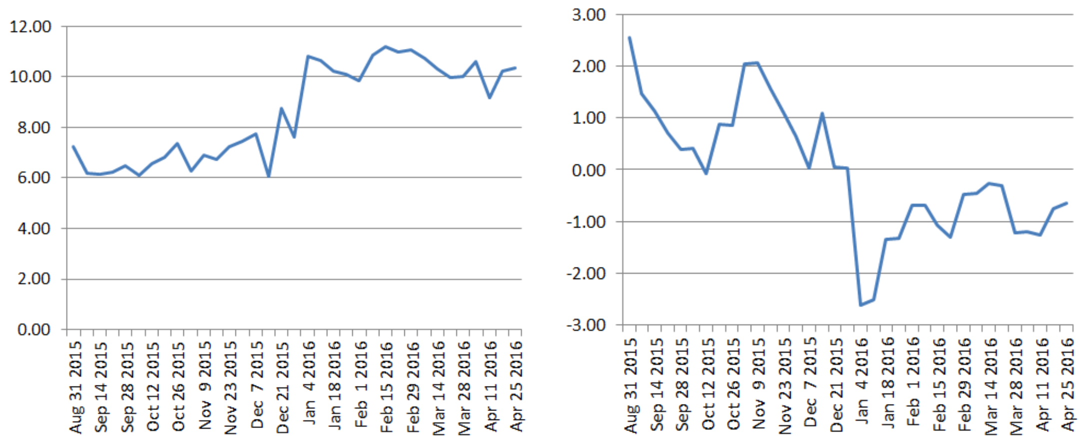

Figure 4.2: **QQI evolution**. In the left chart, selecting the group of BTP with maturity longer than 10 year, the evolution of the difference of QQI of the best and the median specialist is shown. Formally $QQI_{Median,BTP>10y} - QQI_{Best,BTP>10y}$. In the right chart, the evolution of the difference of QQI of the best and the median specialist on treated BTP and on control BTP is shown. Formally $(QQI_{Median,BTP<10y} - QQI_{Best,BTP<10y}) - (QQI_{Median,BTP>10y} - QQI_{Best,BTP>10y})$.

Selecting BTPs with maturities longer than 10 years, the chart on the left of Figure 4.2 shows the difference between QQI of the median specialist in the ranking and the QQI of the best specialist during the September 2015 - April 2016 period[27]. As mentioned above, the best specialist has a lower QQI with respect the other participants. This difference is positive. The figure shows a jump in correspondence of the new year. If we assume that the quoting behavior of the median specialist (that could represent the generic representative specialist) remains unchanged, this jump highlights that the new monitoring rules have differently impacted the behavior of the best and the median specialist.

The chart on the right of Figure 4.2 shows the diff-in-diff impact, considering as control variable the difference between the best and the median specialist on the segment of BTPs with maturity lower than 10 years[28]. From this figure, one can conclude that, from 2016, this difference has become negative. It means that, after the entry into force of the new monitoring rules, the behavior of the best specialist in the $BTP > 10y$ has strongly changed with respect the median operator, decreasing more than other specialists its QQI. The new rules have allowed the best specialist to strongly differentiate its quoting behavior from the quoting preference of the median specialist.

These quantitative and qualitative arguments lead to consider more likely an heteroge-

[27] Formally, $QQI_{Median,BTP>10y} - QQI_{Best,BTP>10y}$.
[28] Formally, $(QQI_{Median,BTP<10y} - QQI_{Best,BTP<10y}) - (QQI_{Median,BTP>10y} - QQI_{Best,BTP>10y})$.

neous impact of the new rules on the whole group of specialist. However, further research, with a different dataset on individual quotes, could specifically address this research question.

4.5.3 Robustness checks

In this paragraph I propose the same robustness checks conducted on the model for testing *Prediction n.1*: I test the hypothesis of selection bias time invariant before the treatment, the hypothesis of a delayed effect of the entry into force of the new rules and potential seasonal effects that can affect the period September-April.

Starting from the first two tests, tables 4.9 and 4.10 show the results got from the tests about the presence of a selection bias time invariant in the pre-treatment period and a delayed impact of the new rules during the treatment period. The model of these tests is formalized in equation 4.2. As expected, both robustness checks confirm the absence of significant coefficients across the whole group of regressions, suggesting that the specialists has immediately reacted to the entry into force of new rules without anticipating effects and selection bias disturbance in the pre-treatment period.

	Sep 15 - Oct 15			*Oct 15 - Nov 15*			*Nov 15 - Dec 15*		
	VAR	*VWBA*	*A2B*	*VAR*	*VWBA*	*A2B*	*VAR*	*VWBA*	*A2B*
β	0.009	-0.009	-0.063	-0.005	0.003	0.169	0.005	0.018	-0.224
SE	0.007	0.019	0.146	0.008	0.017	0.140	0.007	0.022	0.145
p-value	0.197	0.644	0.671	0.496	0.847	0.238	0.804	0.418	0.135
Obs	30	30	30	30	30	30	30	30	30
R^2	0.849	0.515	0.402	0.784	0.847	0.354	0.803	0.534	0.327

Table 4.9: **Selection bias time invariant in pre-treatment period**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.2 in the section 4.4.3. The selection bias is estimated on three different liquidity measures of the quoting book: variance of quoted prices (VAR), volume weighted bid-ask spread (WVBA) and average depth per proposals at the best two prices (A2B). Under each coefficient, standard errors (without any adjustments, in order to get less conservative estimates of potential risk of selection bias time variant) and p-value are presented.

Lastly, I verify whether any seasonal bias exists in the period from September to April. As in the case of robustness checks of *Prediction 1*, I replicate the same analysis of section 4.5.2 considering the September 2016 - April 2017 period.

	Jan 16 - Feb 16			*Feb 16 - Mar 16*			*Mar 16 - Apr 16*		
	VAR	*VWBA*	*A2B*	*VAR*	*VWBA*	*A2B*	*VAR*	*VWBA*	*A2B*
β	-0.021	-0.010	0.528	-0.006	-0.005	0.197	-0.008	-0.006	-0.026
SE	0.007	0.018	0.203	0.006	0.015	0.142	0.006	0.015	0.145
p-value	0.005	0.577	0.016	0.297	0.733	0.179	0.194	0.676	0.858
Obs	30	30	30	30	30	30	30	30	30
R^2	0.910	0.511	0.875	0.918	0.481	0.911	0.892	0.445	0.884

Table 4.10: **Slow acting effect**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.2 in the section 4.4.3. The slow acting effect is estimated on three different liquidity measures of the quoting book: variance of quoted prices (VAR), volume weighted bid-ask spread (WVBA) and average depth per proposals at the best two prices (A2B). Under each coefficient, standard errors (without any adjustments, in order to get less conservative estimates of slow acting effect) and p-value are presented.

	(1)		
	VAR	*VWBA*	*A2B*
β	-0.006	0.003	0.075
Robust SE	0.004	0.002	0.091
p-value	0.175	0.304	0.423
Covariates	yes	yes	yes
Obs	120	120	120
R^2	0.406	0.829	0.621

Table 4.11: **Panel estimates on September 2016 - April 2017 period**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.1 in the section 4.4.1 with bond and time fixed effects with each observation defining a bond-month. The hypothetical seasonal effect between September-December 2016 period and January-April 2017 period is estimated on three different liquidity measures of the quoting book: variance of quoted prices (VAR), volume weighted bid-ask spread (WVBA) and average depth per proposals at the best two prices (A2B). Under each coefficient, robust standard errors (clustering at the level of individual bonds) and p-values are presented.

The results, presented in table 4.11, confirm the absence of any significant seasonal bias during the eight months of the analysis. In fact,in the three specifications, the null hypothesis of irrelevance of the dummy have not been rejected. These results corroborate the conclusions got in the previous section.

4.6 Symmetry between bid and ask sides

This section investigates whether different causal effects on the bid and ask sides could be found if the analysis is conducted separately. The previous liquidity measures on quoted volumes, on price impact and on variability of prices are computed as averages of the measures of bid and ask sides. In this section, regression results from models of equation 4.1, using as outcome variables the liquidity measures (*VAR*, *Q*, *PI* and *A2B*) computed separately for the two market sides, are shown. Several hypotheses could lead to different behavior of market makers on the bid and ask sides. Literature highlights that one of the main reason could be high inventories control costs (Ho and Stoll, 1983), that could affect, in the intraday activity, the quoting preferences of market makers. In previous estimated models, the *Specialness* variable, that measures the (opportunity) cost to own a negative (positive) net position on a given BTPs, should control for this crucial source of direct cost for specialists (Corradin and Maddaloni, 2017).

Table 4.12 shows the results of the estimated models on the causal effect of new market rules and the effect of the *specialness* variable on liquidity measures. First, these results are consistent with the general results got from the aggregated liquidity measures. Variances both for bid and ask sides are significantly and positively related to the new rules' set. A relevant and negative effect is found on A2B in both market sides, with a little stronger effect on the ask side, and on price impact measures. Lastly, no effect is detected on the total quoted quantities, consistent with the results got from the basic specification. The specialness is not found to be a significant variable in these eights specifications. Note that the absence of any relation on the total quantity is consistent with previous literature (Buti and Rindi, 2012): even in the case market makers own a large imbalance on a bond's inventory, they have the incentive to quote proposals with undisclosed size near to the minimum level, limiting the difference between depths on the two sides of the market and minimizing their exposure costs.

	(2)							
	VAR Bid	VAR Ask	Q Bid	Q Ask	A2B Bid	A2B Ask	PI Bid	PI Ask
β	0.006	0.006	0.623	0.947	-0.812	-0.848	-3.973	-3.990
Robust SE	0.003	0.003	1.762	1.737	0.146	0.169	0.678	0.713
p-value	0.060	0.063	0.728	0.594	0.000	0.000	0.001	0.001
Specialness	0.012	0.017	3.756	2.934	0.264	-1.204	7.431	8.707
Robust SE	0.055	0.052	16.408	14.030	0.752	1.356	5.753	6.151
p-value	0.837	0.741	0.822	0.837	0.730	0.389	0.217	0.178
Covariates	yes	yes	yes	yes	yes	yes	yes	yes
Obs	120	120	120	120	120	120	120	120
R^2	0.463	0.484	0.835	0.839	0.730	0.682	0.700	0.681

Table 4.12: **Panel estimates on bid and ask outcome variables: VAR, Q, A2B, PI**. The table shows the estimates of β coefficient of OLS panel regressions defined in model n. 4.1 in the section 4.4.1 with bond and time fixed effects with each observation defining a bond-month. The causal effect of the change in monitoring rules between 2015 and 2016 is estimated on four different liquidity measures, separately for bid and ask sides: variance of bid and ask prices (VAR), average bid and ask depths (Q), average size of proposals in the best two prices (A2B) and price impact of a deal of 20mm (PI). The impact on these outcome variables of *specialness*, defined in section n. 4.4.1, is also shown. Under each coefficient, robust standard errors (clustering at the level of individual bonds) and p-value are presented.

4.7 Threshold date analysis

Lastly, an analysis with higher frequency data is conducted in order to verify whether specialists have adapted their quoting behavior aligned to the first trading day of the new year. This check verifies the speed of reaction of operators to the new obligations and, if a positive output is found, this evidence could reinforce the argument that the effects on the liquidity conditions in the BTPs with longer maturity are strongly related to the monitoring rules change, since it has been the only relevant event that occurred between the two years.

Formally, the daily averages of the liquidity measures for the control and treatment groups are computed separately. Then, the Bai and Perron test (Bai and Perron 1998, 2003) is employed in order to verify whether and when a structural change occurred on the differentiated series between measures of the two groups. The underlying assumption of this test is that the level of liquidity fluctuates around a stable mean in absence of structural changes, hypothesis coherent with the results of the previous robustness check. If new market making rules shift the long-run mean towards a different level, this test detects the dates when the changes have occurred.

In this robustness check, only measures that have been significantly affected by monitoring rules' change are selected: BA, PI, VAR, VWBA, A2B. In the following figures the results of the test applied to the five liquidity measures are shown. Each graph shows the time series of the aggregate liquidity measure for the treatment group (black line), control group (green line) and the correspondent differentiated serie (blu line in the second box). The red line in the second box represents the output of Bai and Perron test. The horizontal segment is the estimated mean for each sub-period. The break dates, binding for a maximum one breakpoint, are estimated by the Bai and Perron approach with 5 percent significance level and are also listed in Table 4.13 with the correspondent WD-max statistics of the test.

This robustness check confirms the main results of the previous analyses. Bai and Perron test detects a perfect alignment between the structural breaks in market making activity and the new monitoring rules for the level of tightness of the market (BA measure), the price impact measure and the average proposals' size in top positions of the book. The signs and values of the variations are coherent with the results of the previous sections. With respect the VWBA measure, the test detects a negative effect 16 trading days later the introduction of the new regulation. Since this liquidity measure aggregates the behavior of the whole

Liquidity	WD-max		Critical values		
Measure	statistic	Date	10%	5%	1%
BA	19.4813	04 January 2016	8.02	9.63	13.58
VWBA	15.1614	26 January 2016	8.02	9.63	13.58
PI	19.8343	04 January 2016	8.02	9.63	13.58
VAR	18.2913	14 December 2015	8.02	9.63	13.58
A2B	252.8207	04 January 2016	8.02	9.63	13.58

Table 4.13: **Bai and Perron test**. The table shows the outcome of Bai and Perron (1998) test applied to daily averages of five different liquidity measures. The null hypothesis is no structural break exists, the alternative is bound to one structural break. The WDmax statistics and the correspondent structural date are shown.

group of specialists, this result reinforces the idea that the responsiveness of market makers to monitoring rules' change could be heterogeneous among operators in terms of intensity and speed of reaction.

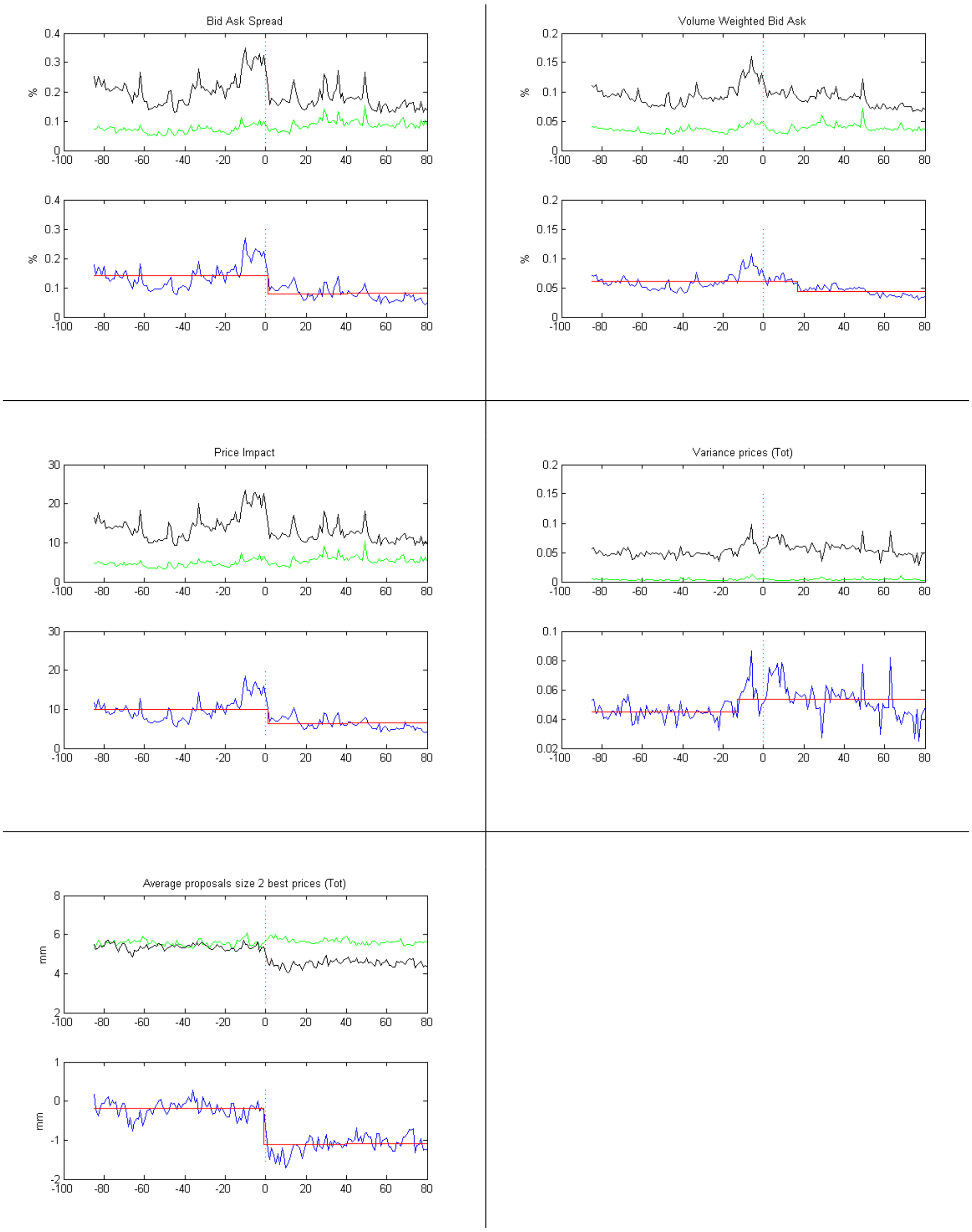

Figure 4.3: **Bai and Perron test results**. For each liquidity measure, the test with 5 percent significance level is applied to daily series computed as the difference between the average liquidity measure of bonds of control group and the average liquidity measure of bonds of treatment group. Test allows for heterogeneity and autocorrelation in the residuals and different moment matrices of the regressors across segments.

4.8 Concluding remarks

This paper has investigated the role of monitoring rules and specialists' ranking system on liquidity conditions of Italian government bonds. The contribution is twofold. To the best of our knowledge, this is one of the very first studies to statistically assess the impact of the public ranking on specialists' quoting preferences. Secondly, I argue and demonstrate that the positive effect of the monitoring rules and public ranking system on the market liquidity conditions is not due to the compulsory requirements of monitoring rules, but it is strictly related to the strong signaling power for the investors community of the public ranking.

The changes in monitoring rules, occurred between 2015 to 2016, has been employed as an instrument to detect the role of ranking system as a positive externality that may boost competition among specialists. Looking at the variation in the mandatory quoting obligations, the minimum size of €5 millions, that has to be quoted by market makers, was removed for a restricted group of BTPs (those with residual maturity longer than 10 years). These changes, that have entered into force on January 4th 2016, have determined both temporal and individual (in terms of bonds) discontinuities and thus have been suitable for a diff-in-diff econometric application.

In the first part of the study, I explain in details the features of MTS Italy and the expected positive effects of the specialists' ranking regime, set by the Italian Treasury, in order to improve liquidity in its wholesale market.

Second, I employ the changes in monitoring rules in order to quantify the global effect of public ranking on the quoting activity and on the related liquidity measures. Then, in the second part of the paper, I find signs of an heterogeneous response to the new market rules across market makers. I argue that I find this result since the benefits from being in the top positions of the public ranking system are closely related to the individual characteristics of each market maker. Given the same set of compulsory requirements, the response to a change in monitoring rules may be different across specialists. The individual response is strictly linked to the potential benefits of signaling its willingness to offer a good liquidity provision service.

Looking at the results, I find that changes in the monitoring criteria have a significant impact on the best bid-ask spread, that decreased in response to new market rules, improving the tightness of the quoting book. At the same time, the volume weighted bid-ask spread decreased but the impact was smaller than in the case of best bid-ask spread. No significant effect on the total quoted depth in the book is found. Looking at the variance of prices, new rules affected proposals distribution in the top levels of the book. More precisely, the variance of prices significantly increased, whereas price impact and average quoted size in top positions decreased in response to new rules. These evidences suggest that the new market rules have heterogeneously affected the decisions of market makers: few specialists have reduced their quoted sizes in order to compete in narrowing the best bid-ask spread, the others have not modified their quoting behavior. The total impact on the quoting book is an higher level of tightness and no relevant variation on the level of the global depth. New monitoring rules have globally improved liquidity conditions in treated BTPs.

These results have some important implications for several policy debates. First, I highlight that ranking regime affects specialists' behavior. This result implies that, in a pure specialists market, public ranking system may boost competitiveness among market makers in providing an high level of liquidity. A strong heterogeneity exists on the structure and rules of government bonds' markets of other European Countries. However, the Italian case is the most suitable framework to analyze how these ranking systems can affect market makers' choices since its quoting obligations are applied to a single eligible trading platform (MTS Italy) and annually the first five positions of the ranking are published. The results of this analysis can be generalized to other markets and to other sovereign issuers. Second, since an heterogeneous impact among different players is found, a decrease in uncertainty about potential privileges and benefits could help the principal (in this case, the Italian Treasury) to obtain a more homogeneous response among market participants. Further research could formally assess the specialists' optimization problem and could identify the determinants of market makers' quoting choices taking into account the impact of ranking system, disentangling the impact of explicit and implicit incentives.

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Appendix A. Definitions and abbreviations

Aggressor: the party in a trade that initiates the deal. The aggressor works with the market maker, who posts the bid and quotes and takes a passive role in the execution of the deal.

Ask price: it represents the minimum price that the investors has to pay to buy the security. From the market makers' perspective, the ask price is the minimum price at which they are willing to offer the security to the investors.

Bid price: it represents the maximum price that the investors receive if they sell the security. From the market makers' perspective, the bid price is the maximum price that they are willing to pay to buy the security from the investors.

Block trade/order: it is an order or trade submitted by the investors for the sale or purchase of a large quantity of security.

Carry trade: a trading strategy that involves borrowing at a low interest rate and investing in an asset that provides a higher rate of return. Typically, the borrowing cost is linked to risk-free rate and to inflation expectations.

CDS: Credit Default Swap. CDS are contracts whereby one party guarantees to a bond holder the principal repayment as well as the interest payments in case the issuer of the bond (the *reference entity*) defaults or experiences another credit event. In exchange for such protection, the *CDS buyer* ensures a constant payment over time, the *CDS spread*.

Depth: liquidity dimension that indicates the quantity available for trade on each side of the book.

DMO: Debt Management Office.

EC: European Commission.

Filler: the party in a trade that satisfies the execution of a deal initiated by the aggressor. Typically, the market maker is the *filler* in a deal.

Inside quote: it represents the best bid or ask prices of the quoting book. The inside quote is the prices at which market order will be executed.

Market maker: the dealer who is active on trading venues, on a continuous basis, and willing to negotiate as a direct counterparty in buying and selling of financial instruments at prices set by the same. Once an order is received from a buyer (seller), market maker immediately sells (buys) the security at its ask (bid) prices.

Market order: an investor makes a market order that guarantees the immediacy of execution at current market price.

On-the-run (bond): it is the most recently issued BTP of a particular maturity. The opposite is off-the-run, which refers to a bond that has been issued before the most recent issue and are still outstanding.

Quoting book: the market place where the quotes of market makers are aggregated and are organized follow the market rules.

Repo: a repurchase agreement (repo) is a form of short-term borrowing for dealers in government securities. For the party selling the security and agreeing to repurchase it in the future, is a repo. For the party on the other end of the transaction, it is a reverse repurchase agreement. Repo market allows investors to implicitly finance its buying and market makers to short-sell the bond in the cash market.

Reserved reopenings of government bond auctions: reserved reopenings give to the Specialists the right to buy predetermined additional quantities of the issued bond at the price settled at the auction. The application deadline is fixed at 3.30 p.m. of the business day following the auction. Thus it represents a free call option on the issued bond.

Naked CDS: the purchase of CDS by a buyer that is not actually exposed to the credit risk of the corresponding reference entity. This type of contract is called *naked CDS* in the sense that it is devoid of the real need to cover an effective credit risk exposure of the protection buyer.

Specialist: bank or investment company, selected by Italian Treasury among those that operates as market makers in the Italian government bonds, that faces other duties on primary and repo markets.

Resiliency: liquidity dimension that indicates how much prices move in response to a trade.

SCDS: Sovereign Credit Default Swap.

Short selling: short selling is the sale, carried out in respect to one or more third-parties, of securities not owned directly by the seller. The short seller, not being in possession of the bond, must borrow it from a broker and, within a certain deadline, he buys back to return it. Usually, interests shall be paid annually to the broker in relation to the duration of the short sale. Short seller benefits if the stock price has a bearish trend. In fact, if after the sale of the asset at the price P_1, the price drops to P_2 ($< P_1$), the bearish, being able to buy back the asset at a price P_2 to return it to the broker, has a gain equal to the difference between P_1 and P_2 and the interest paid. For the short seller, this is the direct effect, but there is another indirect effect for him. In fact, the signal that is sent to the market through a massive sale of a security could represent a negative expectation on asset price. If other investors decide to follow the bearish strategy, it can lead to a downward spiral that amplifies the negative trend of the securities. Therefore, the importance of limiting the contagion effect on government bonds is a determinant aspect to restore stability in the markets.

Stub quote: order placed well off the fair market price.

Tick size: it is the minimum price movement of a trading instrument.

Tightness: liquidity dimension that indicates how far transaction prices diverge from mid market prices.

Trading vanues: regulated markets and multilateral trading systems.

Appendix B. Chapter 2

.1 Panel analysis

.1.1 Variables manipulation.

Variables	Original frequency	Method of frequency conversion
Bond Spread	Daily	Period average
SCDS Spread	Daily	Period average
Bond Liquidity	Daily	Period average
Euribor 3 month	Daily	Period average
International risk aversion	Daily	Period average
Idiosyncratic volatility	Daily	Period average
EVZ Index	Daily	Period average
Counterparty risk	Daily	Period average
Debt-to-GDP ratio	Quarterly	Linear interpolation
GDP Growth	Quarterly	Linear interpolation
Inflation expectations	Daily	Period average
CDS Liquidity	Daily	Period average
CDS net amount to CDS gross amount ratio	Weekly	Period average
Repo specialness	Daily	Period average

Table 14: List of variables used in panel regression analysis and their manipulation.

.1.2 Descriptive statistics and charts of Country-specific variables.

