Essays on the price discovery process in bond future markets

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Preface

The ongoing European debt crisis (2009-20??) and the decision of the European Central Bank (ECB) to consider "Outright Monetary Transactions (OMTs) in secondary markets for sovereign bonds in the euro area" (ECB, 2012a) bring back memories of the importance of "*functioning*" bond markets. The ECB's understanding of "functioning" bond markets is at least the markets' ability of ensuring the transmission of monetary policy (compare ECB, 2012b). A more general definition of "*functioning*" is given by O'Hara (2003) who sees price discovery and liquidity provision as the key functions of financial markets. An intact (bond market's) price discovery process should be able to *incorporate public information*, e.g. macroeconomic announcements, as well as *private information*, e.g. the investors' interpretation of the customer orders' pricing implications. The literature's definition of *liquidity provision* can be subsumed to be the investor's ability of buying or selling a financial contract without owning large price impacts (Hasbrouck, 2009), so that trading volume and bid-ask spreads a often considered candidates for proxying market liquidity (see Fleming, 2003).

The main focus of the following research is on studying the incorporation of non-public/private information in the German and US bond market. Private information can be understood as pricing-relevant information which are not shared by all investors. In other words, private information are owned by investors who have superior access to information and/or skills to interpret economic announcements. In order to take advantage of their information these investors are enforced to open or close positions in the market. Thus, the informed traders' behavior can be observed in trading data – namely order flow (for a theoretical foundation see for example Evans and Lyons, 2002).[1] However, as O'Hara (2003) stresses out the importance of liquidity for functioning financial

[1]Order flow (order imbalance) measures the difference between buyer- and seller-initiated trades. However, the here considered data sets do not offer the information whether a trade is buy- or sell-side initiated. The initiation side is approximated with the Lee and Ready (1991)- or the Easley et al. (2012)-algorithm. Both approaches are explained in the corresponding sections.

markets we additionally analyze the importance of liquidity (trading volume, bid-ask spreads and price impacts) for bond markets.

Section 1 starts with the price discovery process in the German bond future market. We try to answer the issue of the importance of the German bond future contracts by considering an vector error correction model (VECM) which delivers so-called *information shares*. These shares can be understood as the relative contribution of one future contract to the price process which is shared by the three considered bond contracts.

We analyze the relative importance of the most liquid European bond future contracts which are the two-, five- and ten-year German bond futures. Due to its outstanding trading volume the ten-year bond future (called Bund future) is mainly accepted as the single most important European bond contract. This benchmark status is underlined by considering the German ten-year interest rate as reference yield for computing interest rate spreads in the Euro Area. This approach assumes that the ten-year bond reflects the flow of information more precisely than any other European bond contract. However, this assumption stands in contrast to the expectation hypothesis, the theoretical workhorse of bond pricing models. This hypothesis suggests that short-term interest rate innovations role over to longer maturities which proposes that the two-year bond future contract dominates the European bond markets' price discovery process.

Our findings confirm the market view that the ten-year bond future is on average the most important future contract and leads the price discovery process. However, the two- and five-year contract contribute an economically significant amount to the shared price path whereby the former one gains substantial during days with ECB press conferences. This is an indication that the ECB mainly commands over the short end of the yield curve. The importance of the five-year contract is rooted in the average duration of bond portfolios which is roughly five years. This characteristic brings the five-year contract in a role as the major instrument for hedging bond portfolios.

For a deeper understanding of the price process we regress information shares on (i)

order flow as a proxy for the price discovery process and on (ii) bid-ask spreads, trading volume and volatility as proxies for market liquidity. Information shares increase with a relative higher order flow and with a relative improvement of trading conditions which underline their importance for functioning financial markets.

Section 1 reveals that private information, proxied by order flow, is an important driver of the price discovery process in the bond market. Following the argument of Li et al. (2009), the presence of private information (order flow) in the market can be interpreted as information risk for which investors have to be compensated.

Section 2 tests this hypothesis for the German bond market and analyzes how the presence of informed traders influences the term structure of interest rates. Beside information risk, we again pick up the idea of O'Hara (2003) that market liquidity is an important market factor and additionally consider liquidity risk in the analysis.