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	1.772	0.459	4.227	1.154	0.926	1.323	2.491
Spain	1.835	-0.078	5.021	1.530	0.783	1.671	2.691
Germany	-0.325	-0.697	-0.151	0.016	-0.363	-0.285	-0.236
France	0.206	-0.236	0.828	0.052	0.059	0.154	0.334
Portugal	3.816	0.127	11.167	8.933	1.456	3.154	5.382
Netherlands	-0.013	-0.292	0.382	0.017	-0.092	-0.022	0.068
Austria	0.173	-0.274	0.771	0.052	0.066	0.120	0.245
Belgium	0.545	-0.124	2.242	0.201	0.255	0.470	0.686
Finland	-0.046	-0.327	0.381	0.019	-0.097	-0.052	-0.017
Ireland	2.713	0.178	8.995	4.359	1.262	1.857	4.574

Table 15: Descriptive statistics of bond spread

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	2.140	0.693	5.438	1.605	1.194	1.722	2.670
Spain	2.151	0.641	5.927	1.810	0.936	2.058	2.827
Germany	0.421	0.145	1.036	0.058	0.228	0.360	0.497
France	0.807	0.221	2.155	0.265	0.461	0.695	0.865
Portugal	4.103	0.520	12.174	11.336	1.549	3.211	5.191
Netherlands	0.532	0.184	1.229	0.084	0.323	0.454	0.593
Austria	0.787	0.222	2.066	0.276	0.354	0.667	0.992
Belgium	1.084	0.344	3.289	0.624	0.474	0.725	1.443
Finland	0.367	0.176	0.844	0.034	0.237	0.288	0.404
Ireland	2.937	0.470	9.297	5.840	1.256	1.824	5.512

Table 16: Descriptive statistics of CDS spread

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	0.340	0.089	1.081	0.031	0.231	0.352	0.394
Spain	0.482	0.126	1.562	0.116	0.229	0.357	0.676
Germany	0.188	0.074	1.432	0.033	0.113	0.141	0.188
France	0.313	0.109	1.457	0.058	0.138	0.181	0.451
Portugal	2.180	0.291	9.096	4.622	0.660	1.187	2.938
Netherlands	0.410	0.098	2.115	0.090	0.263	0.327	0.425
Austria	0.846	0.103	3.443	0.406	0.390	0.702	1.172
Belgium	0.509	0.136	1.845	0.148	0.221	0.388	0.633
Finland	0.533	0.142	2.898	0.242	0.228	0.345	0.616
Ireland	1.632	0.077	4.747	2.550	0.143	1.146	3.022

Table 17: Descriptive statistics of bond liquidity measure

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	121.103	101.867	137.628	79.284	115.250	118.900	128.950
Spain	73.071	38.300	100.690	369.489	56.567	72.367	91.900
Germany	75.793	65.033	80.700	14.170	73.700	76.233	78.950
France	86.504	67.633	99.213	61.886	81.650	87.783	92.400
Portugal	110.173	70.933	134.984	440.606	90.517	114.517	130.083
Netherlands	62.615	50.900	70.416	23.602	58.833	62.050	67.617
Austria	80.828	67.800	86.300	15.471	81.000	82.050	82.800
Belgium	104.340	91.633	110.900	17.772	101.833	104.417	108.100
Finland	49.146	31.400	62.400	62.958	45.550	48.433	55.600
Ireland	96.689	40.633	125.300	634.595	75.900	107.033	117.633

Table 18: Descriptive statistics of debt to gdp ratio

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	-0.270	-3.017	0.731	0.631	-0.623	-0.066	0.315
Spain	-0.139	-1.600	1.000	0.333	-0.533	-0.100	0.283
Germany	0.212	-4.500	2.000	1.152	0.117	0.350	0.750
France	0.114	-1.600	1.200	0.300	-0.017	0.133	0.500
Portugal	-0.225	-2.300	1.000	0.610	-0.750	0.000	0.400
Netherlands	0.012	-3.300	1.200	0.547	-0.200	0.133	0.467
Austria	0.127	-1.600	1.100	0.334	-0.017	0.200	0.300
Belgium	0.173	-2.100	1.000	0.327	0.033	0.300	0.400
Finland	-0.190	-6.900	2.800	1.968	-0.400	0.000	0.383
Ireland	0.376	-4.100	4.700	2.128	-0.483	0.367	1.433

Table 19: Descriptive statistics of gdp growth rate

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	8.426	0.752	21.766	21.975	5.089	7.432	11.838
Spain	6.357	-2.381	28.607	28.021	2.734	5.670	8.015
Germany	3.426	-4.185	11.529	7.417	1.708	3.396	4.812
France	4.234	0.492	12.551	5.485	2.492	3.631	5.296
Portugal	2.756	-19.004	17.565	40.895	-0.461	3.884	6.350
Netherlands	1.573	-1.244	11.571	4.324	0.559	1.081	1.978
Austria	6.251	-2.136	24.737	21.702	3.037	5.610	8.310
Belgium	0.979	-8.585	6.222	6.912	-0.256	1.038	2.646
Finland	3.295	-2.904	13.892	11.833	0.760	2.680	5.636
Ireland	3.434	-7.276	16.968	18.596	0.808	2.637	5.306

Table 20: Descriptive statistics of idiosyncratic volatility index

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	3.500	1.487	9.705	3.667	2.071	2.696	4.436
Spain	4.062	1.817	12.294	5.834	2.256	3.146	5.350
Germany	9.946	3.654	29.949	27.619	5.872	8.786	12.704
France	6.425	2.393	23.099	19.397	3.552	4.672	8.753
Portugal	5.517	1.747	12.966	6.980	3.514	5.086	6.788
Netherlands	11.807	4.660	29.826	35.253	7.345	10.078	14.259
Austria	8.803	3.632	22.474	22.715	4.979	6.904	11.760
Belgium	6.777	1.931	15.583	7.373	4.461	6.455	8.605
Finland	13.904	5.333	24.115	17.644	10.626	14.576	16.891
Ireland	6.639	2.447	17.399	12.773	3.579	5.936	8.453

Table 21: Descriptive statistics of CDS liquidity

Country	Mean	Min	Max	Variance	P25	P50	P75
Italy	0.076	0.041	0.121	0.001	0.051	0.066	0.107
Spain	0.097	0.047	0.217	0.002	0.055	0.089	0.132
Germany	0.152	0.080	0.262	0.003	0.096	0.167	0.191
France	0.145	0.062	0.258	0.003	0.081	0.162	0.197
Portugal	0.090	0.031	0.200	0.002	0.045	0.077	0.130
Netherlands	0.144	0.075	0.331	0.004	0.093	0.123	0.166
Austria	0.129	0.065	0.302	0.004	0.074	0.100	0.181
Belgium	0.124	0.047	0.300	0.005	0.061	0.087	0.194
Finland	0.158	0.090	0.391	0.004	0.116	0.136	0.167
Ireland	0.096	0.025	0.265	0.004	0.046	0.080	0.127

Table 22: Descriptive statistics of CDS net amount to CDS gross amount

Variable	P-value Phillips-Perron test
Bond spread	0.032
SCDS	0.433
Basis	0.013
Bond liquidity	0.000
CDS liquidity	0.048
Idiosyncratic volatility	0.001
Debt-to-GDP ratio	0.002
GDP growth	0.016
CDS net amount to CDS gross amount ratio	0.000
Repo specialness	0.000

Table 23: Testing for unit root in the set of variables
The table shows the outputs of the Fisher type test (Phillips-Perron) for the presence of unit root. The null hyphotesis of the test is that all the panels contain unit roots.

.1.3 Descriptive statistics and charts of common variables.

Variable	Mean	Min	Max	Variance	P25	P50	P75
Euribor 3m	0.7581	-0.0140	4.0290	0.5122	0.2155	0.6715	1.0675
Evz index	11.7664	5.0650	23.9420	15.9851	8.8645	11.4195	13.7050
Global risk aversion	-4.5377	-11.8140	3.5740	7.1099	-6.3665	-4.2690	-2.9330
Counterparty risk	1.407	0.603	2.859	0.387	0.955	1.243	1.861
Inflation expectations	3.2194	0.8360	4.6780	1.0062	2.5985	3.1330	4.2385

Table 24: Descriptive statistics of common variables across countries

.1.4 Analysis on correct specification of panel analysis

Model	Specification	Subsample	P-value
2.1	Bond	Per+Core	0.000
	CDS	Per+Core	0.000
	Basis	Per+Core	0.053
	Bond	Per	0.001
	Bond	Core	0.000
	CDS	Per	0.000
	CDS	Core	0.000
	Basis	Per	0.051
	Basis	Core	0.000
2.4	Bond	Per+Core	0.000
	CDS	Per+Core	0.000
	Basis	Per+Core	0.051
2.5	Bond	Per+Core	0.001
	CDS	Per+Core	0.000
	Basis	Per+Core	0.047

Table 25: Fixed or random effects. Hausman test.
The table shows the output of Hausman test for the model estimated with equations 2.1, 2.4 and 2.5. The null hypothesis is that the random effect is the appropriate specification.

Model	Specification	Subsample	P-value
2.1	Bond	Per+Core	0.001
	CDS	Per+Core	0.000
	Basis	Per+Core	0.003
	Bond	Per	0.000
	Bond	Core	0.066
	CDS	Per	0.091
	CDS	Core	0.053
	Basis	Per	0.000
	Basis	Core	0.000
2.4	Bond	Per+Core	0.002
	CDS	Per+Core	0.001
	Basis	Per+Core	0.000
2.5	Bond	Per+Core	0.000
	CDS	Per+Core	0.040
	Basis	Per+Core	0.001

Table 26: Time fixed effects. Wald test.
The table shows the output of Wald test for the model estimated with equations 2.1, 2.4 and 2.5. The null hypothesis is that the coefficients for all time-dummies are jointly equal to zero.

Model	Specification	Subsample	P-value LLC test	P-value Phillips-Perron test
2.1	Bond	Per+Core	0.000	0.000
	CDS	Per+Core	0.111	0.078
	Basis	Per+Core	0.002	0.000
	Bond	Per	0.001	0.000
	Bond	Core	0.107	0.012
	CDS	Per	0.538	0.371
	CDS	Core	0.310	0.131
	Basis	Per	0.000	0.000
	Basis	Core	0.000	0.000
2.4	Bond	Per+Core	0.001	0.002
	CDS	Per+Core	0.110	0.076
	Basis	Per+Core	0.002	0.001
2.5	Bond	Per+Core	0.000	0.000
	CDS	Per+Core	0.002	0.000
	Basis	Per+Core	0.000	0.000

Table 27: Testing for autocorrelation residuals.
The table shows the outputs of two autocorrelation tests on the estimated residuals: the Levin-Lin-Chu unit root test and Fisher type test (Phillips-Perron). Both tests have the null hyphotesis that is all the panels contain unit roots.

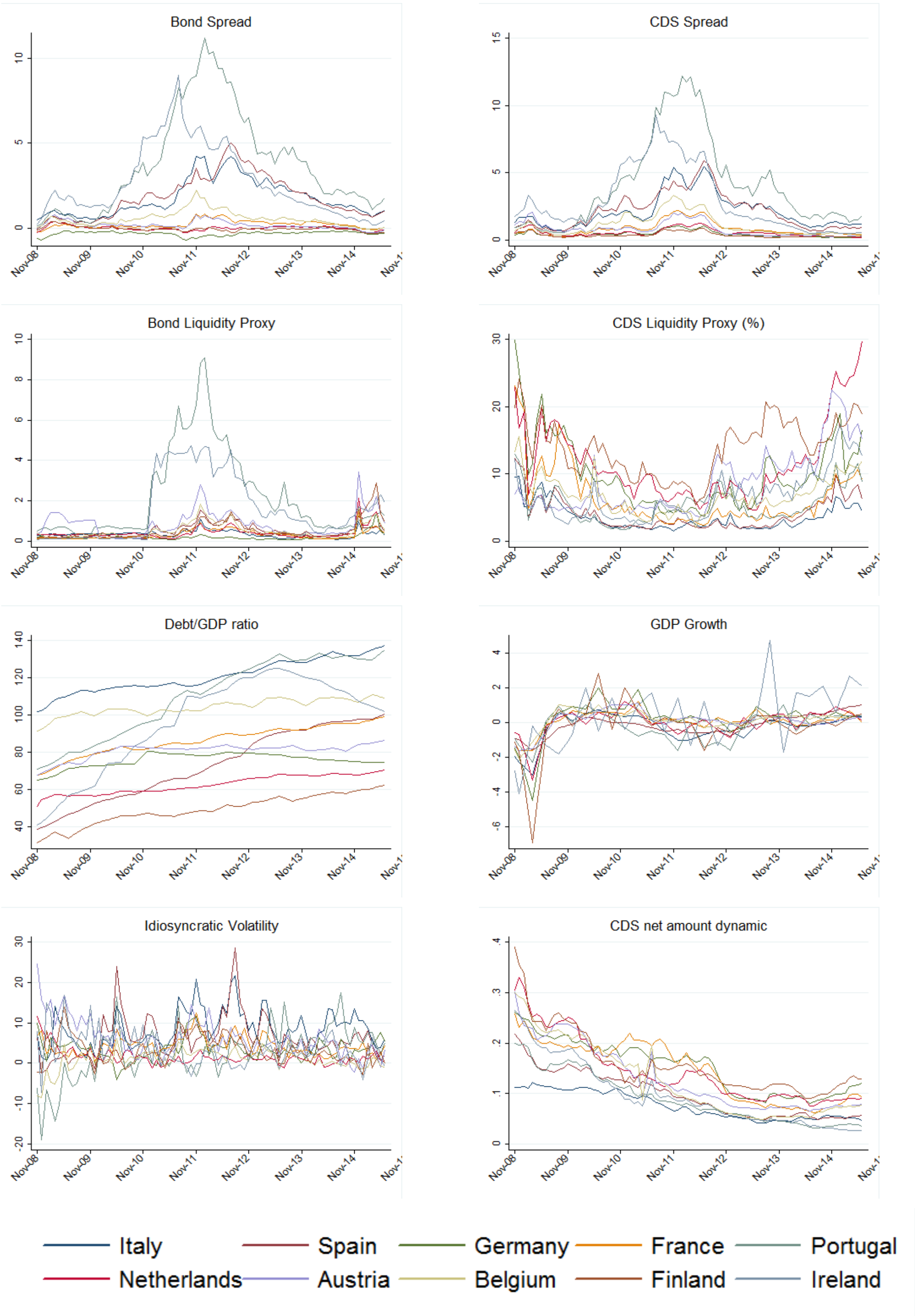

Figure 4: Graphic representation of Country-specific time series

Figure 5: Graphic representation of common across sample time series

.2 Price discovery analysis

.2.1 Dickey Fuller test for stationarity analysis of time series in levels and in first differences.

LAGS	IT	SP	GER	FR	POR	NET	AU	BEL	FIN	IRL	CR. VALUE
22	-0.958	-0.673	-1.691	-1.477	-0.428	-1.312	-1.588	-0.993	-1.270	-0.703	-2.832
21	-1.019	-0.72	-1.668	-1.538	-0.42	-1.312	-1.583	-1.076	-1.281	-0.719	-2.833
20	-0.99	-0.702	-1.668	-1.508	-0.411	-1.267	-1.507	-1.104	-1.246	-0.670	-2.834
19	-0.944	-0.701	-1.643	-1.378	-0.443	-1.292	-1.381	-1.087	-1.177	-0.590	-2.835
18	-1.015	-0.713	-1.633	-1.333	-0.461	-1.315	-1.335	-1.139	-1.116	-0.666	-2.835
17	-1.068	-0.693	-1.71	-1.342	-0.543	-1.366	-1.433	-1.144	-1.153	-0.718	-2.836
16	-1.075	-0.685	-1.73	-1.27	-0.545	-1.444	-1.476	-1.093	-1.190	-0.674	-2.837
15	-1.074	-0.683	-1.78	-1.139	-0.599	-1.461	-1.452	-1.039	-1.225	-0.682	-2.838
14	-1.122	-0.702	-1.92	-1.24	-0.628	-1.568	-1.552	-1.105	-1.355	-0.714	-2.839
13	-1.162	-0.784	-1.818	-1.425	-0.654	-1.606	-1.700	-1.195	-1.398	-0.687	-2.84
12	-1.097	-0.762	-1.772	-1.488	-0.699	-1.686	-1.748	-1.264	-1.469	-0.652	-2.84
11	-1.026	-0.735	-1.79	-1.591	-0.848	-1.855	-1.802	-1.361	-1.567	-0.687	-2.841
10	-0.907	-0.701	-1.862	-1.593	-0.935	-1.905	-1.797	-1.276	-1.582	-0.747	-2.842
9	-0.956	-0.742	-1.828	-1.66	-0.885	-1.857	-1.783	-1.327	-1.547	-0.706	-2.843
8	-1.023	-0.796	-1.784	-1.565	-0.983	-1.815	-1.620	-1.328	-1.481	-0.804	-2.844
7	-1.068	-0.839	-1.914	-1.511	-0.98	-1.746	-1.528	-1.408	-1.510	-0.804	-2.844
6	-1.113	-0.889	-2.044	-1.683	-0.952	-1.778	-1.590	-1.422	-1.475	-0.879	-2.845
5	-1.125	-0.964	-2.088	-1.836	-0.888	-1.834	-1.694	-1.478	-1.543	-0.922	-2.846
4	-1.202	-1.025	-2.098	-1.926	-0.844	-1.863	-1.787	-1.635	-1.553	-0.921	-2.847
3	-1.238	-1.165	-2.159	-1.83	-1.111	-1.853	-1.862	-1.659	-1.558	-0.910	-2.847
2	-1.302	-1.308	-2.377	-2.023	-1.077	-2.026	-2.084	-1.844	-1.707	-0.933	-2.848
1	-1.501	-1.415	-2.562	-2.082	-1.061	-2.117	-2.115	-1.893	-1.760	-0.895	-2.849

Table 28: Stationarity analysis. Dickey Fuller Test. Variable: bond spread, levels.

LAGS	IT	SP	GER	FR	POR	NET	AU	BEL	FIN	IRL	CR. VALUE
22	-1.145	-0.937	-1.669	-1.258	-0.777	-1.625	-1.475	-1.276	-1.848	-0.730	-2.832
21	-1.09	-0.942	-1.633	-1.168	-0.745	-1.541	-1.486	-1.127	-1.718	-0.700	-2.833
20	-1.094	-0.931	-1.605	-1.204	-0.792	-1.557	-1.500	-1.169	-1.743	-0.726	-2.834
19	-1.065	-0.897	-1.517	-1.064	-0.759	-1.511	-1.538	-1.129	-1.783	-0.764	-2.835
18	-1.061	-0.914	-1.577	-1.074	-0.932	-1.492	-1.582	-1.181	-1.856	-0.825	-2.835
17	-1.077	-0.906	-1.616	-1.055	-0.892	-1.451	-1.556	-1.170	-1.869	-0.860	-2.836
16	-1.011	-0.867	-1.567	-1.001	-0.828	-1.356	-1.533	-1.160	-1.828	-0.807	-2.837
15	-1.037	-0.829	-1.482	-0.986	-0.877	-1.312	-1.567	-1.108	-1.821	-0.792	-2.838
14	-1.08	-0.875	-1.42	-0.954	-0.866	-1.266	-1.535	-1.063	-1.711	-0.802	-2.839
13	-1.177	-0.894	-1.527	-1.006	-0.893	-1.228	-1.570	-1.082	-1.698	-0.824	-2.84
12	-1.183	-0.925	-1.499	-1.053	-0.915	-1.277	-1.714	-1.135	-1.693	-0.824	-2.84
11	-1.17	-0.856	-1.489	-1.036	-0.92	-1.188	-1.817	-1.085	-1.634	-0.738	-2.841
10	-1.175	-0.917	-1.485	-0.999	-0.997	-1.159	-1.750	-1.075	-1.653	-0.816	-2.842
9	-1.183	-0.937	-1.432	-1.031	-1.009	-1.174	-1.672	-1.103	-1.633	-0.915	-2.843
8	-1.19	-0.939	-1.433	-1.047	-1.046	-1.25	-1.629	-1.082	-1.630	-0.949	-2.844
7	-1.258	-0.961	-1.379	-1.041	-1.067	-1.249	-1.641	-1.123	-1.637	-1.008	-2.844
6	-1.284	-0.972	-1.324	-1.048	-1.037	-1.26	-1.612	-1.057	-1.667	-1.044	-2.845
5	-1.274	-1.018	-1.29	-1.073	-0.998	-1.259	-1.640	-1.090	-1.625	-1.145	-2.846
4	-1.332	-1.025	-1.329	-1.115	-0.927	-1.277	-1.601	-1.141	-1.670	-1.084	-2.847
3	-1.36	-1.175	-1.331	-1.146	-1.003	-1.366	-1.562	-1.187	-1.710	-1.071	-2.847
2	-1.471	-1.301	-1.446	-1.307	-1.174	-1.412	-1.577	-1.359	-1.712	-1.090	-2.848
1	-1.619	-1.449	-1.373	-1.283	-1.161	-1.39	-1.522	-1.397	-1.812	-1.076	-2.849

Table 29: Stationarity analysis. Dickey Fuller Test. Variable: CDS spread, levels.

LAGS	IT	SP	GER	FR	POR	NET	AU	BEL	FIN	IRL	CR. VALUE
22	-2.715	-3.063	-2.36	-1.921	-4.862	-2.112	-2.005	-2.328	-2.051	-3.595	-2.832
21	-2.738	-3.103	-2.295	-1.908	-5.126	-2.054	-1.997	-2.333	-2.017	-3.792	-2.833
20	-2.763	-3.151	-2.205	-1.901	-5.497	-2.002	-1.978	-2.345	-1.980	-3.895	-2.834
19	-2.916	-3.332	-2.148	-1.886	-5.941	-1.953	-1.963	-2.404	-1.940	-4.216	-2.835
18	-3.126	-3.504	-2.09	-1.883	-6.223	-1.937	-1.981	-2.527	-1.913	-4.733	-2.835
17	-3.165	-3.665	-2.042	-1.895	-6.621	-1.924	-2.015	-2.588	-1.899	-4.708	-2.836
16	-3.233	-3.932	-2.026	-1.916	-6.687	-1.921	-2.024	-2.713	-1.903	-4.764	-2.837
15	-3.39	-4.214	-2.002	-1.978	-7.216	-1.926	-2.055	-2.953	-1.919	-5.221	-2.838
14	-3.583	-4.53	-1.984	-2.117	-7.485	-1.942	-2.125	-3.270	-1.943	-5.516	-2.839
13	-3.702	-4.836	-1.982	-2.174	-7.946	-1.953	-2.151	-3.430	-1.948	-5.734	-2.84
12	-3.851	-4.958	-1.959	-2.177	-8.493	-1.99	-2.154	-3.558	-1.981	-6.289	-2.84
11	-4.262	-5.465	-1.969	-2.263	-8.981	-2.026	-2.209	-3.738	-2.014	-7.017	-2.841
10	-4.814	-6.132	-2.009	-2.337	-8.723	-2.03	-2.275	-3.880	-2.044	-7.444	-2.842
9	-5.758	-7.051	-2.059	-2.521	-8.843	-2.095	-2.402	-4.510	-2.135	-7.741	-2.843
8	-6.302	-7.79	-2.154	-2.676	-9.983	-2.221	-2.564	-4.928	-2.279	-8.851	-2.844
7	-6.875	-8.624	-2.34	-3.088	-10.149	-2.41	-2.974	-5.628	-2.527	-9.048	-2.844
6	-7.693	-9.749	-2.484	-3.637	-11.157	-2.705	-3.508	-6.237	-2.758	-10.088	-2.845
5	-8.743	-11.164	-2.694	-3.997	-12.668	-3.046	-4.028	-7.324	-3.200	-10.664	-2.846
4	-10.396	-12.871	-3.065	-4.489	-15.132	-3.488	-4.651	-8.640	-3.652	-11.632	-2.847
3	-12.266	-15.422	-3.768	-5.317	-18.608	-4.24	-5.620	-9.884	-4.493	-13.329	-2.847
2	-15.499	-18.11	-5.039	-7.35	-18.344	-5.724	-7.269	-12.621	-6.035	-15.817	-2.848
1	-20.87	-22.168	-7.212	-9.967	-23.029	-7.971	-9.411	-15.683	-8.408	-18.982	-2.849

Table 30: Stationarity analysis. Dickey Fuller Test. Variable: bond spread, first differences.

LAGS	IT	SP	GER	FR	POR	NET	AU	BEL	FIN	IRL	CR. VALUE
22	-8.713	-8.658	-8.071	-7.809	-9.885	-7.348	-9.302	-7.751	-8.114	-9.492	-2.832
21	-9.146	-8.914	-7.922	-7.937	-9.979	-7.565	-9.353	-7.894	-8.026	-10.109	-2.833
20	-9.744	-9.11	-8.221	-8.569	-10.581	-8.049	-9.558	-8.966	-8.809	-10.736	-2.834
19	-9.995	-9.435	-8.505	-8.551	-10.501	-8.117	-9.757	-8.917	-8.922	-10.828	-2.835
18	-10.513	-9.965	-9.127	-9.608	-11.177	-8.483	-9.819	-9.421	-8.965	-10.809	-2.835
17	-10.893	-10.15	-9.029	-9.803	-10.024	-8.748	-9.858	-9.325	-8.854	-10.564	-2.836
16	-11.157	-10.553	-9.032	-10.22	-10.68	-9.155	-10.329	-9.664	-9.025	-10.569	-2.837
15	-12.159	-11.272	-9.502	-10.956	-11.667	-9.936	-10.836	-10.029	-9.470	-11.484	-2.838
14	-12.457	-12.098	-10.247	-11.48	-11.657	-10.51	-11.011	-10.779	-9.793	-12.132	-2.839
13	-12.648	-12.205	-10.967	-12.238	-12.264	-11.177	-11.674	-11.587	-10.763	-12.559	-2.84
12	-12.376	-12.604	-10.637	-12.294	-12.544	-11.899	-11.915	-11.907	-11.264	-12.893	-2.84
11	-12.907	-12.924	-11.179	-12.42	-12.913	-11.979	-11.406	-11.949	-11.782	-13.560	-2.841
10	-13.699	-14.427	-11.669	-13.168	-13.534	-13.315	-11.194	-13.011	-12.810	-15.649	-2.842
9	-14.456	-14.627	-12.185	-14.288	-13.403	-14.35	-12.095	-13.849	-13.357	-15.582	-2.843
8	-15.313	-15.392	-13.183	-14.824	-14.018	-15.091	-13.263	-14.374	-14.364	-15.232	-2.844
7	-16.374	-16.576	-13.879	-15.665	-14.442	-15.255	-14.417	-15.638	-15.422	-15.581	-2.844
6	-16.91	-17.766	-15.27	-16.98	-15.126	-16.385	-15.277	-16.326	-16.607	-16.229	-2.845
5	-18.133	-19.487	-17.067	-18.483	-16.654	-17.659	-16.776	-18.878	-17.849	-17.043	-2.846
4	-20.279	-21.202	-19.2	-20.17	-18.806	-19.493	-18.005	-20.587	-20.484	-17.092	-2.847
3	-22.171	-24.498	-20.93	-22.199	-22.528	-21.687	-20.588	-22.608	-22.830	-19.774	-2.847
2	-25.564	-26.206	-24.116	-25.485	-24.763	-23.489	-24.486	-25.767	-26.566	-22.739	-2.848
1	-29.269	-29.789	-26.656	-27.585	-25.864	-27.243	-29.927	-27.538	-34.699	-26.587	-2.849

Table 31: Stationarity analysis. Dickey Fuller Test. Variable: CDS spread, first differences.