We follow Hasbrouck (2009) and define liquidity risk as the effective cost of an order execution which is also used as a benchmark measure for liquidity (see Goyenko et al., 2009). Information risk is the possibility of a price discovery event which coincides with asymmetric information. With the presence of asymmetric information risk, investors ask for risk compensation (see O'Hara, 2003). As propagated by Easley et al. (1996) and Easley et al. (2002) we define information risk as the probability of informed trading, in short PIN, whereby PIN is defined as the number of trades from informed investors divided by total trading. In the Easley et al. (1996) model market makers learn about information events and the presence of informed traders by observing the arrival of buy and sell orders. In order to protect against potential losses to informed traders, the market maker sets prices which compensate for bearing this risk.

Regressing changes of interest rates and term structure factors on liquidity and information risk for the time period 10/2004 to 02/2009 reveals that an increase of risk results in stronger movements of Euro Area interest rates and term structure factors. Liquidity risk is priced along the whole yield curve and seems to be more important than infor-

mation risk. This finding is consistent with Li et al. (2009) who document a stronger link of US Treasury bond prices to liquidity risk than to information risk. Neither controlling for trading volume, spread, order flow nor realized volatility rules out the effects of information and liquidity risks. However, information risk becomes a relevant pricing factor in the aftermath of the Lehman Brothers bankruptcy which suggests increasing risk sensitivity during the financial crisis.

Sections 3 and **4** additionally analyze the finding that information and liquidity risk is priced in the term structure of interest rates. Both sections are built on the Adrian et al. (2012) term structure model which extracts the bond market risk premium from raw interest rates.[2]

Section 3 analyzes the determinants of US realized, expected and unexpected bond excess returns on a monthly basis. Besides publicly announced information, such as consumer prices or unemployment rates, order flow (interpreted as private information) determines future bond risk premia. Additionally controlling for bond market liquidity does not change this finding. The predictability of bond excess returns stems from the strong linkage of expected excess returns to contemporaneous order flow. Changes of the macroeconomic state variables (macroeconomic factors) and order flow determine unpredictable excess returns – so-called excess return innovations.

Section 4 transfers the findings of Section 3 to a daily basis. For the US market, order flow is the main driver of innovations of the bond risk premium. Consistent with findings of Section 2, the pricing effect of liquidity risk becomes relevant in times of market stress, namely the Russian default and the LTCM crisis (1998-1999), the dot-com (2001-2002) and the subprime (2007-2009) asset price bubble. Macroeconomic information do only play a minor role.

To sum up, the bond market's price discovery process aggregates public and dispersed

[2]The risk premium is the difference between realized (observed) interest rates and model-implied risk-neutral interest rates. Risk-neutral yields are derived by setting the derived market prices of risk of the bond pricing factors to zero.

private information. As pointed out by Sections 1 and 2, liquidity provision is essential for ensuring an intact price discovery process. The economic implication of information and liquidity risk is discussed in Sections 2 to 4. Section 2 reveals that an increase of one of these risk elements leads to higher interest rate changes. The importance of market liquidity for bond pricing should be seen with recent developments in European peripheral bond markets where market liquidity dried up (ECB, 2011) and illiquidity is an important pricing factor for interest rate spreads (see De Grauwe, 2011 and Monfort and Renne, 2011).

Final remarks are offered at the end of this dissertation. This last section will discuss some policy implications of the conducted research.

Abstract

The main focus of the following research is on studying the incorporation of non-public/private information in the German and US bond market. Section 1 starts with the price discovery process in the German bond future market. Section 2 tests the hypothesis of priced information risk for the German bond market and analyzes how the presence of informed traders influences the term structure of interest rates. We additionally pick up the idea that market liquidity is an important market factor and additionally consider liquidity risk in the analysis. Sections 3 and 4 analyze the finding that information and liquidity risk is priced in the term structure of interest rates.

Keywords: Bond future, order flow, bond excess returns.

Zusammenfassung

Die Forschungsarbeit befasst sich mit der Verarbeitung von nicht-öffentlichen/privaten Informationen im deutschen und US-amerikanischen Bondmarkt. Abschnitt 1 beginnt mit dem Preisfindungsprozess im deutschen Bond-Future-Markt. Abschnitt 2 testet die Hypothese ob Informationsrisiken im deutschen Bondmarkt gepreist sind und analysiert wie die Anwesenheit von informierten Händlern die Zinsstrukturkurve beeinflusst. Zudem wird die Vorstellung aufgegriffen, dass Marktliquidität eine wichtige Marktgröße ist, so dass Liquiditätsrisiko ebenfalls in der Analyse berücksichtigt wird. Abschnitte 3 und 4 analysieren wie Informations- und Liquiditätsrisiken die Zinsstrukturkurve beeinflussen.

Schlagworte: Bond Future, Order Flow, Bond-Überschussrendite.