.3 Panel Var Analysis

.3.1 Eigenvalues analysis

Model	Eigenvalue	Real	Imaginary	Modulus
Entire	1	0.956	0	0.956
period	2	0.729	0	0.729
Pre	1	0.974	0	0.974
Ban	2	0.789	0	0.789
Post	1	0.865	0	0.865
Ban	2	0.177	0	0.177

Table 32: Eigenvalues condition of panel var models.
The table shows the output of the test on the stability condition of panel var estimates of equation 2.3. The null hypothesis is that the coefficients for all time-dummies are jointly equal to zero.

.3.2 IRFs

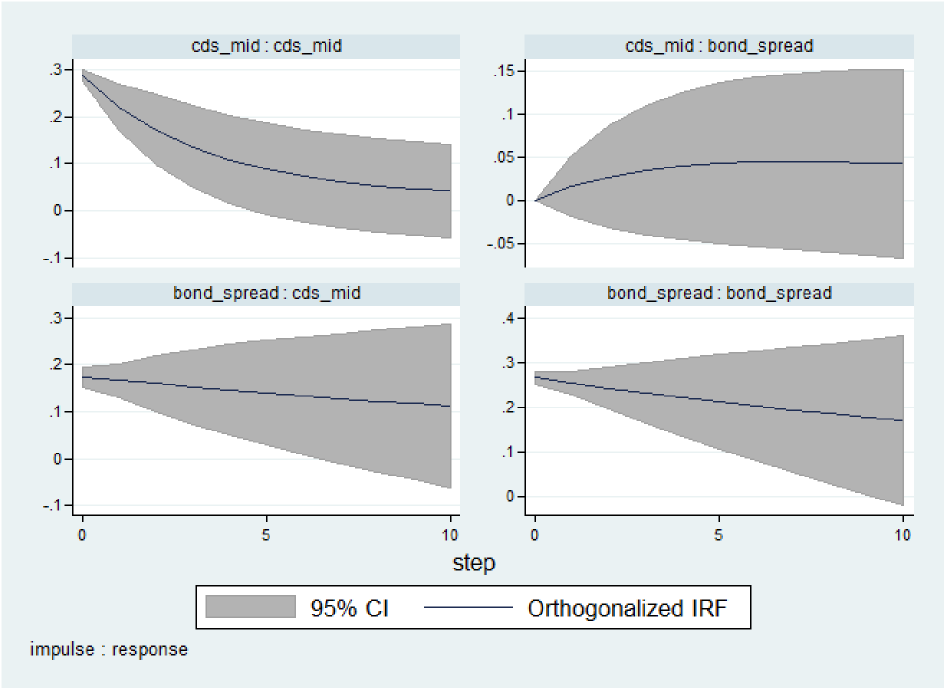

Figure 6: Impulse Response Fuction - Panel Var

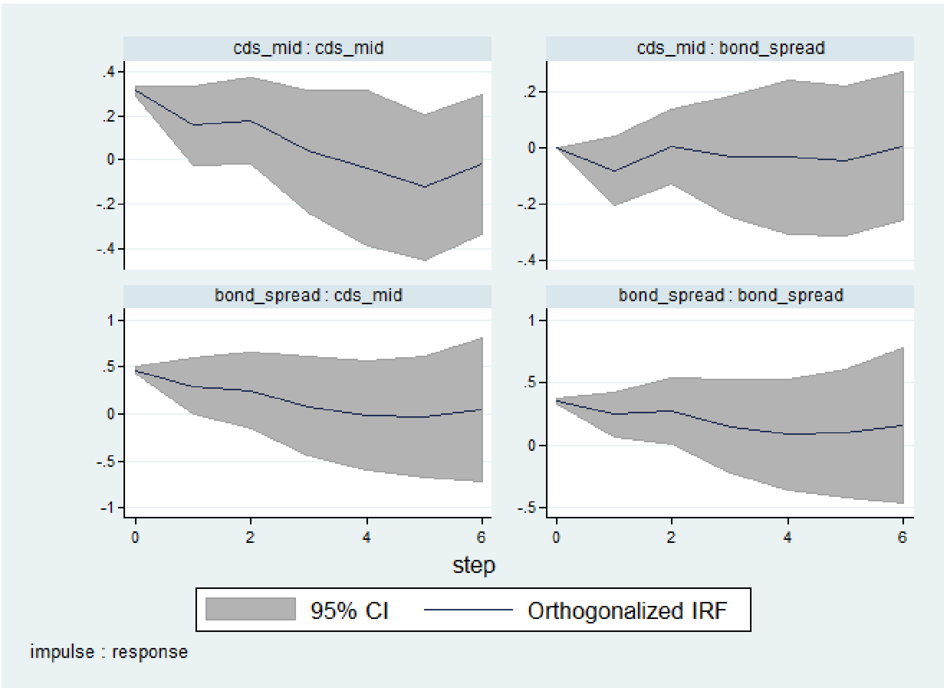

Figure 7: Impulse Response Fuction - Panel Var. Before entry into force ban on naked CDS

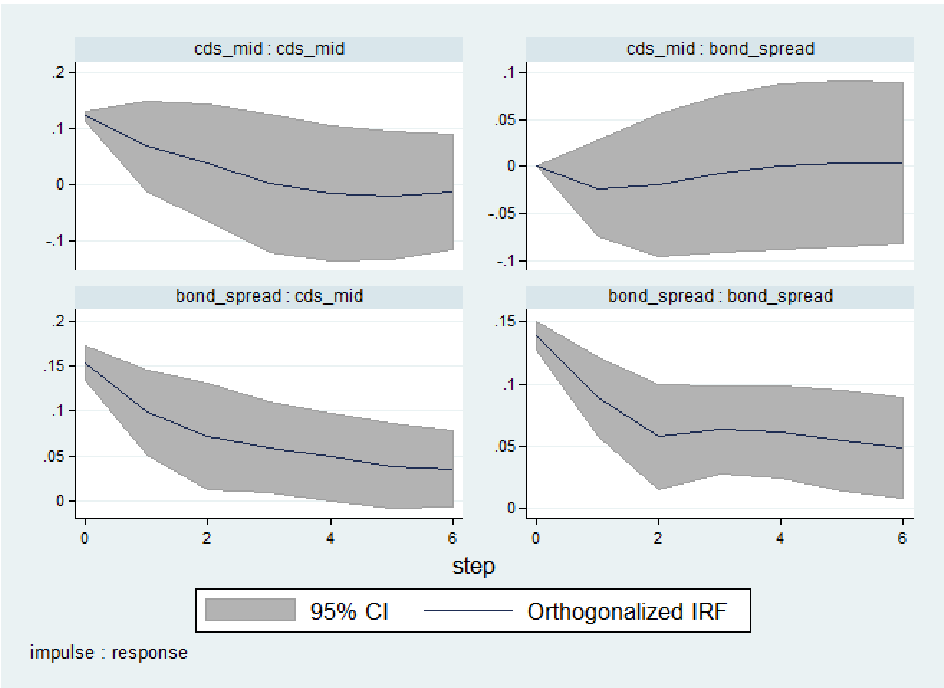

Figure 8: Impulse Response Fuction - Panel Var. After entry into force ban on naked CDS

Appendix C. Chapter 3

.4 Structural breaks analysi

.4.1 Dataset manipulation.

Dataset	Description	Original frequency	Filter	Transformation to daily ts
Quoting	Snapshots of the MTS quoting book between 9.00am and 5.00pm of the BTP 10 year benchmark	Five minute	1. Exclusion of quotes far more than 200 tick prices from the best price. 2. Thompson's Tau method.	Daily averages
Trading	Full list of the deals on MTS of each trading day on the BTP 10 year benchmark	-	- -	Daily cumulative trading volumes

Table 33: Dataset manipulation

.4.2 Bai and Perron test

Best bid-ask spread (BBA)

Dimension: Quoting.

Definition: Difference between best ask price and best bid price.

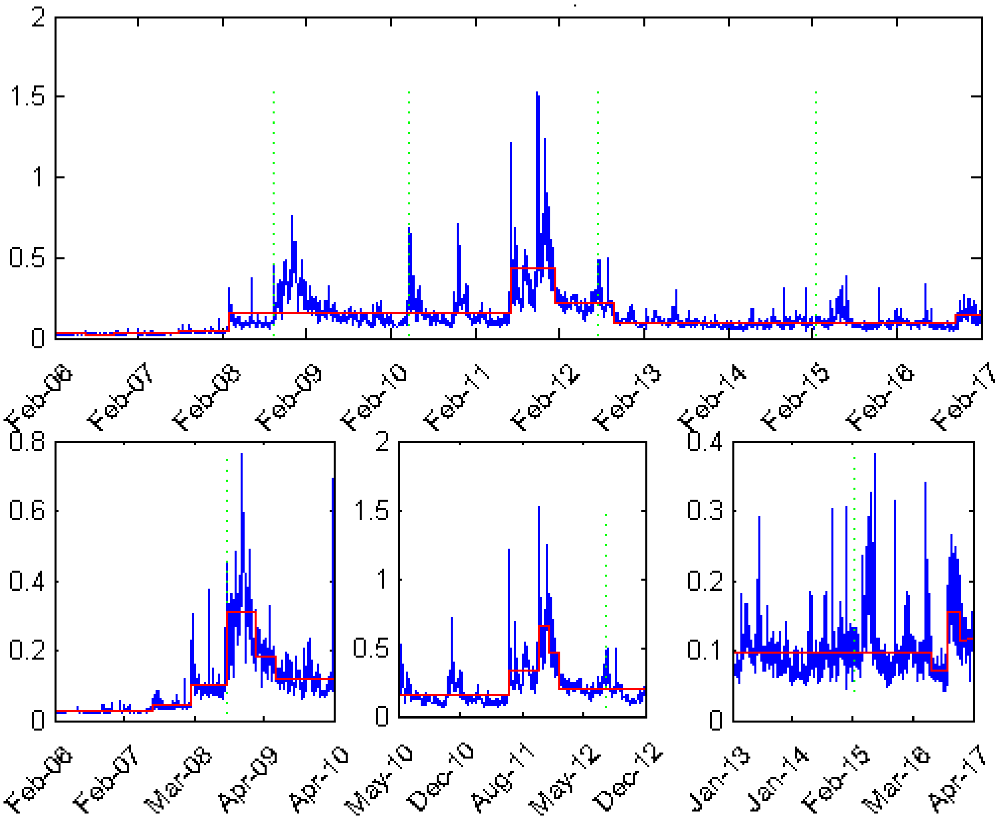

Figure 9: Bai and Perron test - Best bid-ask spread (bps)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	8	Jun-06	Oct-06	Jul-07	Mar-08	Jul-11	Jan-12	Oct-12	Nov-16	
I Per	8	Apr-06	Jul-06	Oct-06	Jul-07	Mar-08	Sep-08	Feb-09	Jun-09	
II Per	4	Jul-11	Nov-11	Dec-11	Jan-12					
III Per	3	Jul-16	Nov-16	Jan-17						

Table 34: Bai and Perron test - Best bid-ask spread

Total quoted depth on bid side (VTB)

Dimension: Quoting.

Definition: Sum of the volumes quoted on the bid side.

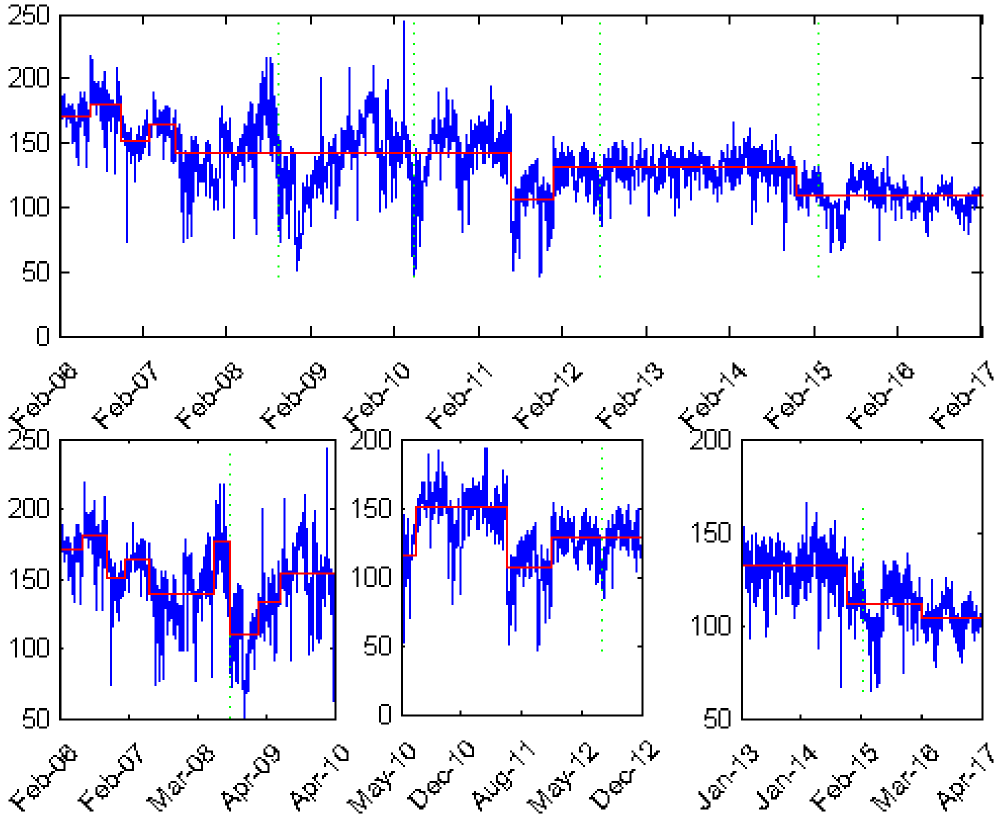

Figure 10: Bai and Perron test - Total quoted depth on bid side (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	7	Jun-06	Nov-06	Mar-07	Jun-07	Jul-11	Jan-12	Dec-14		
I Per	8	Jun-06	Nov-06	Feb-07	Jun-07	Jun-08	Sep-08	Feb-09	Jul-09	
II Per	3	Jun-10	Jul-11	Jan-12						
III Per	2	Nov-14	Apr-16							

Table 35: Bai and Perron test - Total quoted depth on bid side

Total quoted depth on ask side (VTA)

Dimension: Quoting.

Definition: Sum of the volumes quoted on the ask side.

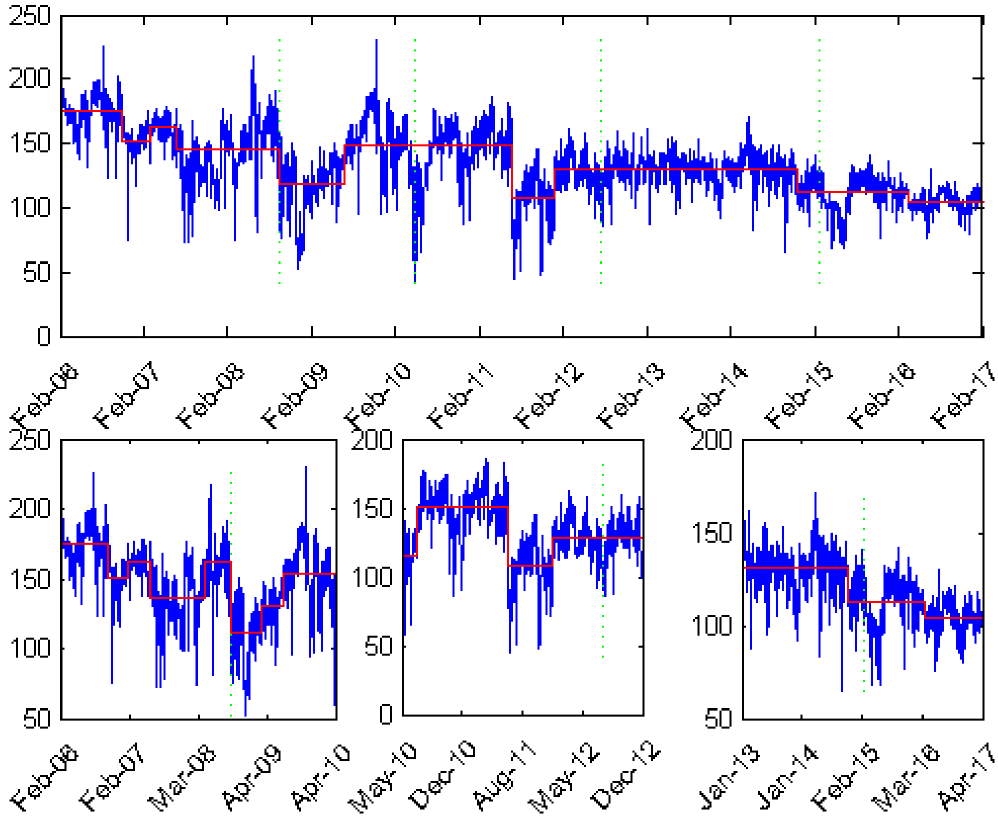

Figure 11: Bai and Perron test - Total quoted depth on ask side (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Nov-06	Mar-07	Jun-07	Sep-08	Jul-09	Jul-11	Jan-12	Dec-14	Apr-16
I Per	7	Nov-06	Feb-07	Jun-07	Apr-08	Sep-08	Mar-09	Jul-09		
II Per	3	Jul-10	Jul-11	Jan-12						
III Per	2	Nov-14	Apr-16							

Table 36: Bai and Perron test - Total quoted depth on ask side

3 best bid quoted depth / Total bid depth (V3TB)

Dimension: Quoting.

Definition: Ratio of the volumes quoted on the three best bid prices to the total depth on the bid side.

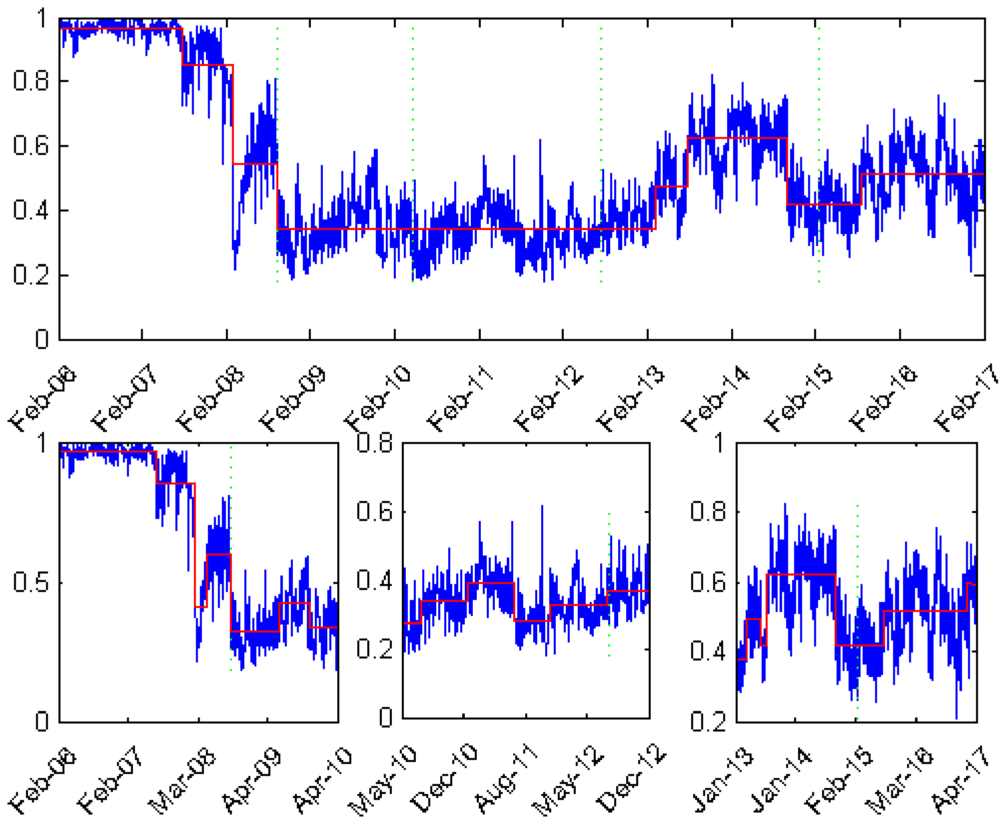

Figure 12: Bai and Perron test - 3 best bid quoted depth / Total bid depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	7	Jul-07	Mar-08	Sep-08	Mar-13	Aug-13	Oct-14	Sep-15		
I Per	6	Jul-07	Mar-08	May-08	Sep-08	Jun-09	Nov-09			
II Per	5	Jul-10	Jan-11	Jul-11	Dec-11	Jul-12				
III Per	6	Mar-13	Jan-13	Jul-13	Oct-14	Sep-15	Feb-17			

Table 37: Bai and Perron test - 3 best bid quoted depth / Total bid depth

3 best ask quoted depth / Total ask depth (V3TA)

Dimension: Quoting.

Definition: Ratio of the volumes quoted on the three best ask prices to the total depth on the ask side.

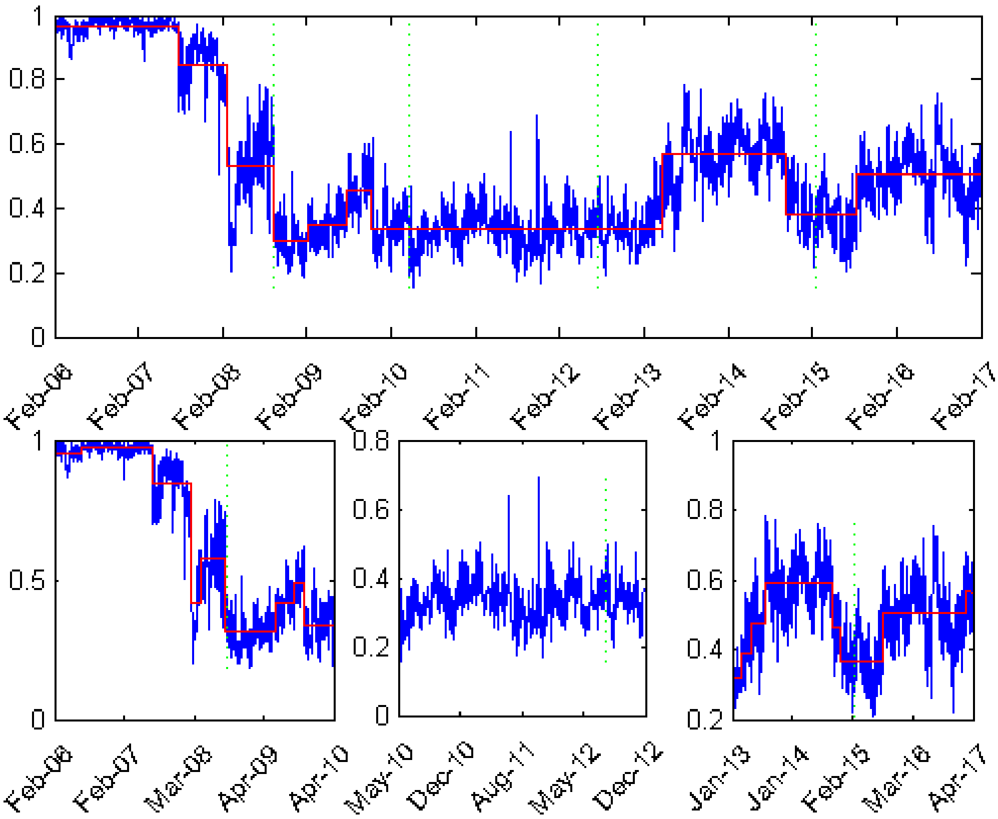

Figure 13: Bai and Perron test - 3 best ask quoted depth / Total ask depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Feb-08	Sep-08	Feb-09	Jul-09	Nov-09	May-13	Oct-14	Aug-15
I Per	8	Jun-06	Jul-07	Feb-08	Apr-08	Sep-08	Jun-09	Sep-09	Nov-09	
II Per	0									
III Per	7	Feb-13	May-13	Aug-13	Oct-14	Dec-14	Sep-15	Mar-17		

Table 38: Bai and Perron test - 3 best ask quoted depth / Total ask depth

Total bid depth / Theoretical total depth (VTTB)

Dimension: Quoting.

Definition: Ratio of the total volumes quoted on the bid side to theoretical total depth. Theoretical total depth is defined as the sum of the number of specialists multiplied by 5mm (the minimum size, defined by Italian Treasury) and the number of the other market makers multiplied by 2mm (the minimum size, defined by MTS market rules).

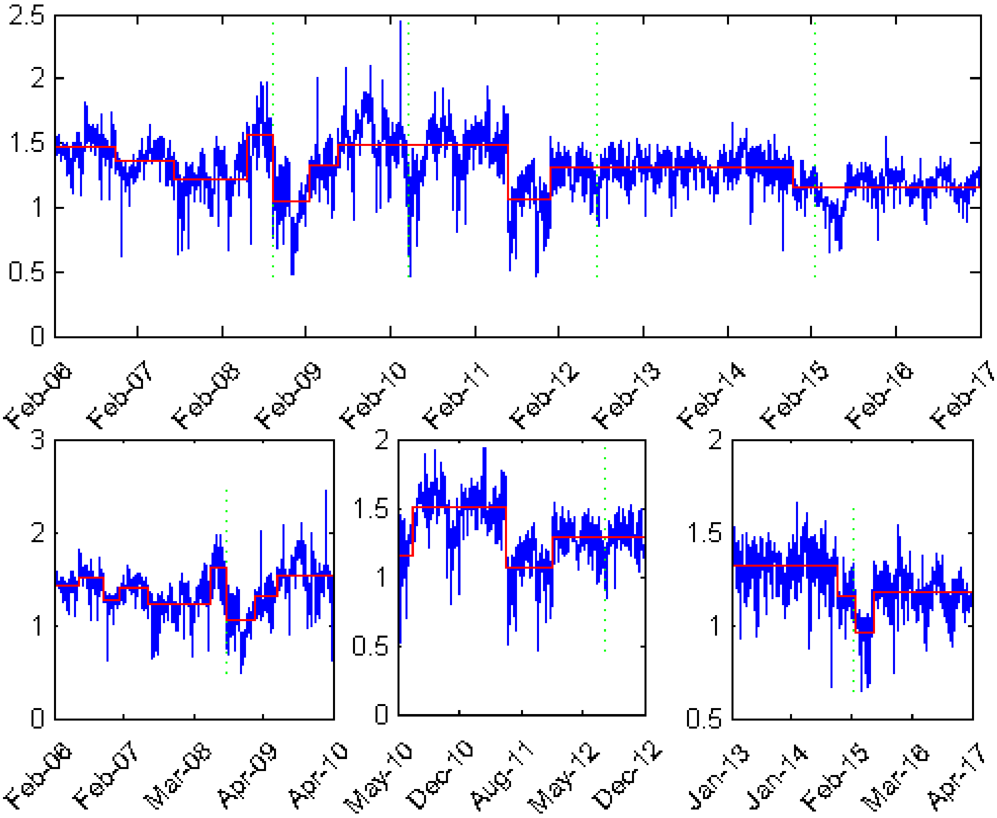

Figure 14: Bai and Perron test - Total bid depth / Theoretical total depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Nov-06	Jul-07	May-08	Sep-08	Feb-09	Jun-09	Jul-11	Jan-12	Nov-14
I Per	8	Jun-06	Nov-06	Feb-07	Jul-07	Jun-08	Sep-08	Feb-09	Jun-09	
II Per	3	Jun-10	Jul-11	Jan-12						
III Per	2	Nov-14	Apr-15	Jul-15						

Table 39: Bai and Perron test - Total bid depth / Theoretical total depth

Total ask depth / Theoretical total depth (VTTA)

Dimension: Quoting.

Definition: Ratio of the total volumes quoted on the ask side to theoretical total depth. Theoretical total depth is defined as the sum of the number of specialists multiplied by 5mm (the minimum size, defined by Italian Treasury) and the number of the other market makers multiplied by 2mm (the minimum size, defined by MTS market rules).

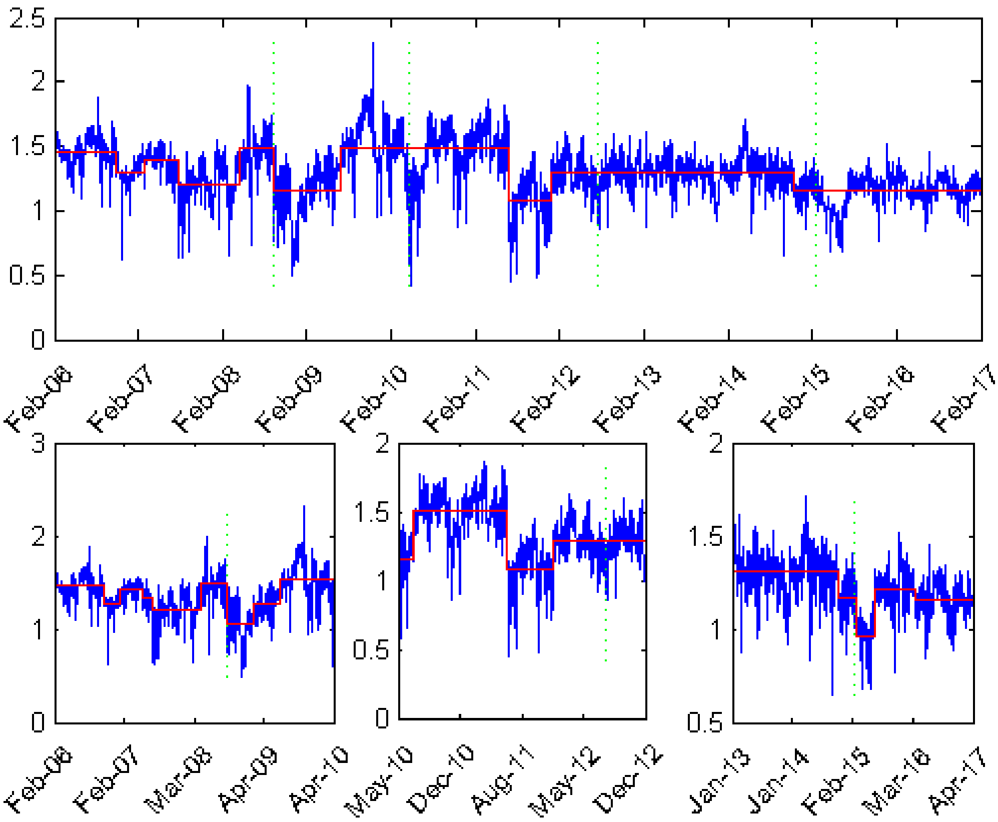

Figure 15: Bai and Perron test - Total ask depth / Theoretical total depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Nov-06	Mar-07	Jul-07	Apr-08	Sep-08	Jul-09	Jul-11	Jan-12	Nov-14
I Per	8	Jan-06	Feb-07	May-07	Jul-07	Apr-08	Sep-08	Feb-09	Jul-09	
II Per	3	Jul-10	Jul-11	Jan-12						
III Per	4	Nov-14	Apr-15	Jul-15	Apr-16					

Table 40: Bai and Perron test - Total ask depth / Theoretical total depth

3 best bid quoted depth / Theoretical total depth (V3TOB)

Dimension: Quoting.

Definition: Ratio of the volumes quoted on the three best bid prices to theoretical total depth. Theoretical total depth is defined as the sum of the number of specialists multiplied by 5mm (the minimum size, defined by Italian Treasury) and the number of the other market makers multiplied by 2mm (the minimum size, defined by MTS market rules).

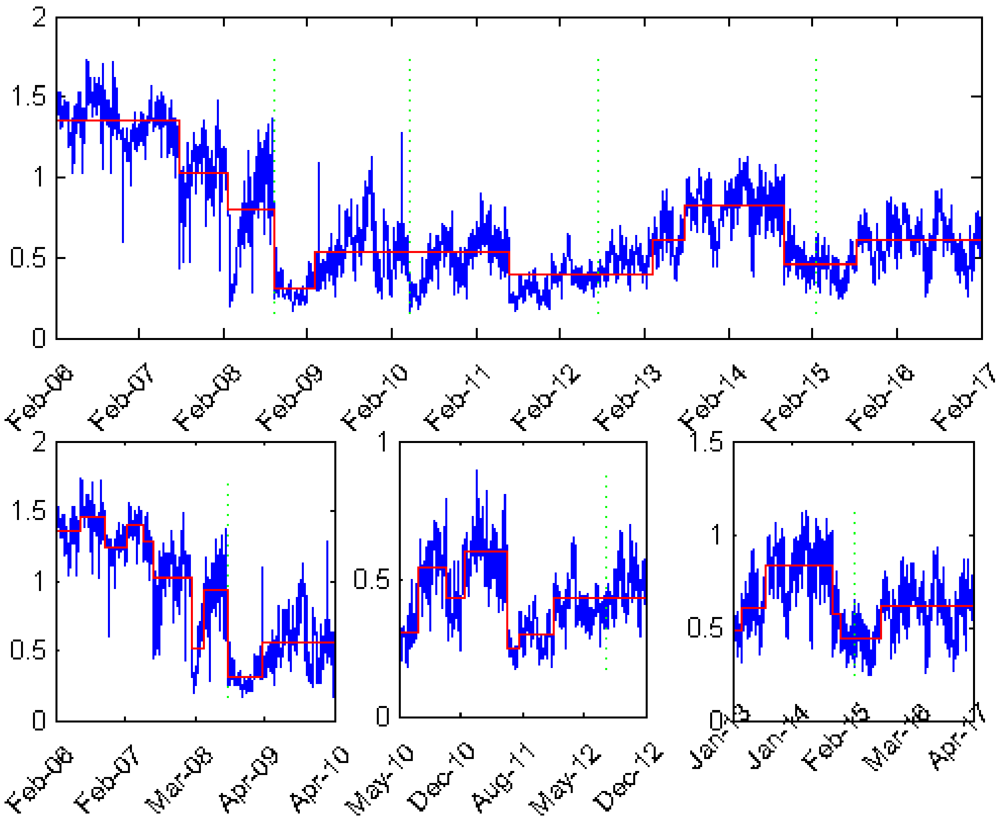

Figure 16: Bai and Perron test - 3 best bid quoted depth / Theoretical total depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Feb-08	Sep-08	Mar-09	Jul-11	Mar-13	Aug-13	Oct-14	Aug-15
I Per	9	Jun-06	Nov-06	Mar-07	May-07	Jul-07	Feb-08	May-08	Sep-08	Mar-09
II Per	6	Jul-10	Nov-10	Jan-11	Jul-11	Aug-11	Jan-12			
III Per	5	Mar-13	Aug-13	Oct-14	Dec-14	Aug-15				

Table 41: Bai and Perron test - 3 best bid quoted depth / Theoretical total depth

3 best ask quoted depth / Theoretical total depth (V3TOA)

Dimension: Quoting.

Definition: Ratio of the volumes quoted on the three best ask prices to theoretical total depth. Theoretical total depth is defined as the sum of the number of specialists multiplied by 5mm (the minimum size, defined by Italian Treasury) and the number of the other market makers multiplied by 2mm (the minimum size, defined by MTS market rules).

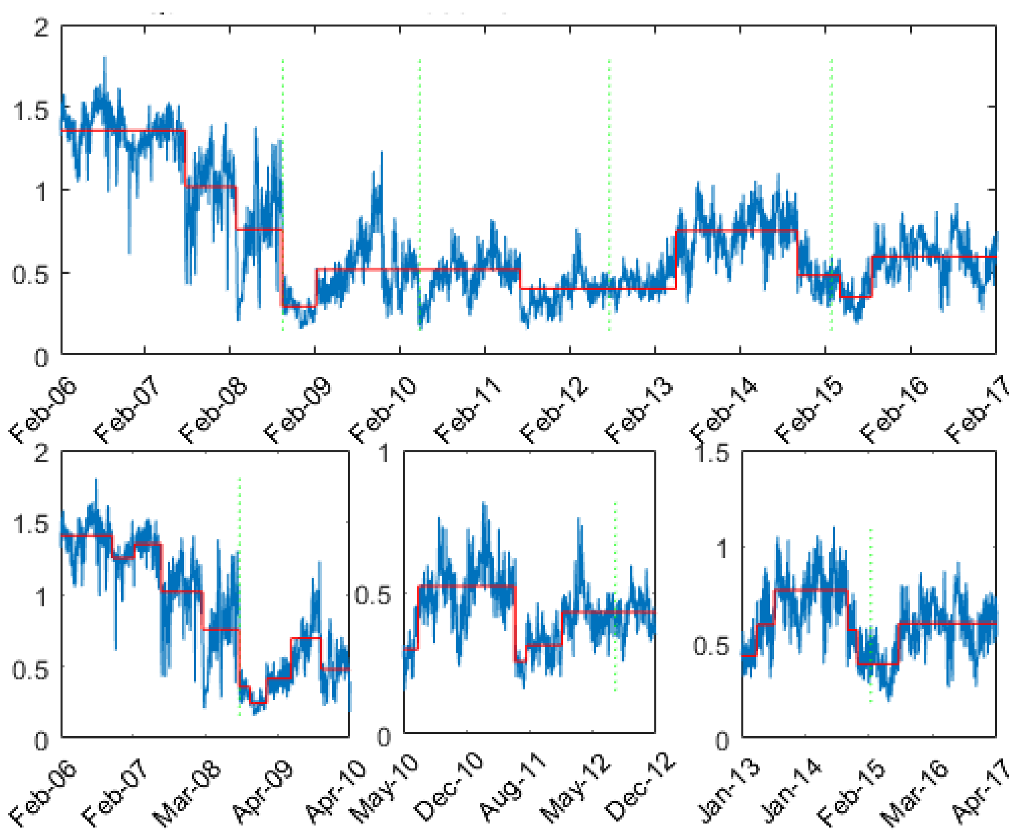

Figure 17: Bai and Perron test - 3 best ask quoted depth / Theoretical total depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Feb-08	Sep-08	Feb-09	Jul-11	May-13	Oct-14	Apr-15	Aug-15
I Per	9	Nov-06	Mar-07	Jul-07	Feb-08	Sep-08	Nov-08	Feb-09	Jun-09	Nov-09
II Per	4	Jun-10	Jul-11	Aug-11	Jan-12					
III Per	5	Apr-13	Jul-13	Oct-14	Dec-14	Aug-15				

Table 42: Bai and Perron test - 3 best ask quoted depth / Theoretical total depth

Total number of proposals on bid side (NTB)

Dimension: Quoting.

Definition: Total number of proposals quoted on the bid side.

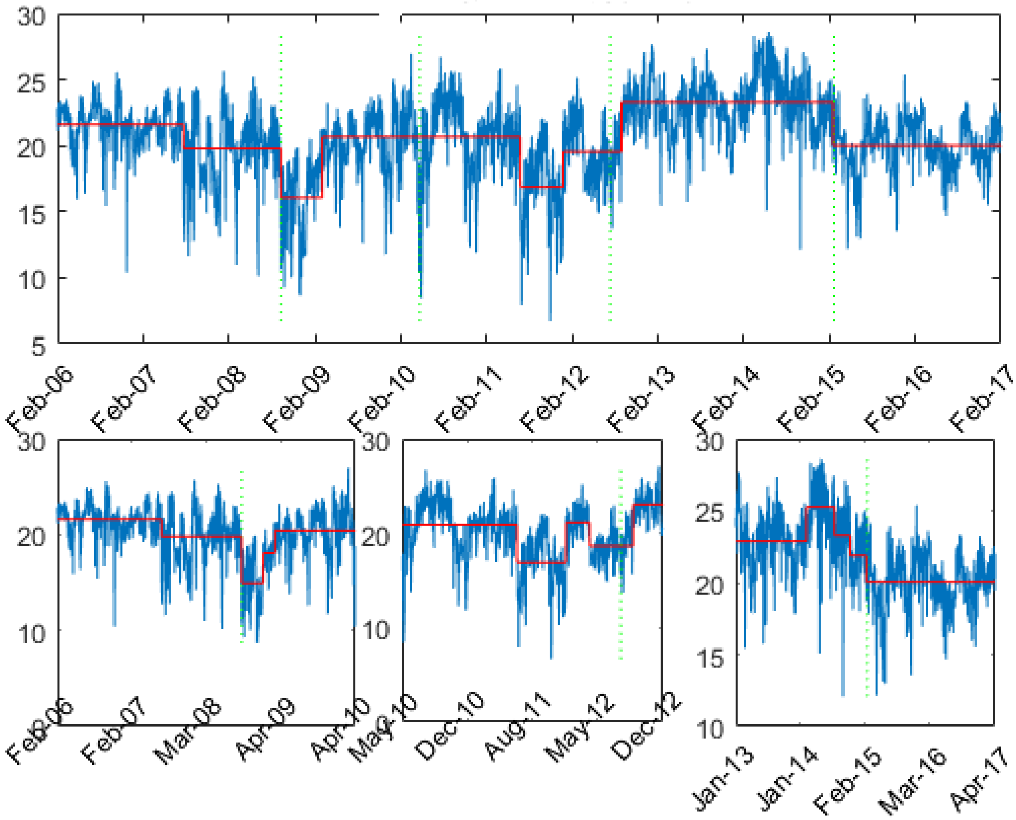

Figure 18: Bai and Perron test - Total number of proposals on bid side

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	7	Jul-07	Sep-08	Mar-09	Jul-11	Jan-12	Sep-12	Mar-15		
I Per	4	Jul-07	Sep-08	Jan-09	Mar-09					
II Per	4	Jul-11	Jan-12	Apr-12	Sep-12					
III Per	4	Mar-14	Aug-14	Nov-14	Mar-15					

Table 43: Bai and Perron test - Total number of proposals on bid side

Total number of proposals on ask side (NTA)

Dimension: Quoting.

Definition: Total number of proposals quoted on the ask side.

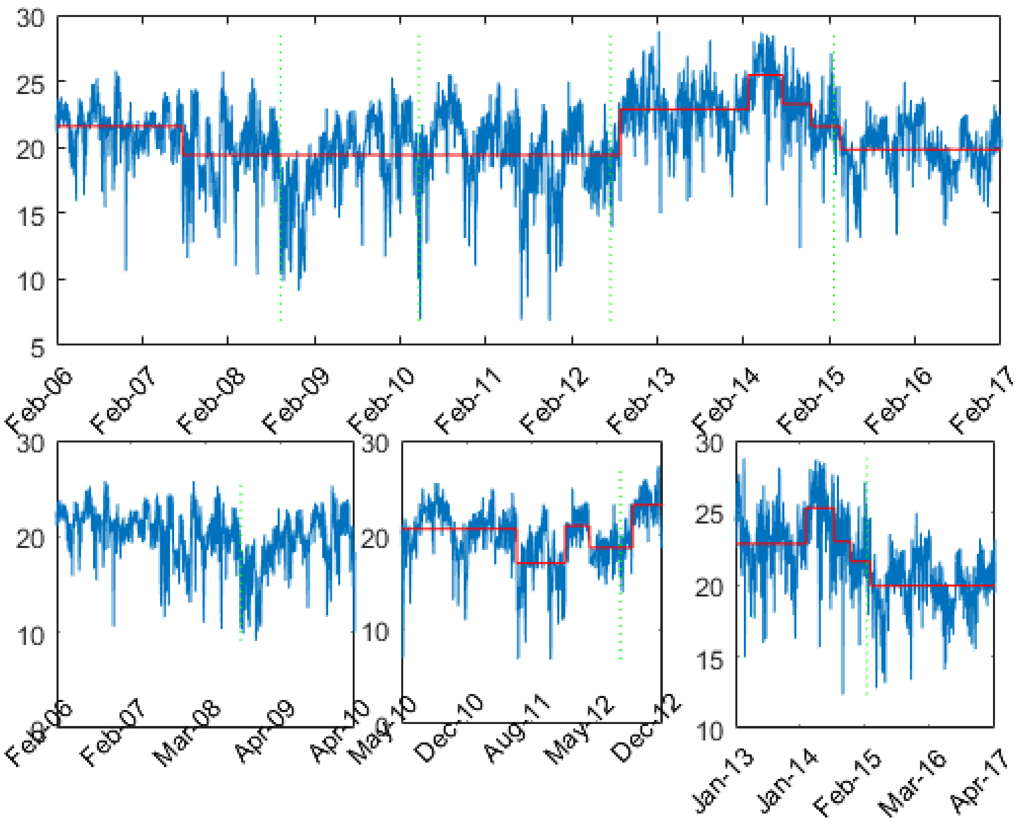

Figure 19: Bai and Perron test - Total number of proposals on ask side

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	6	Jul-07	Sep-12	Mar-14	Aug-14	Dec-14	Apr-15			
I Per	1	Jul-07								
II Per	4	Jul-11	Jan-12	Apr-12	Sep-12					
III Per	4	Mar-14	Aug-14	Dec-14	Apr-15					

Table 44: Bai and Perron test - Total number of proposals on ask side

Number of proposals in the 3 best bid (N3B)

Dimension: Quoting.

Definition: Total number of proposals quoted on the three best bid prices.

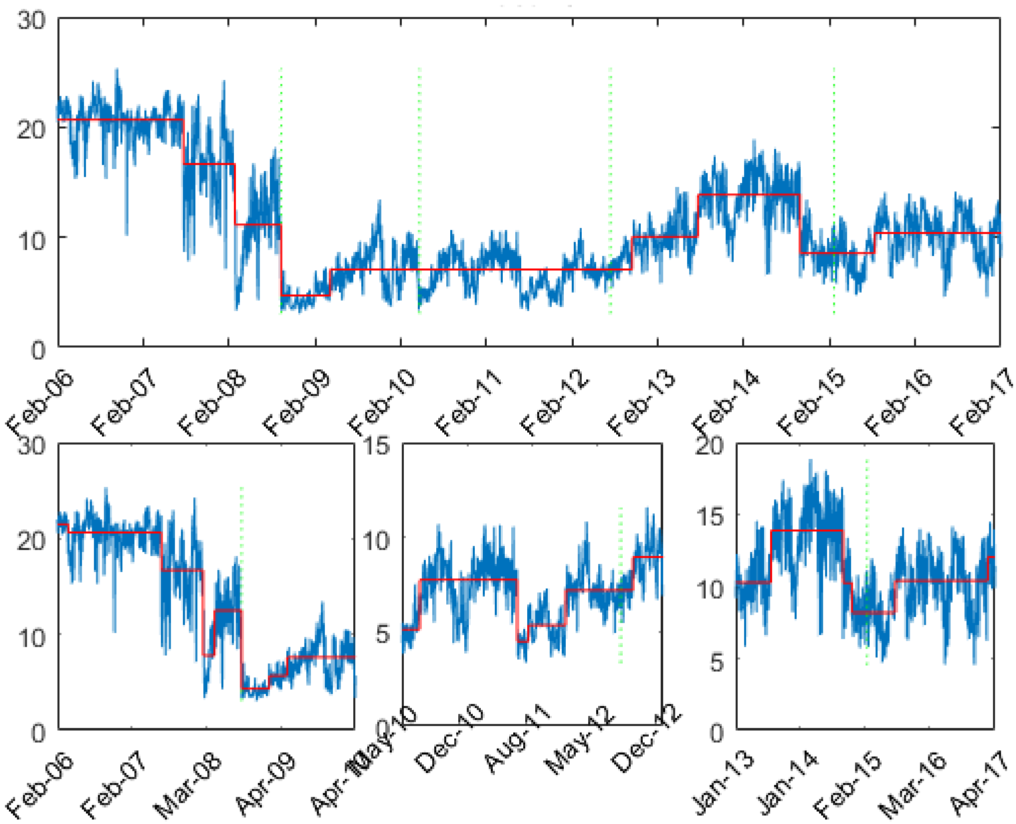

Figure 20: Bai and Perron test - Number of proposals on the 3 best bid

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	8	Jul-07	Feb-08	Sep-08	Apr-09	Oct-12	Aug-13	Oct-14	Aug-15	
I Per	7	Mar-06	Jul-07	Feb-08	Apr-08	Sep-08	Feb-09	May-09		
II Per	5	Jul-10	Jul-11	Aug-11	Jan-12	Sep-12				
III Per	5	Aug-13	Oct-14	Dec-14	Aug-15	Mar-17				

Table 45: Bai and Perron test - Number of proposals on the 3 best bid

Number of proposals in the 3 best ask (N3A)

Dimension: Quoting.

Definition: Total number of proposals quoted on the three best ask prices.

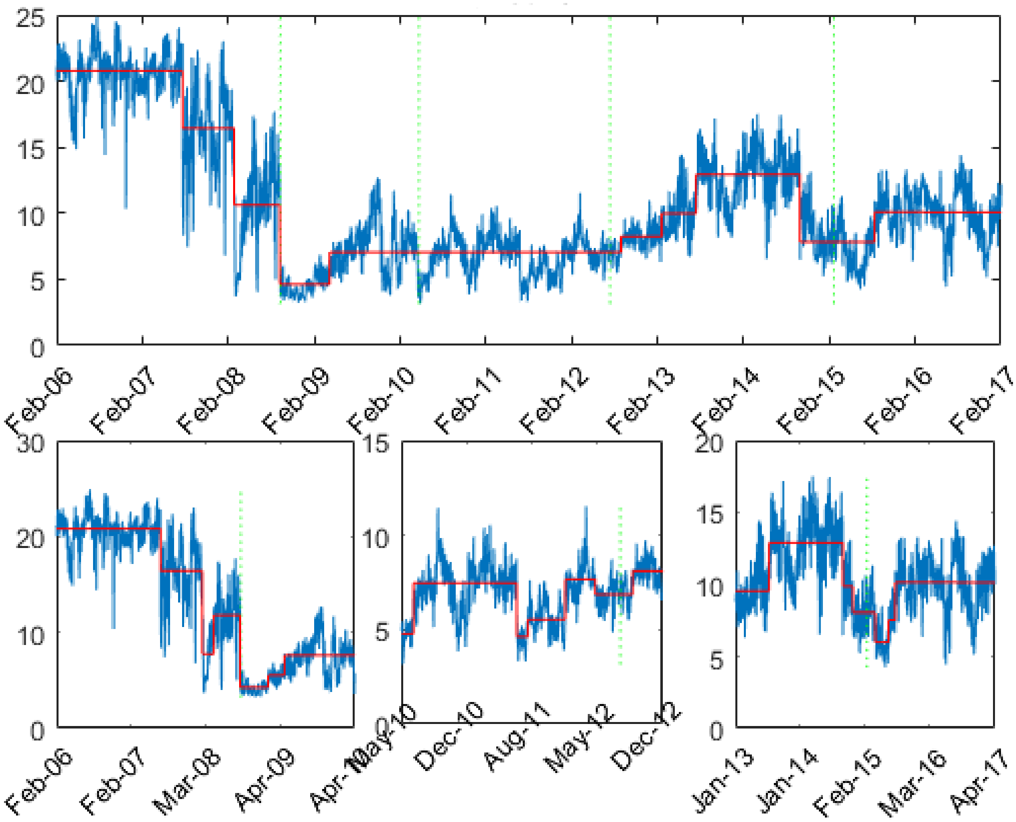

Figure 21: Bai and Perron test - Number of proposals on the 3 best ask

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Feb-08	Sep-08	Apr-09	Sep-12	Mar-13	Jul-13	Oct-14	Aug-15
I Per	6	Jul-07	Feb-08	Apr-08	Sep-08	Feb-09	Apr-09			
II Per	6	Jun-10	Jul-11	Aug-11	Jan-12	Apr-12	Sep-12			
III Per	6	Jul-13	Oct-14	Dec-14	Apr-15	Jul-15	Aug-15			

Table 46: Bai and Perron test - Number of proposals on the 3 best ask

Number of proposals in the 3 best bid / Total number of bid proposals (N3TB)

Dimension: Quoting.

Definition: Ratio of number of proposals quoted on the three best bid prices to total number of proposals on the bid side.

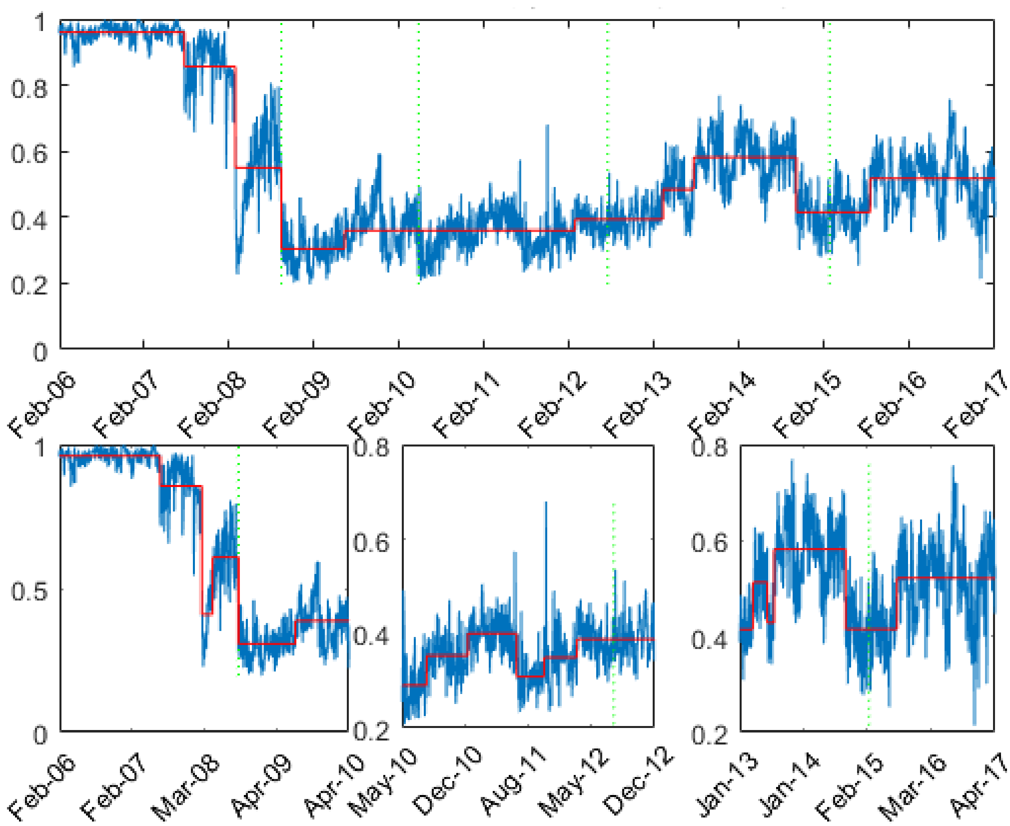

Figure 22: Bai and Perron test - Number of proposals on the 3 best bid / Total number of bid proposals (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jul-07	Mar-08	Sep-08	Jun-09	Mar-12	Mar-13	Aug-13	Oct-14	Aug-15
I Per	5	Jul-07	Mar-08	Apr-08	Sep-08	Jul-09				
II Per	5	Aug-10	Jan-11	Jul-11	Nov-11	Mar-12				
III Per	5	Mar-13	Jun-13	Aug-13	Oct-14	Aug-15				

Table 47: Bai and Perron test - Number of proposals on the 3 best bid / Total number of bid proposals

Number of proposals in the 3 best ask / Total number of ask proposals (N3TA)

Dimension: Quoting.

Definition: Ratio of number of proposals quoted on the three best ask prices to total number of proposals on the ask side.

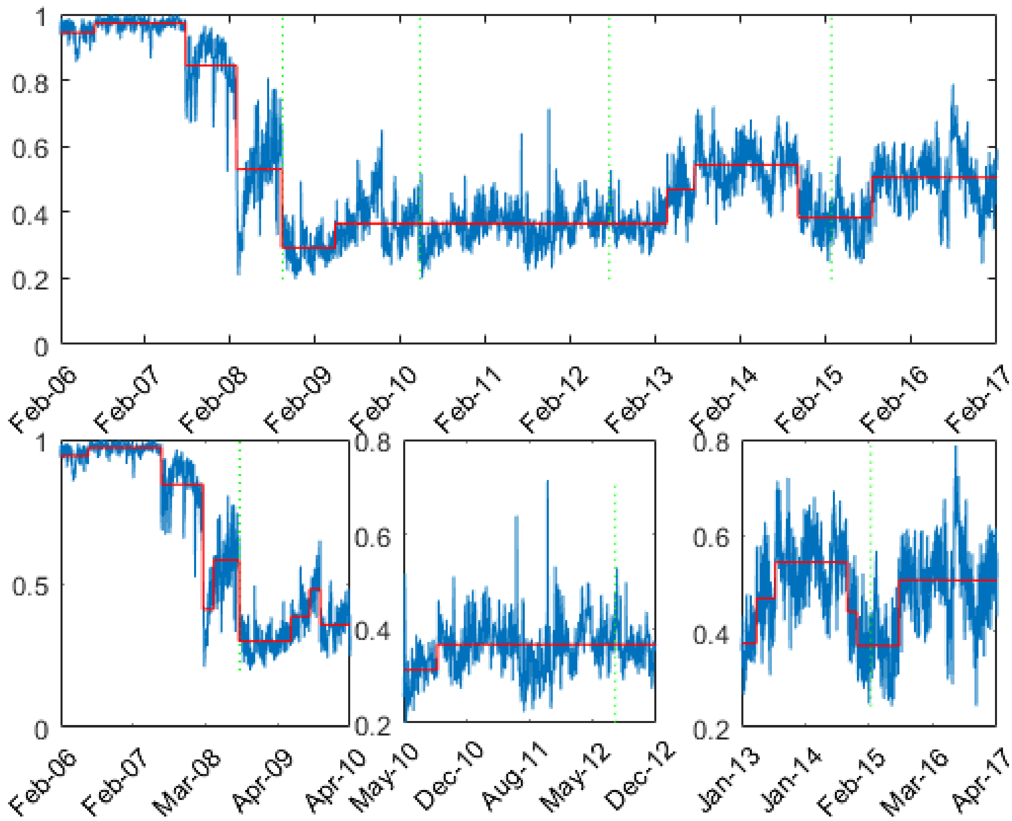

Figure 23: Bai and Perron test - Number of proposals on the 3 best ask / Total number of ask proposals (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Jun-06	Jul-07	Mar-08	Sep-08	Apr-09	Apr-13	Sep-13	Oct-14	Aug-15
I Per	8	Jun-06	Jul-07	Mar-08	Apr-08	Sep-08	Jun-09	Sep-09	Nov-09	
II Per	1	Sep-10								
III Per	5	Apr-13	Jul-13	Oct-14	Dec-14	Aug-15				

Table 48: Bai and Perron test - Number of proposals on the 3 best ask / Total number of ask proposals

Total number of bid proposals / Theoretical total number of proposals (NTTB)

Dimension: Quoting.

Definition: Ratio of number of proposals quoted on the bid side to theoretical number of proposals. Theoretical number of proposals is the sum of specialists and other market makers.

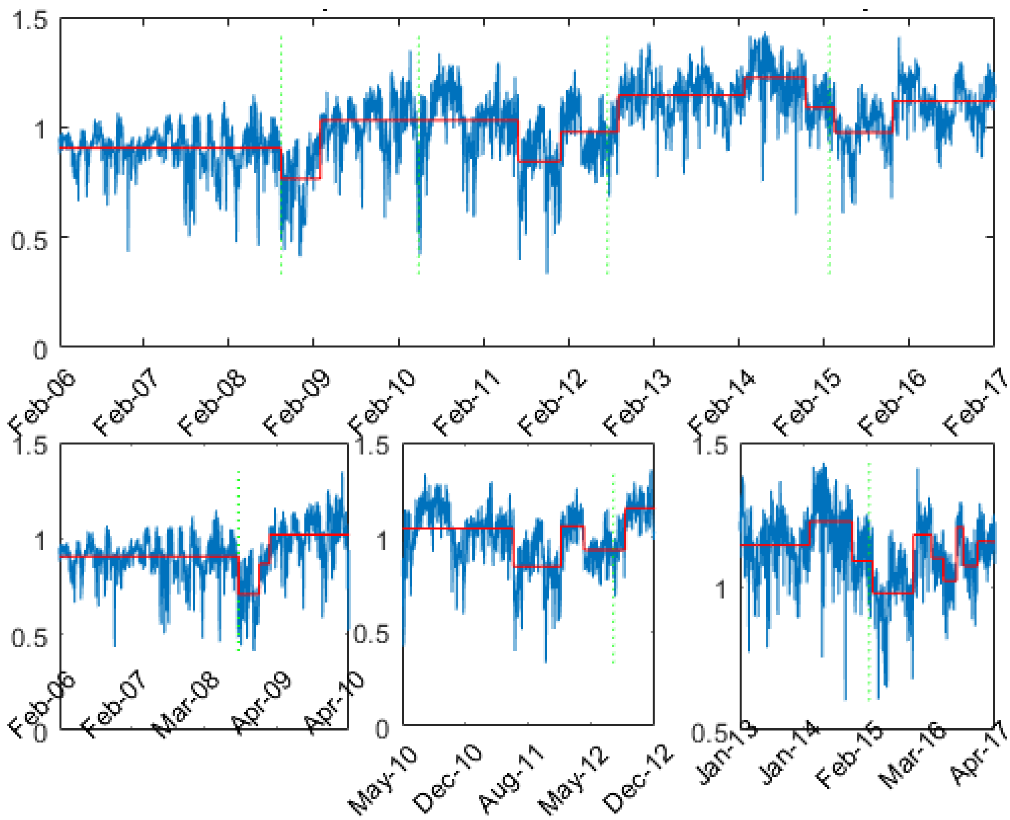

Figure 24: Bai and Perron test - Total number of bid proposals / Theoretical total number of proposals (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Sep-08	Mar-09	Jul-11	Jan-12	Sep-12	Mar-14	Nov-14	Apr-15	Dec-15
I Per	3	Sep-08	Jan-09	Mar-09						
II Per	4	Jul-11	Jan-12	Apr-12	Sep-12					
III Per	9	Mar-14	Nov-14	Apr-15	Dec-15	Apr-16	Jun-16	Sep-16	Oct-16	Jan-17

Table 49: Bai and Perron test - Total number of bid proposals / Theoretical total number of proposals

Total number of ask proposals / Theoretical total number of proposals (NTTA)

Dimension: Quoting.

Definition: Ratio of number of proposals quoted on the ask side to theoretical number of proposals. Theoretical number of proposals is the sum of specialists and other market makers.

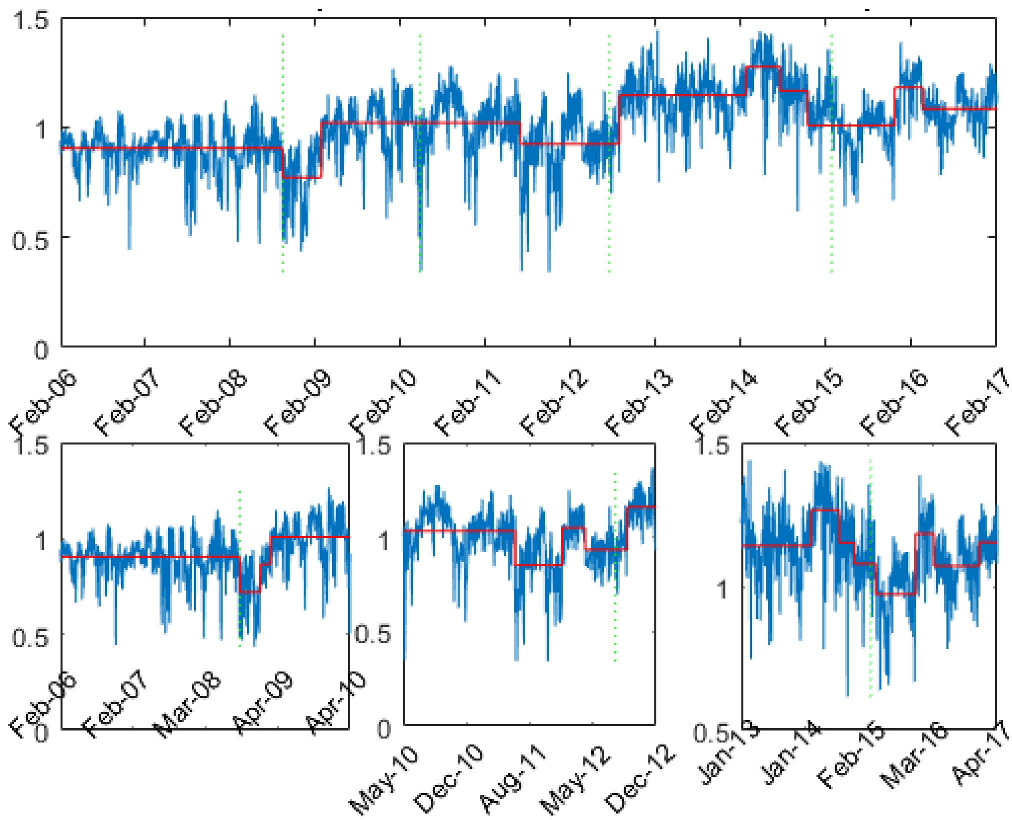

Figure 25: Bai and Perron test - Total number of ask proposals / Theoretical total number of proposals (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Sep-08	Mar-09	Jul-11	Sep-12	Mar-14	Aug-14	Nov-14	Dec-15	Apr-16
I Per	3	Sep-08	Jan-09	Mar-09						
II Per	4	Jul-11	Jan-12	Apr-12	Sep-12					
III Per	9	Mar-14	Aug-14	Nov-14	Apr-15	Dec-15	Apr-16	Jan-17		

Table 50: Bai and Perron test - Total number of ask proposals / Theoretical total number of proposals

Number of proposals in the 3 best bid / Theoretical total number of proposals (N3TOB)

Dimension: Quoting.

Definition: Ratio of number of proposals quoted on the three best bid prices to theoretical number of proposals. Theoretical number of proposals is the sum of specialists and other market makers.

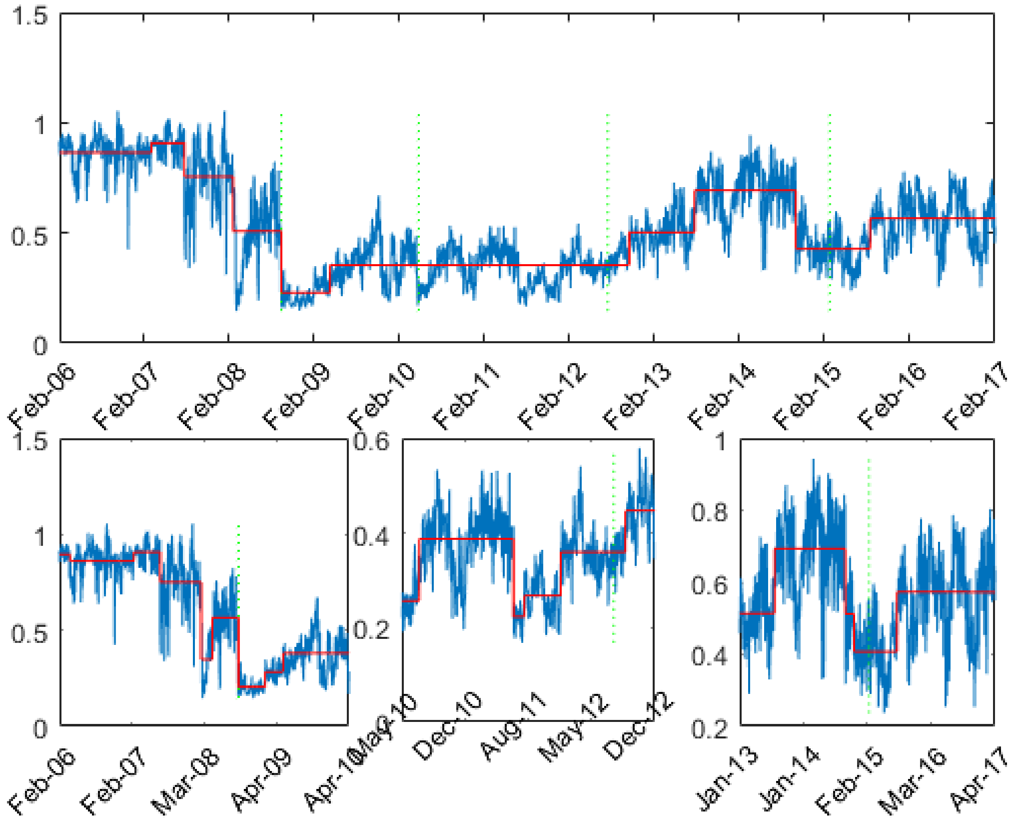

Figure 26: Bai and Perron test - Number of proposals on the 3 best bid / Theoretical total number of proposals (%)

Period	**Num. breaks**	**Date 1**	**Date 2**	**Date 3**	**Date 4**	**Date 5**	**Date 6**	**Date 7**	**Date 8**	**Date 9**
Entire	9	Mar-07	Jul-07	Feb-08	Sep-08	Apr-09	Oct-12	Aug-13	Oct-14	Aug-15
I Per	8	Mar-06	Mar-07	Jul-07	Feb-08	Apr-08	Sep-08	Feb-09	May-09	
II Per	5	Jul-10	Jul-11	Aug-11	Jan-12	Sep-12				
III Per	4	Aug-13	Oct-14	Dec-14	Aug-15					

Table 51: Bai and Perron test - Number of proposals on the 3 best bid / Theoretical total number of proposals

Number of proposals in the 3 best ask / Theoretical total number of proposals (N3TOA)

Dimension: Quoting.

Definition: Ratio of number of proposals quoted on the three best ask prices to theoretical number of proposals. Theoretical number of proposals is the sum of specialists and other market makers.

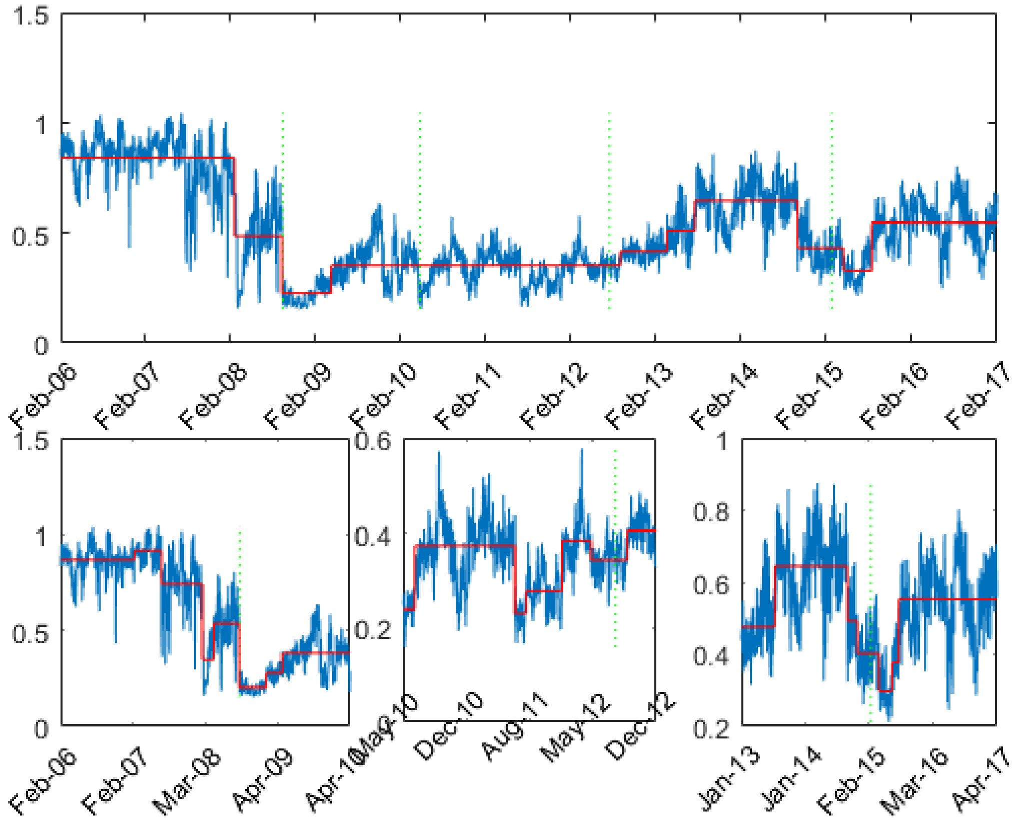

Figure 27: Bai and Perron test - Number of proposals on the 3 best ask / Theoretical total number of proposals (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Feb-08	Sep-08	Apr-09	Sep-12	Apr-13	Jul-13	Oct-14	Apr-15	Aug-15
I Per	7	Mar-07	Jul-07	Feb-08	Apr-08	Sep-08	Feb-09	Apr-09		
II Per	6	Jun-10	Jul-11	Aug-11	Jan-12	Apr-12	Sep-12			
III Per	6	Jul-13	Oct-14	Dec-14	Apr-15	Jul-15	Aug-15			

Table 52: Bai and Perron test - Number of proposals on the 3 best ask / Theoretical total number of proposals

Volume outliers on bid side (VOB)

Dimension: Quoting.

Definition: Total volumes on the bid side identified as outliers through the method descriped in the introduction.

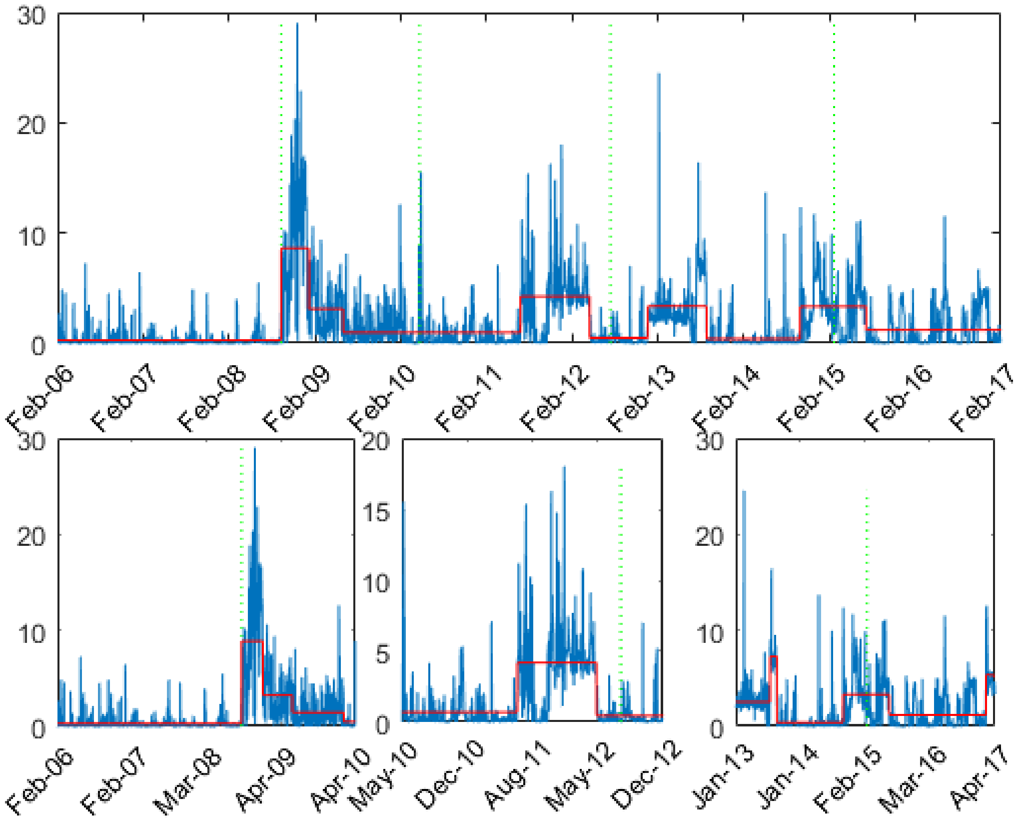

Figure 28: Bai and Perron test - Volume outliers on bid side (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Sep-08	Jan-09	Jun-09	Jul-11	Apr-12	Jan-13	Sep-13	Oct-14	Jul-15
I Per	4	Sep-08	Jan-09	Jun-09	Mar-10					
II Per	2	Jul-11	Apr-12							
III Per	5	Jul-13	Sep-13	Oct-14	Jul-15	Mar-17				

Table 53: Bai and Perron test - Volume outliers on bid side

Volume outliers on ask side (VOA)

Dimension: Quoting.

Definition: Total volumes on the ask side identified as outliers through the method descriped in the introduction.

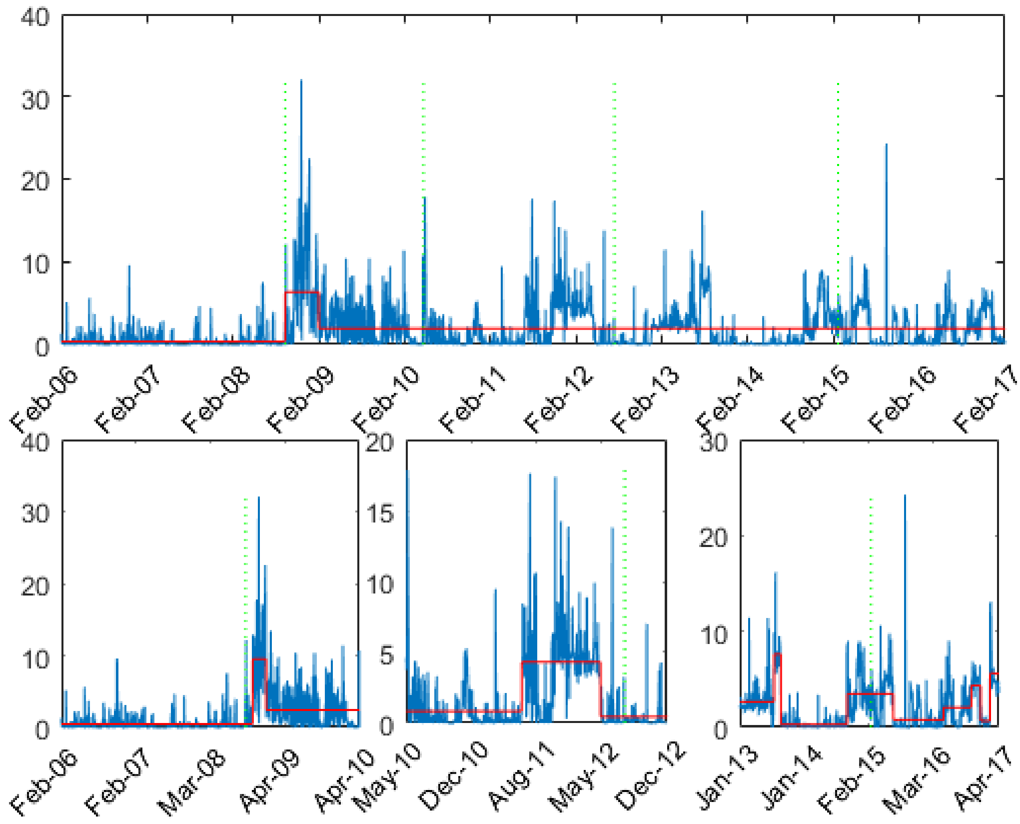

Figure 29: Bai and Perron test - Volume outliers on ask side (mm)

Period	**Num. breaks**	**Date 1**	**Date 2**	**Date 3**	**Date 4**	**Date 5**	**Date 6**	**Date 7**	**Date 8**	**Date 9**
Entire	2	Sep-08	Jan-09							
I Per	2	Oct-08	Jan-09							
II Per	2	Jul-11	Apr-12							
III Per	8	Jul-13	Sep-13	Oct-14	Jul-15	May-16	Nov-16	Jan-17	Mar-17	

Table 54: Bai and Perron test - Bai and Perron test - Volume outliers on ask side

Volume outliers on bid side / Theoretical total depth (VOBTE)

Dimension: Quoting.

Definition: Ratio of the total volumes on the bid side identified as outliers to the theoretical total depth.

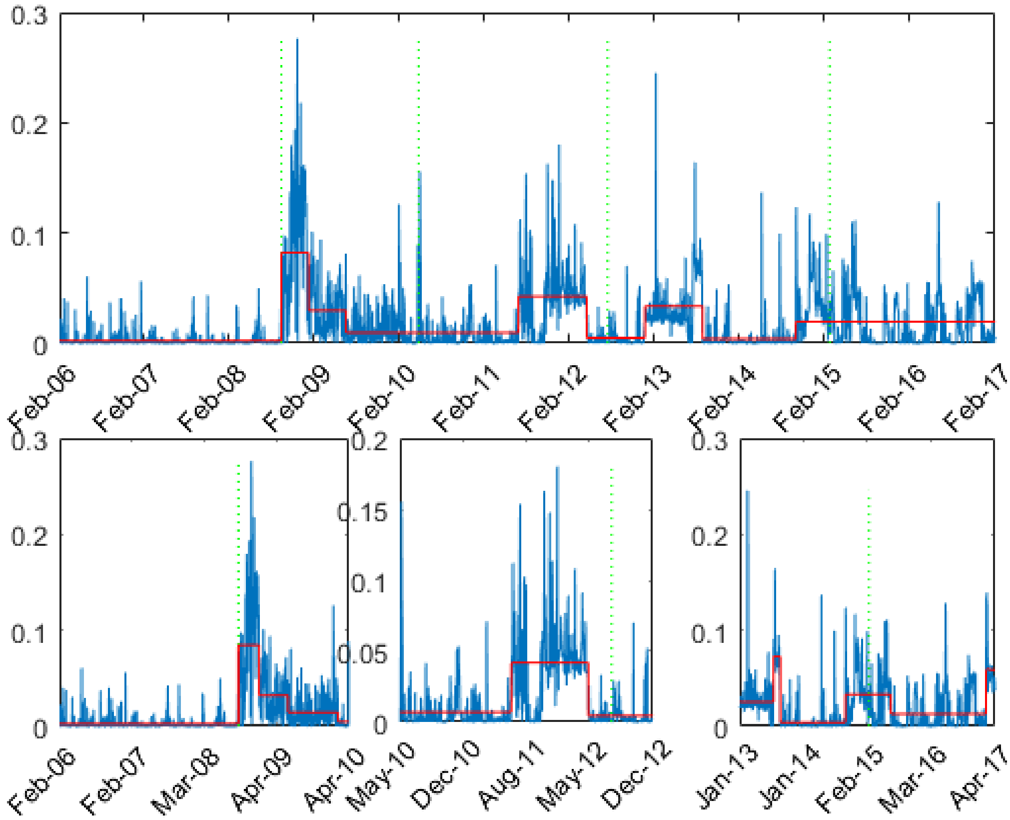

Figure 30: Bai and Perron test - Volume outliers on bid side / Theoretical total depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	9	Sep-08	Jan-09	Jun-09	Jul-11	Apr-12	Jan-13	Sep-13	Oct-14	Jul-15
I Per	4	Sep-08	Jan-09	Jun-09	Mar-10					
II Per	2	Jul-11	Apr-12							
III Per	5	Jul-13	Sep-13	Oct-14	Jul-15	Mar-17				

Table 55: Bai and Perron test - Volume outliers on bid side / Theoretical total depth

Volume outliers on ask side / Theoretical total depth (VOATE)

Dimension: Quoting.

Definition: Ratio of the total volumes on the ask side identified as outliers to the theoretical total depth.

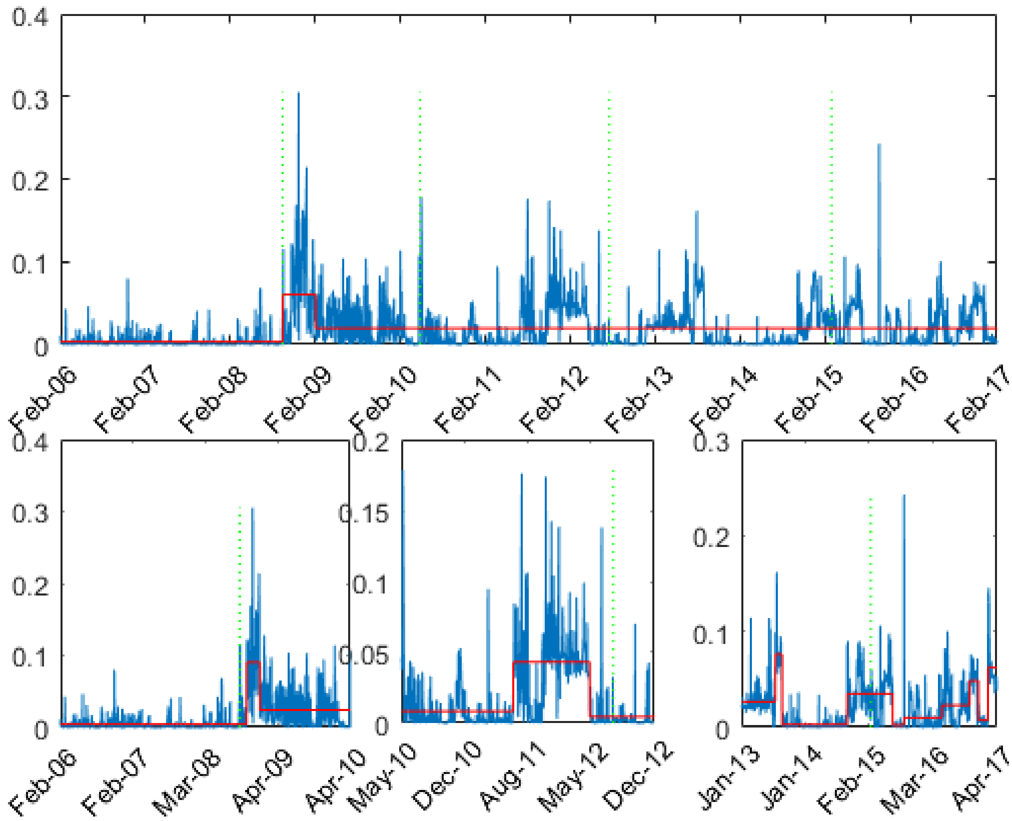

Figure 31: Bai and Perron test - Volume outliers on ask side / Theoretical total depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	2	Sep-08	Feb-09							
I Per	2	Oct-08	Jan-09							
II Per	2	Jul-11	Apr-12							
III Per	9	Jul-13	Sep-13	Oct-14	Jul-15	Oct-15	May-16	Nov-16	Jan-17	Mar-17

Table 56: Bai and Perron test - Volume outliers on ask side / Theoretical total depth

Volume outliers on bid side / Total bid depth (VOBTO)

Dimension: Quoting.

Definition: Ratio of the total volumes on the bid side identified as outliers to the total depth on the bid side.

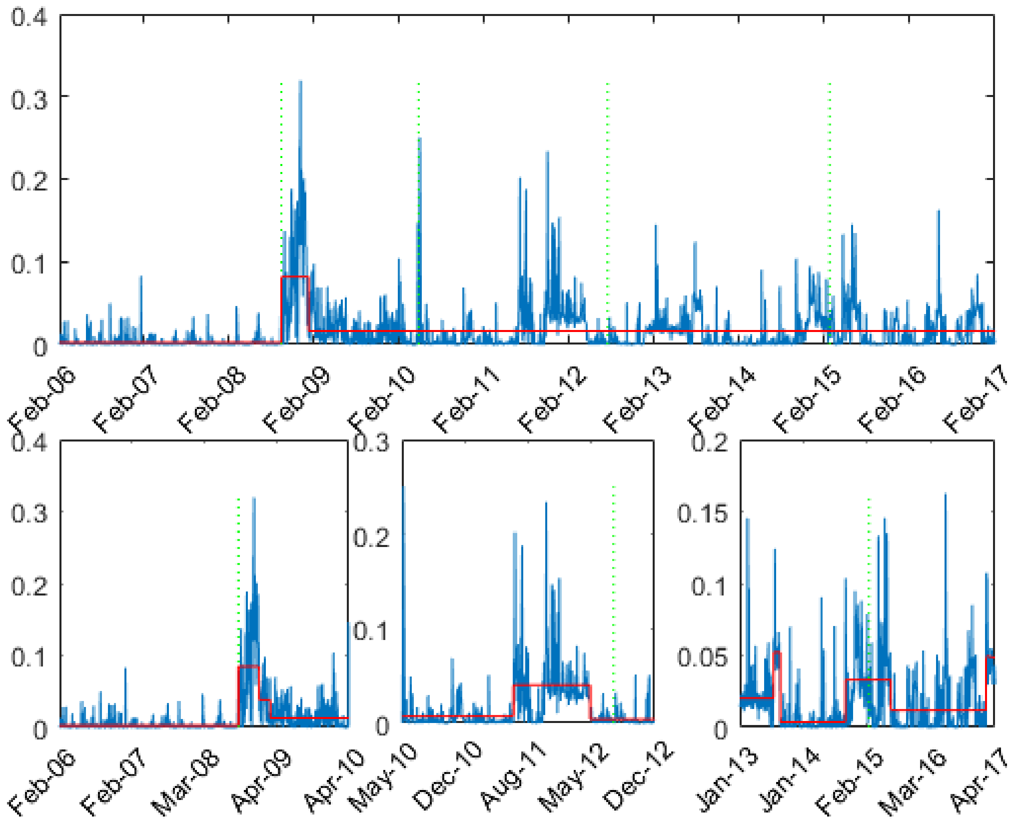

Figure 32: Bai and Perron test -Volume outliers on bid side / Total bid depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	2	Sep-08	Jan-09							
I Per	3	Sep-08	Jan-09	Mar-09						
II Per	2	Jul-11	Apr-12							
III Per	5	Jul-13	Sep-13	Oct-14	Jul-15	Mar-17				

Table 57: Bai and Perron test - Volume outliers on bid side / Total bid depth

Volume outliers on ask side / Total ask depth (VOATO)

Dimension: Quoting.

Definition: Ratio of the total volumes on the ask side identified as outliers to the total depth on the ask side.

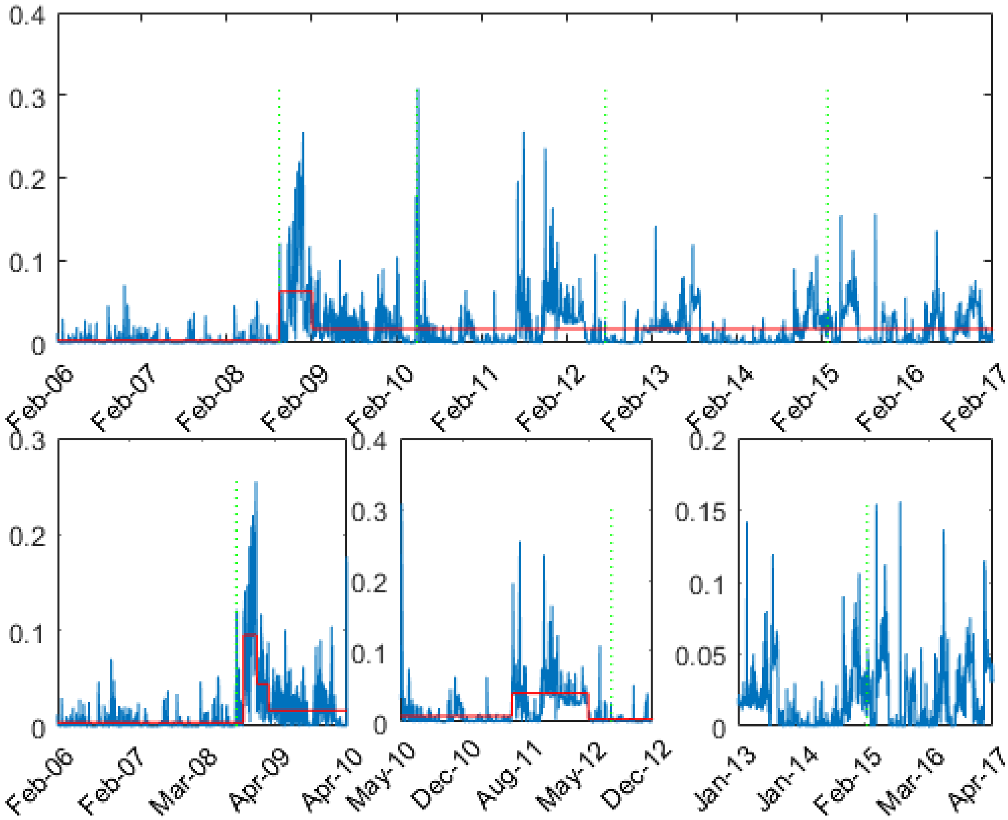

Figure 33: Bai and Perron test -Volume outliers on ask side / Total ask depth (%)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	2	Sep-08	Feb-09							
I Per	2	Oct-08	Jan-09	Mar-09						
II Per	2	Jul-11	Apr-12							
III Per	0									

Table 58: Bai and Perron test - Volume outliers on ask side / Total ask depth

Total buying volumes (VB)

Dimension: Trading.

Definition: Total buying volumes.

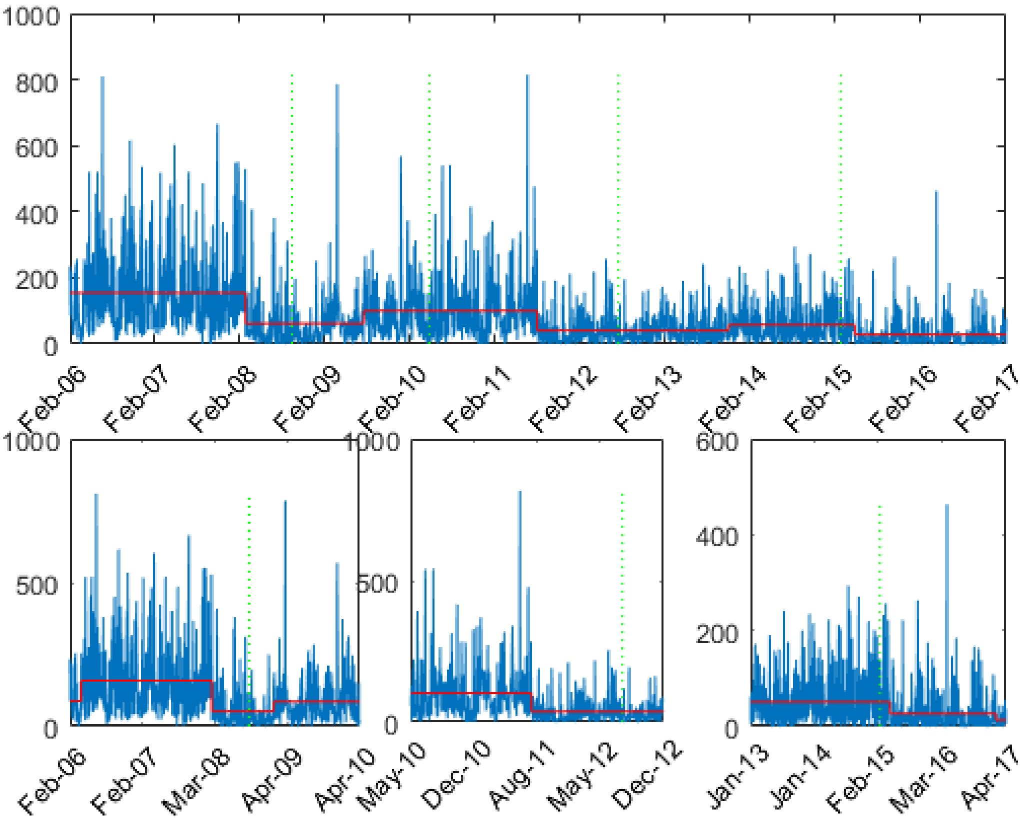

Figure 34: Bai and Perron test - Total buying volumes (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	5	Feb-08	Jul-09	Aug-11	Nov-13	May-15				
I Per	3	Apr-06	Feb-08	Jan-09						
II Per	1	Aug-11								
III Per	2	May-15	Feb-17							

Table 59: Bai and Perron test - Total buying volumes

Total selling volumes (VS)

Dimension: Trading.

Definition: Total selling volumes.

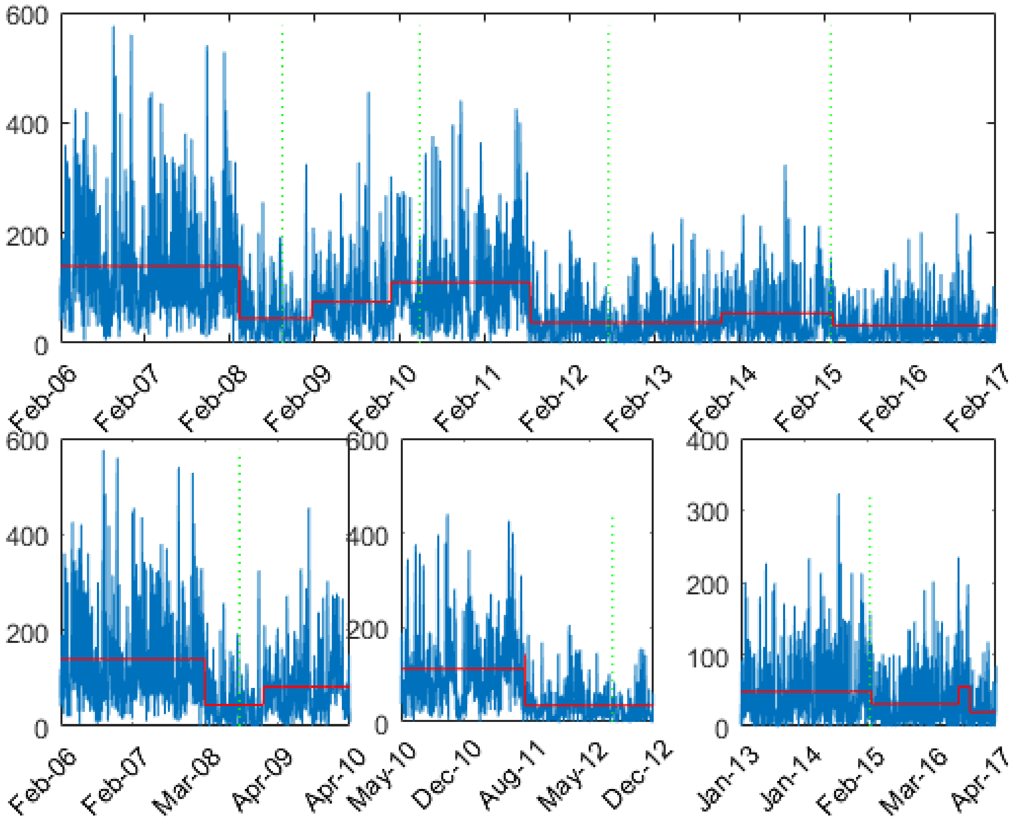

Figure 35: Bai and Perron test - Total selling volumes (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	6	Mar-08	Jan-09	Dec-09	Aug-11	Nov-13	Mar-15			
I Per	2	Mar-08	Jan-09							
II Per	1	Aug-11								
III Per	3	Mar-15	Sep-16	Nov-16						

Table 60: Bai and Perron test - Total selling volumes

Trades > 15mm - Total volumes (BVT)

Dimension: Trading.

Definition: Total trading volumes of block trades greater than 15mm.

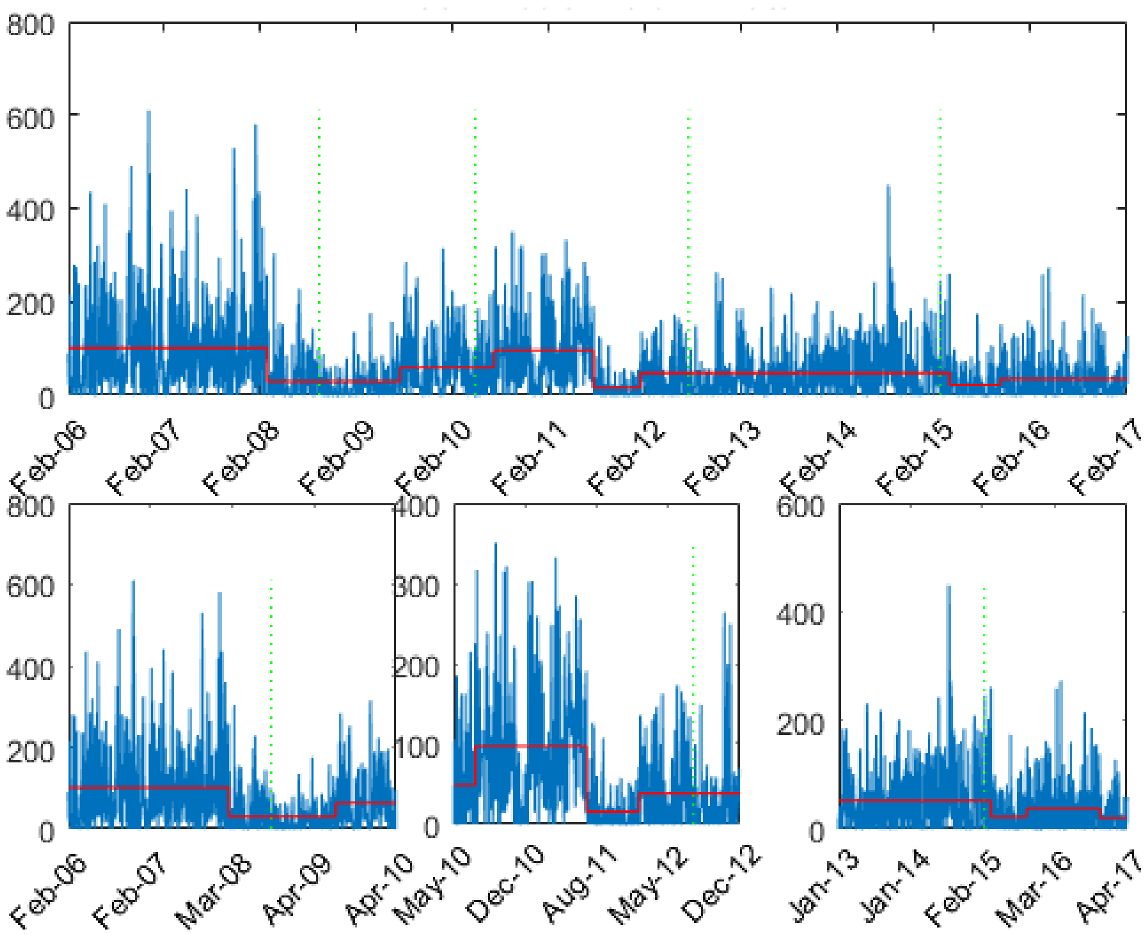

Figure 36: Bai and Perron test - Trades > 15mm - Total volumes (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	7	Feb-08	Jul-09	Jul-10	Jul-11	Jan-12	Apr-15	Oct-15		
I Per	2	Feb-08	Jul-09							
II Per	3	Jul-10	Jul-11	Jan-12						
III Per	3	Apr-15	Oct-15	Nov-16						

Table 61: Bai and Perron test - Trades > 15mm - Total volumes

Trades > 15mm - Total buying (BVB)

Dimension: Trading.

Definition: Total buying volumes of block trades greater than 15mm.

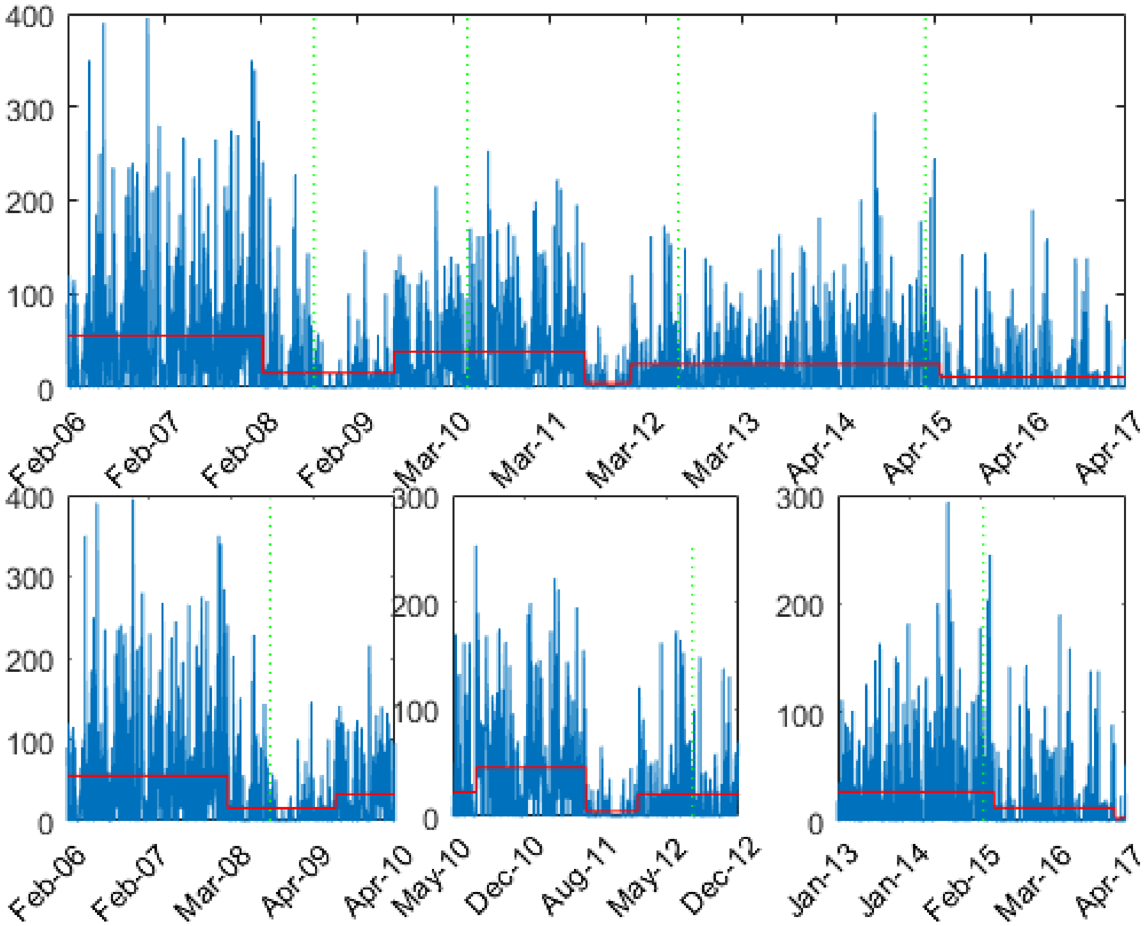

Figure 37: Bai and Perron test - Trades > 15mm - Total buying (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	5	Feb-08	Jul-09	Jul-11	Jan-12	May-15				
I Per	2	Feb-08	Jul-09							
II Per	3	Jul-10	Jul-11	Jan-12						
III Per	2	May-15	Feb-17							

Table 62: Bai and Perron test - Trades > 15mm - Total buying

Trades > 15mm - Total selling (BVS)

Dimension: Trading.

Definition: Total selling volumes of block trades greater than 15mm.

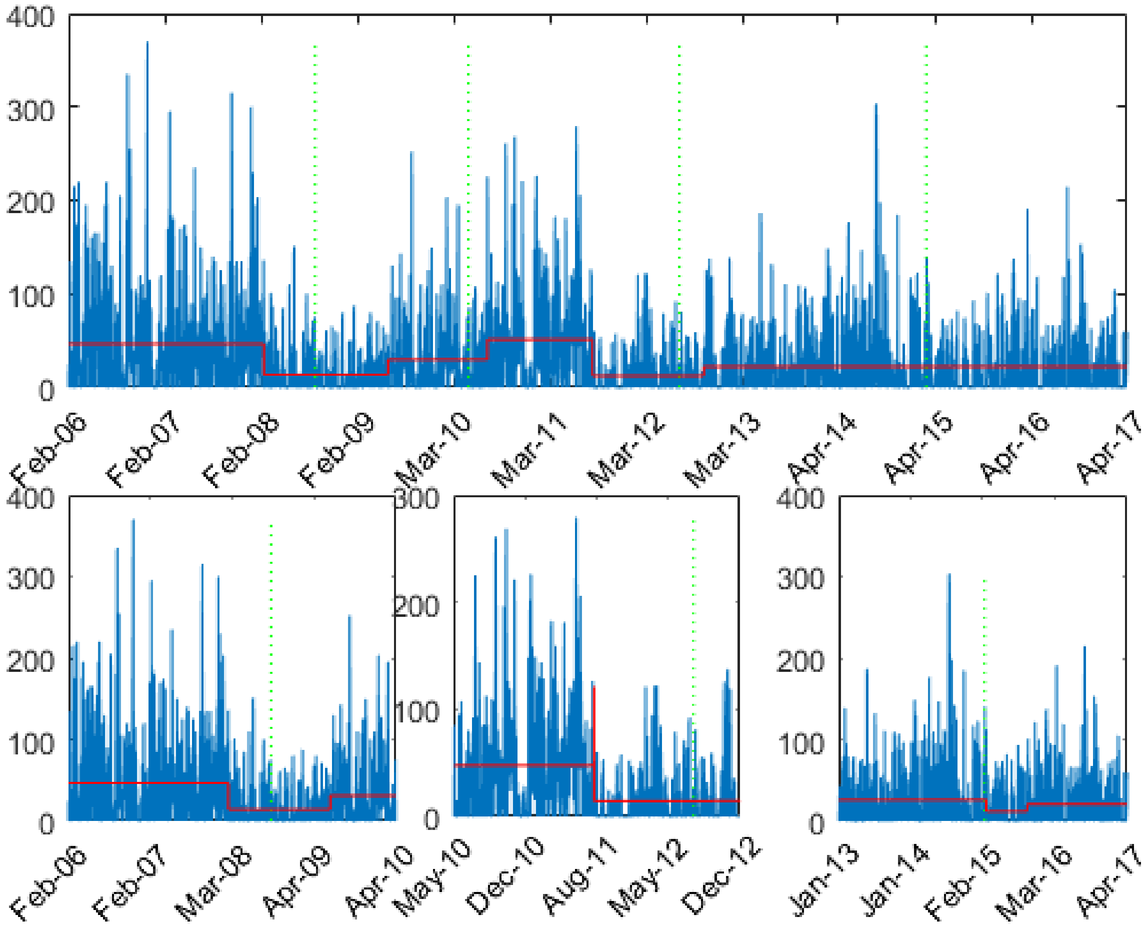

Figure 38: Bai and Perron test - Trades > 15mm - Total selling (mm)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	5	Feb-08	Jun-09	Jul-10	Aug-11	Oct-12				
I Per	3	Feb-08	Jun-09							
II Per	1	Aug-11								
III Per	2	Mar-15	Oct-15							

Table 63: Bai and Perron test - Trades > 15mm - Total selling

Trades > 15mm - Total number of deals (BNT)

Dimension: Trading.

Definition: Total number of block trades greater than 15mm.

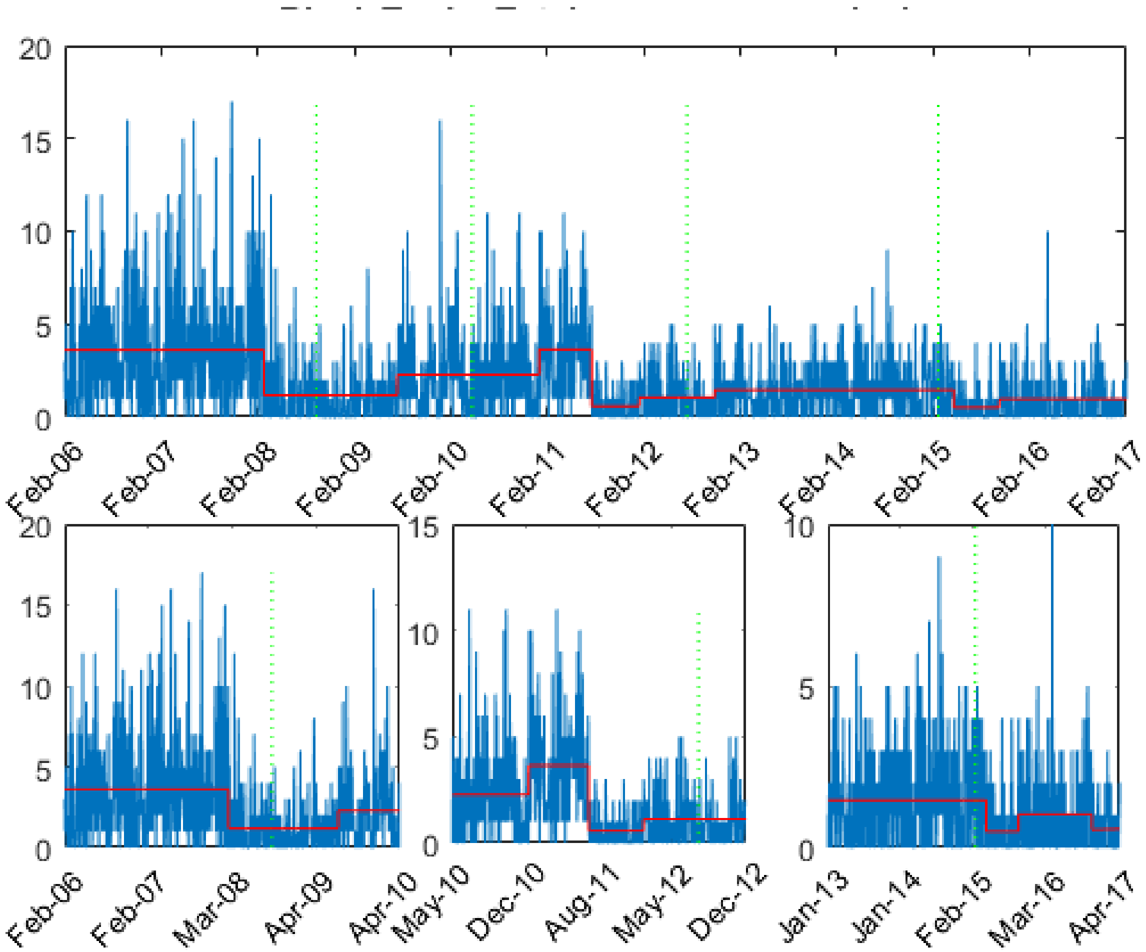

Figure 39: Bai and Perron test - Trades > 15mm - Total number of deals

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	8	Feb-08	Jul-09	Jan-11	Jul-11	Jan-12	Nov-12	May-15	Oct-15	
I Per	2	Feb-08	Jul-09							
II Per	3	Jan-11	Jul-11	Jan-12						
III Per	3	May-15	Oct-15	Nov-16						

Table 64: Bai and Perron test - Trades > 15mm - Total number of deals

Trades > 15mm - Total number of buying (BNB)

Dimension: Trading.

Definition: Total number of block buying trades greater than 15mm.

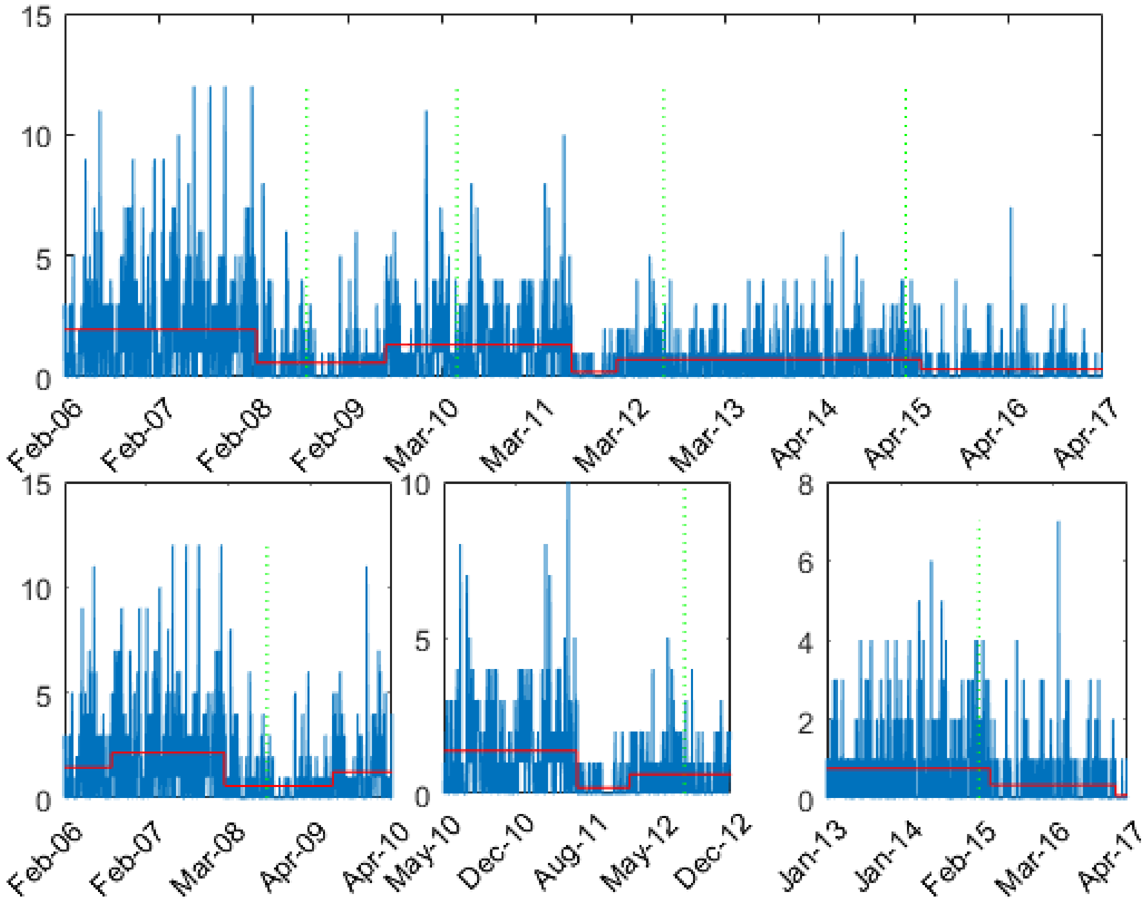

Figure 40: Bai and Perron test - Trades > 15mm - Total number of buying

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	5	Feb-08	Jul-09	Jul-11	Jan-12	May-15				
I Per	3	Sep-06	Feb-08	Jul-09						
II Per	2	Jul-11	Jan-12							
III Per	2	May-15	Feb-17							

Table 65: Bai and Perron test - Trades > 15mm - Total number of buying

Trades > 15mm - Total number of selling (BNS)

Dimension: Trading.

Definition: Total number of block selling trades greater than 15mm.

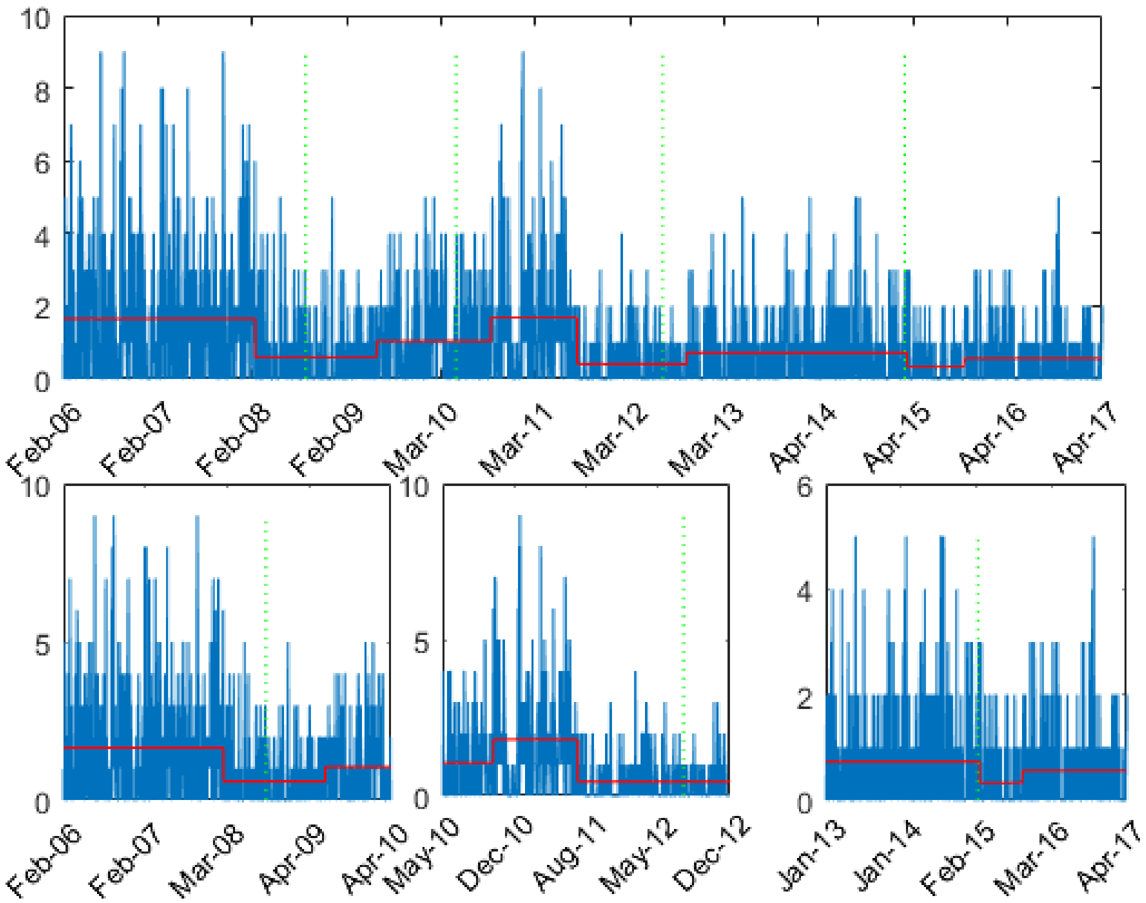

Figure 41: Bai and Perron test - Trades > 15mm - Total number of selling

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	7	Feb-08	Jun-09	Sep-10	Aug-11	Oct-12	Mar-15	Oct-15		
I Per	2	Feb-08	Jun-09							
II Per	2	Oct-10	Aug-11							
III Per	2	Mar-15	Oct-15							

Table 66: Bai and Perron test - Trades > 15mm - Total number of selling

Price impact on best bid (PIB)

Dimension: Resiliency.

Definition: Impact of selling trades greater of 15mm on the best bid prices after 15 minutes the deal execution.

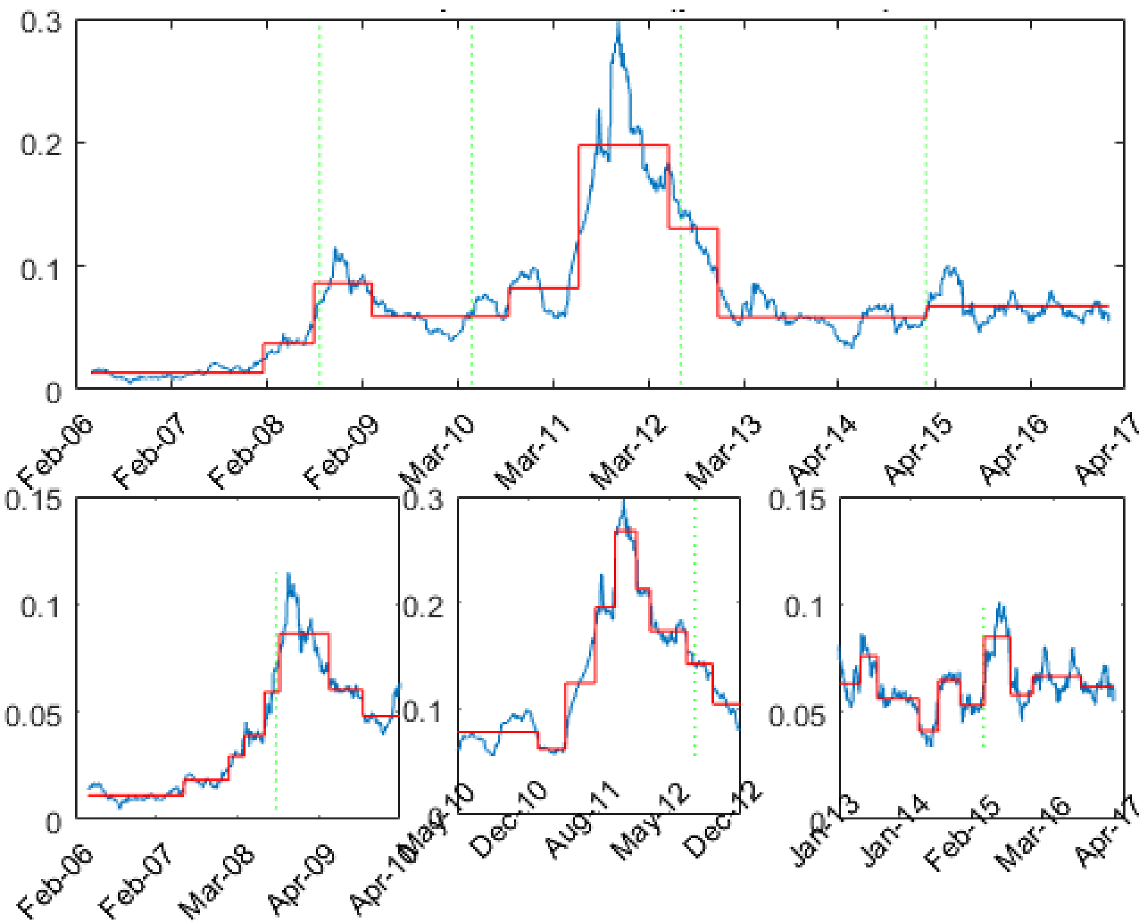

Figure 42: Bai and Perron test - Price impact on best bid (price ticks)

Period	Num. breaks	Date 1	Date 2	Date 3	Date 4	Date 5	Date 6	Date 7	Date 8	Date 9
Entire	8	Feb-08	Aug-08	Apr-09	Sep-10	Jun-11	Jun-12	Dec-12	Mar-15	
I Per	7	Jul-07	Feb-08	Apr-08	Jul-08	Oct-08	May-09	Nov-09		
II Per	8	Feb-11	May-11	Aug-11	Oct-11	Jan-12	Feb-12	Jun-12	Sep-12	
III Per	9	Apr-13	Jul-13	Mar-14	Jul-14	Oct-14	Mar-15	Aug-15	Dec-15	Aug-16

Table 67: Bai and Perron test - Price impact on best bid

Price impact on best ask (PIA)

Dimension: Resiliency.

Definition: Impact of buying trades greater of 15mm on the best ask prices after 15 minutes the deal execution.

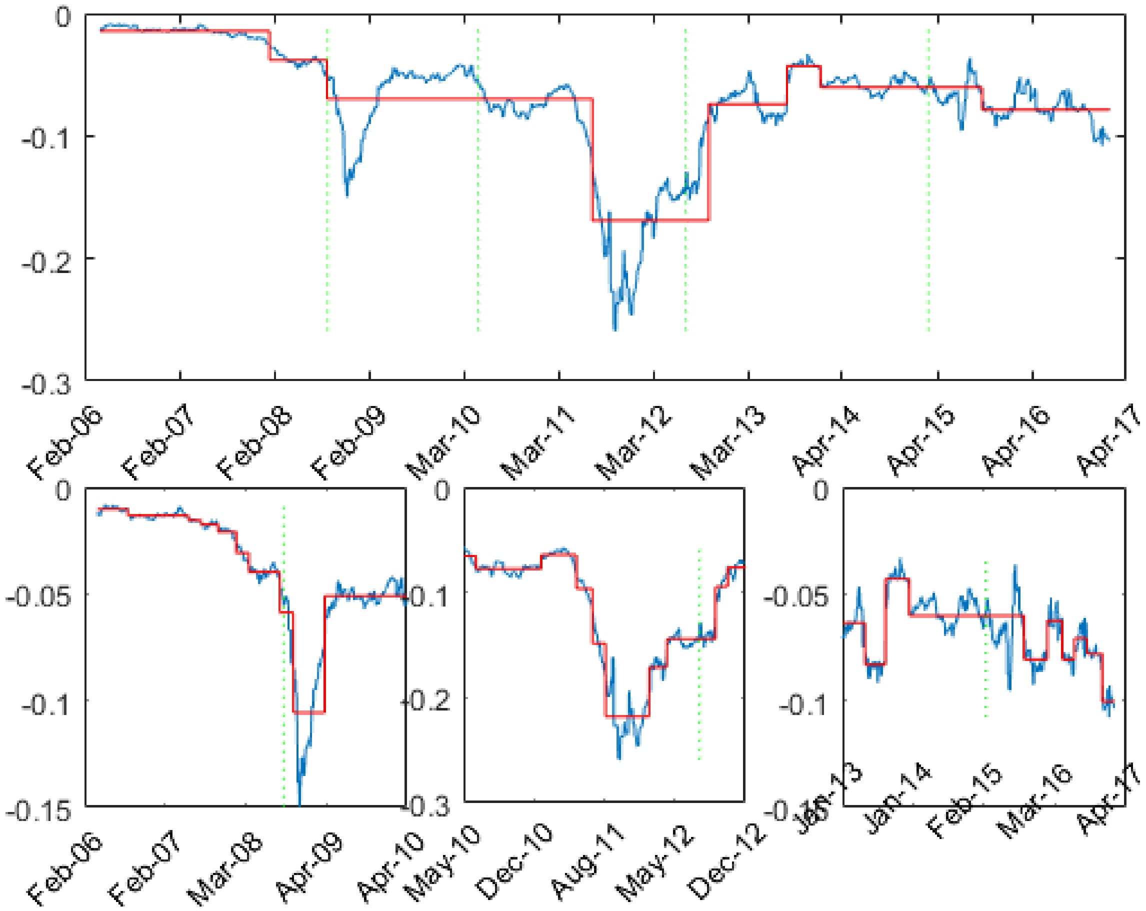

Figure 43: Bai and Perron test - Price impact on best ask (price ticks)

Period	**Num. breaks**	**Date 1**	**Date 2**	**Date 3**	**Date 4**	**Date 5**	**Date 6**	**Date 7**	**Date 8**	**Date 9**
Entire	7	Jan-08	Sep-08	Jul-11	Oct-12	Aug-13	Jan-14	Oct-15		
I Per	9	Aug-06	Jun-07	Aug-07	Nov-07	Jan-08	Apr-08	Aug-08	Oct-08	Mar-09
II Per	9	Jun-10	Jan-11	May-11	Jul-11	Sep-11	Feb-12	Apr-12	Sep-12	Nov-12
III Per	9	May-13	Aug-13	Jan-14	Oct-15	Feb-16	May-16	Jul-16	Sep-16	Sep-16

Table 68: Bai and Perron test - Price impact on best ask

Appendix D. Chapter 4

.5 Specialists' evaluation criteria. Year 2015

Table 69: Evaluation Criteria of Specialists in Government bonds. Year 2015

Parameter		Description	Max score
Primary Market	Primary Market Quota	Each Specialist is assigned a score, between 0 and 33, in proportion to the share allocated obtained in the reference period. The score begins to be assigned with the allocation of a share above the minimum required to maintain the Specialist qualification (3%) up to a maximum level of 6%. The score for the primary quantitative parameter is assigned according to the following formula: (Specialist's market share – 3%)/(6% - 3%)*33. The specialist's market share in the reference period is calculated weighting the allocated amounts of each type of bond with weights that take into account the financial characteristics of the same bonds as well as the status of the bonds placed on auction (bonds currently being issued – on-the-run – or no longer being issued – off-the-run) according to the table 71	33.00

Parameter		Description	Max score
Primary Market	Qualitative evaluation – AAI	AAI measures the contribution of each Specialist's auction strategy in determining the difference between the bond auction price and the prices reported on the secondary market. AAI measures the degree of aggresivity of the auction participation strategy of each Specialist, in other words, the combined effect of the difference between bid prices and market prices (overbidding) associated with bid quantities that ration the amount available to the remaining participants (overdemanding). The score is attributed according to the average value of the AAI, calculated on each auction of on-the-run BTPs, BTPI, CCT, CTZ, obtained by each Specialist and is assigned according to the following scheme: a) if $0 < AAI < 0.2$, 12 points; b) $0.2 < AAI < 1.2$, 0-12 points in proportion to the AAI value; c) $AAI > 1.2$, 0 points. For each auction the value of the AAI may be adjusted by the Treasury in order to take into consideration the specific contribution of the Specialists to the auction result, the requests of the bond at auction by final investors and, more generally, the overall outcome of the auction with respect to the performance on the secondary market of the same bond in the period preceding the auction cut-off time.	12.00

Parameter		Description	Max score
Primary Market	Qualitative evaluation – Bidding Continuity	This criteria evaluates the regularity of participation of Specialists in all the auctions of Government bonds. The indicator measures the number of times in which the Specialist, in auctions, did not bid for a quota of at least 4The indicator is made so as to proportionally penalize (by up to a maximum of 4 points) those Specialists that more frequently did not respect the minimum level of participation in the auctions.	0.00

Parameter		Description	Max score
Secondary Market	Quality quotation index	QQI is an indicator based on high frequency snapshots (that mimic continuous monitoring), made on each market day, on the order book of each bond, for each Specialist. For each snapshot, the ranking of the Specialist in the order book of the bond with respect to the best ranked Specialist, both for the bid and ask sides, is recorded. To calculate the indicator, those snapshots, both on the bid and ask sides, that reveal buy and/or sale price proposals associated with (visible) quantities that are equal to at least 5 million euros, will be considered, with the exception of the BTP€i segment where all proposals are evaluated. For each bond, the average ranking of the Specialist is calculated, relative to the market day. To calculate the average ranking, each position in the order book (in terms of ranking with respect to the best Specialist) is weighted with decreasing coefficients that are in proportion to the position in the order book with respect to the best price, in order to reward more those dealers that continuously show the best prices both for the bid and the ask sides. The absence of the Specialist from the order book determines a worsening of the average rank and thus of the performance measured by the QQI, having taken into account, in any case, the safeguard mechanism, if the Specialist is "technically suspended" having just settled a contract.	8.00

Parameter	Description	Max score
	Lower QQI values, which indicate an average overall positioning closer to the best prices, denote a better performance. The daily rankings relative to each bond are then aggregated (simple average) by these classes of bonds: BOT/CTZ/BTP $<$18months, BTP $<$3 years, BTP $<$5 years, BTP $<$10 years, BTP$>$10 years, BTPI, CCT. For each class of bonds, each Specialist is assigned a class score in proportion to the QQI indicator value. This class score is calculated in reference to the index value obtained by the best Specialist for the given bond class. Each Specialist, finally, is assigned an overall score equal to the sum of the class points, rescaled respect to a maximum of 8 points assigned to the Specialist with the highest sum of class points.	

Parameter		Description	Max score
Secondary Market	Cash – Volumes traded – Market Share	Given the number of open market days during the reference period, the "Cash traded volumes" parameter is calculated with two subsequent weightings. The first takes into account the type of bonds traded whose volumes are weighted according to the weights presented in the table 71, without distinguishing between off-the-run and on-the-run. Afterwards, the volumes traded by the operator, thus weighted, are proportioned to the total volume of cash traded in the trading venues selected, taking into account if the trade was as filler or aggressor. Volumes traded as fillers are weighted 1 while those traded as aggressors are weighted 0.50. The best Specialist is assigned a score of 8 points. All the other Specialists are proportionally assigned a score between 0 and 8. Those Specialists with a market share less than that of the average of market makers that are neither Specialists nor Candidate Specialists are assigned a score equal to 0.	8.00

Parameter		Description	Max score
Secondary Market	Cash – Bond Traded as Filler	The parameter measures the ability of each Specialist to trade, as filler, the highest possible number of bonds on the selected trading venue, taking into account the financial characteristics of the bonds. For the calculation of the parameter, bonds traded as filler, from each Specialist, are analyzed for different segments (by type/class of maturity), as in QQI indicator. For each segment a ranking is carried out and a standardized maximum score is assigned to the best and in proportion to the others. The sum of the scores obtained in each segment by each Specialist represents the reference indicator of the parameter. To the best Specialist 4 points are assigned. A score between 0 and 4 is proportionally assigned to the other Specialists.	4.00

Parameter		Description	Max score
Secondary Market	Cash – Large in size trades	The parameter measures the contribution of each Specialist to provide size to contracts traded as filler, on the selected trading venue, taking into account the characteristics of the bonds. For the calculation of the parameter, bonds are analyzed for different segments (by type/class of maturity), as in QQI indicator. For each segment all contracts larger than or equal to a threshold size are selected. The threshold size, for each segment, is defined by averaging the size of contracts traded during the observation period, to which a buffer is added calculated as a percentage of the average. Having selected the contracts for each segment, then Treasury calculates the share of each Specialist as filler. For each segment the Specialists are then ranked giving a maximum standardized score to the better and in proportion to the others. The sum of the scores obtained on all segments by each Specialist represents the reference indicator of the parameter. The Specialist with the highest indicator is given a score of 2 points. All other Specialists is assigned a score proportional between 0 and 2.	2.00

Parameter			Description	Max score
Secondary Market	Repo Market Share	–	Given the number of open market days during the reference period, the parameter is calculated, both for the General Collateral segment and for the Special Repo segment, as a percentage of volumes traded trough ordinary contracts or Request-for-quote type of contracts, weighted for the duration of the contract, of the overall total of the segment. In weighting for the duration, contracts with a duration above 90 days will be considered as 90-day contracts. The best Specialist, on each segment, is assigned a maximum score of 3 points. A score between 0 and 3 is proportionally assigned to the other Specialists with a market share above that of the average of market makers that are neither Specialists nor Candidate Specialists. Those Specialists with a market share less than that of the average of market makers that are neither Specialists nor Candidate Specialists are assigned a score equal to 0.	6.00

Parameter		Description	Max score
Secondary Market	Contribution to the efficiency of the market (Bank of Italy)	The bonds quoted are divided for each open market day into 7 classes according to their segment and their degree of liquidity. For each class the following parameters, indicative of each primary dealer's contribution to overall market efficiency, are considered: average spread weighted for page exposition time; volume of applications received; number of bonds quoted; number of bonds traded; sum of the quoted quantities weighted for page exposition time. To permit the comparison of non-homogeneous quantities, insomuch as they refer to bonds with different financial characteristics and degrees of liquidity, processes of standardization of data used for analysis are carried out. The daily parameters, calculated for each dealer within the context of each class of liquidity, are subsequently aggregated on a period basis in order to complete a comparative evaluation of the behavior of all the main dealers in the market. A comprehensive ranking is thus drawn up, which constitutes the basis for the Treasury's attribution of points. 6 points are assigned to the best Specialist. A score between 0 and 6 is proportionally assigned to the other Specialist.	6.00

Parameter		Description	Max score
Secondary Market	Cash – Volumes traded on Electronic System	This parameter, calculated each quarter, assesses the Specialist's trading activity on electronic trading systems. This indicator, whose calculation takes into account information included in the European harmonized report format (HRF), is calculated as the percentage of volumes traded by the operator of the total of electronic trading systems, analyzed for different segments (by type/class of maturity), as shown in table 71, without distinction between on-the-run and off-the-run. Trading volumes on strips, whether they take place in electronic or non-electronic markets, are measured with a weight equal to that of the segment BTP 15 years. The best Specialist is assigned a score of 4 points. A score between 0 and 4 is proportionally assigned to the other Specialists.	4.00
Secondary Market	Distributional capacity in the Cash Market – HRF	The parameter evaluates the overall ability of the Specialist to distribute the complete range of instruments issued by the Treasury. The indicator is calculated each quarter on the basis of information in the HRF, that provides details of trading activity for: bond type and residual maturity, geographical area and type of counterparty, trading system. 2 points are assigned to the Specialist with the best performance. A score between 0 and 2 is proportionally assigned to the other Specialists.	2.00

Parameter		Description	Max score
Secondary Market	Distributional capacity in the Repo Market – HRF	This is a synthetic indicator that measures the quality of the trading activity of Government bonds outside wholesale regulated markets, on the repo segment, with regards to the diversification of bond types, of counterparties and of systems used. The parameter is calculated each quarter on the basis of data communicated by the Specialist according to the format defined by the Treasury together with the Bank of Italy. 2 points are assigned to the Specialist with the best performance. A score between 0 and 2 is proportionally assigned to the other Specialists.	2.00
Organizational structure		The evaluation of the Organizational Structure given by the Treasury is made yearly and assigns up to 8 points. The parameter takes into account the overall assessment given by the Treasury on the Specialist's activity, with reference to aspects concerning the reliability of the organizational structure and the advisory and research ability on themes related to the management of public debt. In assigning points, the contribution to the efficient functioning of the primary and secondary markets, which is not directly measurable with the indicators mentioned in the preceding articles, is also assessed.	8.00

Parameter	Description	Max score
Exchange and Buy-Back	The participation of each Specialist in buyback and exchange operations is assessed up to a maximum of 5 points. The maximum score that can be assigned, in any case not below 3 points, will be set by the Treasury on the basis of the number and overall value of operations conducted during the year. The performance of each Specialist will be evaluated in proportion to the best operator. Specialists that within the deadlines set for the settlement of exchange or buy-back transactions fail to deliver, even partially, the share of bonds sold in the transaction, will be penalized. This penalty will result in a deduction from the score that the Specialists will be assigned on the parameter at year end, equal to 10% of the maximum score potentially assigned at year end (0.3 - 0.5) for each fail, up to a maximum of points achieved by the Specialist.	3.00 - 5.00
Total score		98.00 - 100.00

Table 70: Coefficients for QQI index. Year 2015.

Ranking in the order book	**Coefficient**
1	0
2	5
3	8
4	9
5	10
...	...
Absent	28

Table 71: Weights for TV index. Year 2015.

Bond	**BOT**			**CTZ**	**BTP**						**CCT**
	3m	**6m**	**12m**	**24m**	**3y**	**5y**	**7y**	**10y**	**15y**	**30y**	**7y**
On-the-run	0.25	0.50	1.00	2.50	2.75	4.50	6.50	7.50	12.00	17.00	8.00
Off-the-run					1.375	2.25	3.25	3.75	6.00	8.50	8.00
BTP€i					4.00	6.50	8.50	9.50	14.00	21.00	

.6 Changes in evaluation criteria. Year 2016

Table 72: Changes to the Evaluation Criteria of Specialists in Government bonds. Year 2016

Parameter	Description
Primary Market Quota	I) A positive score (>0) is obtained if the primary market share is between 3,5% - 6,5% (instead of the 2015 range of 3% - 6%) II) The maximum score assigned is reduced by one point moving from 33 to 32 points III) In calculating the quantitative indicator on the primary market - primary market share, the weights assigned to the nominal and inflation securities on maturities longer than 10 years are increased. The weight of CCTs/CCTeus is almost aligned to their maturity at issuance. The weight of nominal 3 and 5 year BTPs and of CTZs is slightly reduced. Table 74 presents the new coefficients.
Primary Market Qualitative Evaluation – AAI	I) The "threshold' share (the quota above which a Specialist is considered "aggressive") for the purposes of calculation of AAI, when the prices of the bid offered at auction are higher than the reference price of the secondary market, is increased to 5.30% II) The maximum score assigned is reduced by two points, moving from 12 to 10 points
Primary Market Bidding Continuity	I) The minimum share of participation at each auction, in order not to be penalized with a reduction in points, is increased from 4% to 5% II) The maximum penalization is unchanged to -4 points

Parameter	Description
Secondary Market - QQI	I) The weight of quoting activity on nominal BTPs with a maturity longer than 10 years is increased with respect to the other segments. The weight assigned to this category is doubled while the others are left unchanged II) The minimum size required (previously 5 millions) for the evaluation of quotation activity on nominal BTPs with a maturity longer than 10 years is removed III) The coefficients for weighting the positions in the order book are modified to increase the distance between the second and subsequent rankings, by assigning to the third position a coefficient equal to 8 (against the current 6). Subsequent positions after the third are ranked consistently with the ordinary pace of 1 (9,10,11 etc..) . The weighting of the first two positions remains unchanged (0 and 5) IV) The maximum score assigned is increased by one point from 8 to 9 points
Secondary Market - Volumes traded	I) The weight of several segments is changed, increasing that of nominal and inflation segments longer than 10 years while reducing that of CTZs, nominal 3 and 5 year BTPs as well as CCTs (as reported on the table 74) II) The maximum score assigned is unchanged
Secondary Market - Number of bonds traded as filler	I) The weight of trading activity on nominal BTPs longer than 10 years is increased with respect to the other segments. The weight assigned to this category is doubled while the others are left unchanged II) The maximum score assigned is unchanged
Secondary Market - Large in size contract	I) The size of the contracts threshold beyond which is considered a positive contribution to the market depth is determined by the average of the size of the contracts made in the period of observation II) The weight of trading activity nominal BTPs longer than 10 years is increased with respect to the other segments. The weight assigned to this category is doubled while the others are left unchanged III) The maximum score assigned is unchanged

Parameter	Description
Secondary Market - Volumes traded in other electronic platforms	I) The weight of several segments is changed, increasing that of nominal and inflation ones longer than 10 years while reducing that of CTZs, nominal 3 and 5 year BTPs as well as CCTs (as reported on the table 74) II) For the calculation of the parameter, trading activity executed with final investors (BtC) is furtherly rewarded III) The maximum score assigned is increased by two points moving from 4 to 6 points
Secondary Market - Volumes in MTS Repo	I) The total maximum score – unchanged at 6 points - is distributed differently among the General Collateral segment and the Special Repo one: up to 2 points for the best Specialist in the GC segment and up to 4 points to the best Specialist in the SR segment. Currently the scores for the two segments were equivalent (3 and 3)
Secondary Market - Repo Volumes traded outside MTS Repo	I) Calculation of the parameter and the maximum score assigned to the best Specialist are unchanged

Table 73: Weights for QQI index. Year 2015 and 2016.

	2015			**2016**		
Bonds	**10y**	**15y**	**30y**	**10y**	**15y**	**30y**
On the run	7.50	12.00	17.00	7.50	14.00	20.00
Off the run	3.75	6.00	8.50	3.75	7.00	10.00

Table 74: Weights for TV index. Year 2016.

Bond	BOT			CTZ	BTP						CCT
	3m	**6m**	**12m**	**24m**	**3y**	**5y**	**7y**	**10y**	**15y**	**30y**	**7y**
On-the-run	0.25	0.50	1.00	2.00	2.50	4.00	6.50	7.50	14.00	20.00	7.00
Off-the-run					1.375	2.25	3.25	3.75	7.00	10.00	7.00
BTP€i					4.00	6.50	8.50	9.50	16.00	24.00	

1. The overall evaluation of the primary market is reduced from 45 to 42 points. The overall evaluation of the secondary market is conversely increased from 42 points to 45 points

2. The score assigned to the primary market share changes from 33 to 32 points while the score assigned to the qualitative assessment of the bidding behavior in auction changes from 12 to 10 points

3. On the secondary market, volumes traded according to the HRF data (outside MTS platform) are evaluated with 2 points more, while the QQI parameter is increased by 1point

.7 Italian Treasury issuance activity (2013 - 2017).

Table 75: Treasury issued amounts in BTPs 10y and 15y segments in September-April period during last five years.

	Sep 13 - Apr 14	**Sep 14 - Apr 15**	**Sep 15 - Apr 16**	**Sep 16 - Apr 17**	**Average**
BTP 10y	22.050 (mm)	23.250 (mm)	21.750 (mm)	20.250 (mm)	21.825 (mm)
BTP 15y	6.000 (mm)	8.000 (mm)	5.956 (mm)	4.386 (mm)	6.114 (mm)

.8 Descriptive statistics of outcome variables

Table 76: Descriptive statistics of outcome variables

ISIN	Description	Stats	BA	Q	VWVA	PI	VAR	V2B	A2B	Vol MM	Perc MM
		Mean	0.021	107.054	0.033	7.018	0.003	45.379	5.464	0.875	0.013
	BTPS 9.00%	P50	0.021	105.042	0.033	6.932	0.002	46.072	5.517	0.000	0.000
IT0000366655		SD	0.003	8.882	0.003	0.969	0.001	2.750	0.154	2.475	0.037
	01/11/2023	Min	0.017	95.748	0.028	5.591	0.002	40.054	5.280	0.000	0.000
		Max	0.028	119.903	0.040	8.949	0.004	49.278	5.626	7.000	0.106
		Mean	0.019	119.170	0.032	4.901	0.002	48.321	5.923	31.063	0.042
	BTPS 4.50%	P50	0.019	113.780	0.031	5.071	0.002	48.796	5.901	21.750	0.026
IT0004953417		SD	0.005	8.814	0.005	1.212	0.001	3.735	0.091	25.809	0.029
	01/03/2024	Min	0.012	111.923	0.025	3.213	0.001	43.339	5.820	5.000	0.017
		Max	0.025	132.227	0.039	6.517	0.004	54.222	6.064	74.500	0.092
		Mean	0.019	118.369	0.034	4.774	0.002	44.131	5.541	43.875	0.070
	BTPS 3.75%	P50	0.019	115.128	0.033	4.747	0.002	44.179	5.525	40.000	0.045
IT0005001547		SD	0.003	7.892	0.004	0.790	0.001	5.852	0.173	34.696	0.068
	01/09/2024	Min	0.015	108.872	0.029	3.744	0.001	35.565	5.261	0.000	0.000
		Max	0.025	130.552	0.041	6.138	0.004	51.541	5.788	112.000	0.180
		Mean	0.022	116.622	0.039	4.930	0.003	45.585	5.753	75.563	0.116
	BTPS 2.50%	P50	0.022	113.634	0.038	4.989	0.002	46.175	5.781	67.750	0.110
IT0005045270											

ISIN	Description	Stats	BA	Q	VWVA	PI	VAR	V2B	A2B	Vol MM	Perc MM
		SD	0.004	10.908	0.006	0.961	0.001	4.416	0.081	46.576	0.057
	01/12/2024	Min	0.015	106.190	0.030	3.427	0.001	39.150	5.628	29.000	0.037
		Max	0.027	131.700	0.047	6.007	0.005	52.473	5.864	163.000	0.225
	BTPS 5.00%	Mean	0.018	114.509	0.041	4.922	0.012	42.722	5.541	49.625	0.070
		P50	0.017	110.170	0.042	4.736	0.012	43.517	5.502	41.500	0.074
IT0004513641		SD	0.003	10.813	0.005	0.898	0.002	5.201	0.097	18.852	0.023
	01/03/2025	Min	0.013	104.433	0.034	3.643	0.009	32.868	5.448	33.500	0.037
		Max	0.023	129.665	0.048	6.171	0.016	49.162	5.685	85.000	0.098
	BTPS 1.50%	Mean	0.023	111.648	0.042	4.871	0.003	40.756	5.518	171.813	0.208
		P50	0.021	108.483	0.042	4.647	0.003	41.432	5.544	173.750	0.198
IT0005090318		SD	0.005	8.944	0.006	1.000	0.001	6.914	0.156	69.465	0.073
	01/06/2025	Min	0.016	102.907	0.033	3.536	0.001	31.565	5.263	73.000	0.130
		Max	0.029	123.506	0.051	6.238	0.005	52.819	5.672	301.500	0.363
	BTPS 2.00%	Mean	0.022	114.105	0.043	5.012	0.003	40.591	5.529	116.313	0.101
		P50	0.024	112.750	0.043	5.215	0.003	40.413	5.571	129.500	0.090
IT0005127086		SD	0.004	4.380	0.005	0.833	0.001	6.355	0.188	44.088	0.037
	01/12/2025	Min	0.017	110.463	0.036	3.783	0.002	29.822	5.222	55.500	0.061
		Max	0.027	123.514	0.050	5.984	0.005	50.011	5.763	172.500	0.174

ISIN	Description	Stats	BA	Q	VWVA	PI	VAR	V2B	A2B	Vol MM	Perc MM
	BTPS 4.50%	Mean	0.026	106.253	0.056	7.120	0.023	37.385	5.447	32.188	0.080
		P50	0.025	102.887	0.053	6.907	0.015	37.973	5.452	35.250	0.067
IT0004644735		SD	0.004	8.492	0.012	0.964	0.017	4.596	0.157	20.593	0.076
	01/03/2026	Min	0.022	94.433	0.043	6.219	0.012	30.983	5.228	0.000	0.000
		Max	0.033	117.889	0.077	8.755	0.050	44.084	5.612	58.000	0.244
	BTPS 7.25%	Mean	0.037	99.670	0.071	12.192	0.050	31.230	5.115	3.500	0.021
		P50	0.036	99.365	0.069	11.723	0.051	29.255	5.103	2.500	0.023
IT0001086567		SD	0.007	5.388	0.009	2.175	0.003	5.667	0.337	4.652	0.019
	01/11/2026	Min	0.031	91.653	0.059	10.194	0.046	25.105	4.653	0.000	0.000
		Max	0.051	106.334	0.090	16.602	0.054	39.768	5.525	14.000	0.048
	BTPS 6.50%	Mean	0.042	97.085	0.076	13.190	0.050	32.687	5.156	2.563	0.023
		P50	0.040	95.132	0.075	12.552	0.049	34.647	5.183	1.000	0.020
IT0001174611		SD	0.010	7.052	0.011	3.006	0.006	5.006	0.246	3.849	0.025
	01/11/2027	Min	0.034	89.973	0.064	10.659	0.044	24.556	4.693	0.000	0.000
		Max	0.065	106.691	0.101	20.193	0.060	38.179	5.415	11.000	0.052
	BTPS 4.75%	Mean	0.048	97.099	0.090	13.553	0.049	28.143	4.836	14.938	0.050
		P50	0.043	95.175	0.088	12.315	0.048	27.831	4.831	10.250	0.053
IT0004889033		SD	0.013	5.397	0.015	3.509	0.005	5.357	0.562	18.690	0.045
	01/09/2028										

ISIN	Description	Stats	BA	Q	VWVA	PI	VAR	V2B	A2B	Vol MM	Perc MM
		Min	0.036	90.306	0.069	10.206	0.042	18.864	4.015	0.000	0.000
		Max	0.077	105.674	0.121	21.411	0.058	35.017	5.623	57.000	0.107
		Mean	0.054	94.794	0.092	15.769	0.053	31.881	4.962	3.125	0.028
	BTPS 5.25%	P50	0.049	96.107	0.093	14.406	0.053	30.355	4.949	2.250	0.023
IT0001278511		SD	0.014	4.775	0.016	3.823	0.005	7.720	0.710	3.346	0.029
	01/11/2029	Min	0.041	88.135	0.073	12.208	0.047	21.014	4.033	0.000	0.000
		Max	0.084	101.893	0.125	23.961	0.065	43.113	5.771	8.500	0.074
		Mean	0.060	97.561	0.113	15.052	0.061	27.908	4.746	17.563	0.064
	BTPS 3.50%	P50	0.056	96.331	0.110	14.183	0.059	24.919	4.722	18.000	0.045
IT0005024234		SD	0.015	7.324	0.018	3.428	0.008	6.443	0.631	14.364	0.080
	01/03/2030	Min	0.042	89.945	0.086	11.293	0.051	21.186	4.008	2.000	0.011
		Max	0.092	108.441	0.148	22.624	0.071	38.155	5.473	39.500	0.254
		Mean	0.053	89.326	0.091	16.610	0.055	27.993	4.746	1.188	0.003
	BTPS 6.00%	P50	0.050	87.725	0.089	15.587	0.054	27.657	4.757	0.000	0.000
IT0001444378		SD	0.013	9.283	0.015	3.822	0.007	4.261	0.492	3.359	0.008
	01/05/2031	Min	0.040	78.814	0.073	13.227	0.047	22.514	4.191	0.000	0.000
		Max	0.081	103.354	0.122	25.091	0.067	34.166	5.325	9.500	0.023
	BTPS 1.65%	Mean	0.069	89.131	0.139	14.091	0.061	23.886	4.639	26.813	0.066
IT0005094088											

ISIN	Description	Stats	BA	Q	VWVA	PI	VAR	V2B	A2B	Vol MM	Perc MM
		P50	0.063	85.263	0.136	12.757	0.062	22.451	4.575	15.500	0.069
		SD	0.019	13.120	0.023	3.453	0.011	5.671	0.599	31.963	0.028
	01/03/2032	Min	0.052	76.417	0.113	11.240	0.048	18.086	3.928	10.500	0.019
		Max	0.104	108.974	0.183	20.820	0.082	34.940	5.377	105.000	0.109

.9 Descriptive statistics of the number of proposals for each bond in the sample.

ISIN	Obs.	Mean	Median	Max	Var	Skew	Kurtosis
IT0005127086	16296	21.02	21.50	27.00	8.815	-1.986	10.791
IT0005090318	16296	19.57	20.00	25.00	7.306	-1.802	10.322
IT0004513641	16296	20.22	20.50	28.00	9.835	-1.451	8.561
IT0005045270	16296	20.48	21.00	26.00	7.945	-2.018	11.755
IT0005001547	16296	21.06	21.00	28.00	11.466	-1.065	7.201
IT0004953417	16296	19.87	20.00	27.00	9.502	-1.206	7.914
IT0000366655	16296	19.61	20.00	25.00	7.620	-2.056	11.404
IT0004644735	16296	20.29	20.50	27.00	9.166	-1.593	9.380
IT0001086567	16296	20.31	21.00	26.00	7.432	-2.548	14.069
IT0001174611	16296	19.93	20.00	26.00	8.032	-2.282	13.023
IT0004889033	16296	20.51	21.00	25.00	8.351	-2.523	13.527
IT0001278511	16296	20.27	20.50	26.00	10.807	-1.605	8.654
IT0005024234	16296	20.94	21.50	27.00	9.080	-2.461	13.119
IT0001444378	16296	19.55	20.00	26.00	9.484	-1.759	9.905
IT0005094088	16296	18.88	18.50	28.00	12.635	-0.783	5.546

Table 77: **Descriptive statistics of the number of proposals for the fifteen bonds of the sample**. For each bond in the sample, the table presents descriptive statistics of the number of proposals in the quoting book. The dataset is composed by the snapshots of the quoting book of each bond with a frequency of 5 minutes from 9.00 am to 5.00 pm, in the period that runs from September 1, 2015 to April 28, 2016.

.10 Public rankings of Specialists on Italian Government Bond (2007-2017).

Year	1	2	3	4	5
2017	MPS CS	Unicredit	Banca Imi	JP Morgan	Barclays
2016	MPS CS	JP Morgan	Banca Imi	Unicredit	Bnp Paribas
2015	MPS CS	JP Morgan	Banca Imi	Unicredit	Citi
2014	MPS CS	Unicredit	JP Morgan	Citi	Barclays
2013	Citi	Unicredit	HSBC	JP Morgan	Banca Imi
2012	Barclays	Banca Imi	JP Morgan	Credit Agricole	Unicredit
2011	Barclays	Banca Imi	Unicredit	JP Morgan	Deutsche Bank
2010	Barclays	Deutsche Bank	Citi	Soc Gen	RBS
2009	Barclays	Soc Gen	Credit Agricole	Deutsche Bank	Bnp Paribas
2008	Soc Gen	Bnp Paribas	Unicredit	Banca Imi	JP Morgan
2007	Banca Imi	Barclays	Soc Gen	JP Morgan	Bnp Paribas

Table 78: Rankings 2017 - 2007. Five top specialists.