The Cost of Immediacy for Corporate Bonds*

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Abstract

Liquidity provision in the corporate bond market has become significantly more expensive after the 2008 credit crisis. Using index exclusions as a natural experiment during which uninformed index trackers request immediacy, we find that the price of immediacy has doubled for short-term investment grade bonds, and more than tripled for speculative-grade bonds. The increased cost of immediacy is a side-effect of a ban on proprietary trading (Volker Rule) and tighter post-crisis capital regulations, which have resulted in lower aggregate dealer inventories.

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Introduction

In dealership, over-the-counter markets, such as the market for corporate bonds, dealers are compensated for providing liquidity to market participants. The ability of dealers to provide immediacy–balancing the temporary miss-match between buy and sell orders– depends critically on whether they hold sufficient inventory (Garman, 1976; Stoll, 1978; Amihud and Mendelson, 1980; Ho and Stoll, 1981). Since the onset of the 2008 credit crisis, the amount of corporate bonds outstanding has doubled, and so have institutional holdings by bond index trackers. During the same period, corporate bond dealer inventories have shrunk by at least 60%[1]. These two facts suggest that the cost of providing immediacy to liquidity seekers has increased substantially. But is this actually the case? And if so, by how much? These are the questions we answer in this paper.

Following the credit crisis, dealers have decreased their inventories in anticipation of regulations banning proprietary trading (the Volker Rule) and imposing tighter capital requirements (e.g. Basel III accord). While regulation could have the unfortunate side-effect of reducing market efficiency by reducing liquidity (Duffie, 2012), empirical investigations based on effective bid-ask spreads, or other price impact measures, are unlikely to uncover the adverse effect of regulations on liquidity (Trebbi and Xiao, 2015). A direct application of the well-known Lucas (1976) critique, suggests that, by increasing the cost of immediacy, the regulation may affect the optimal behavior of market participants, who will likely, albeit reluctantly, spread their large trades over time, or give up on large trades altogether. Thus, measured trading costs might actually decrease, leading to erroneous conclusions about the impact of recent regulations. To use an analogy, rules making the cost of air travel prohibitive will induce more travellers to use the bus. By discouraging air travel, such regulations might well lower the average cost of transportation (after all, taking the bus is cheaper than a plane ticket), but average utility will surely decline because of the loss of immediacy. Getting from Los Angeles to New York in three days by bus is not the same as completing the trip in five hours by plane.

The main contribution of this study is to quantify the cost of immediacy for corpo-

[1]Primary dealer inventories of corporate securities peaked at the beginning of the crisis at $281 bn. In early 2009 the inventories had been cut to $100 bn and in September 2012 the inventories were down to $60 bn (see Figure 1). The specific drop in inventories of corporate bonds is also approximately around 50% from the peak before the crisis.

rate bonds in a trading environment that circumvents the Lucas (1976) critique. We identify trading situations in which the motive to obtain immediacy is strong, so that liquidity seekers cannot orchestrate alternative trading arrangements. Furthermore, in our setting, the desire to trade reveals no information about the fundamental value of the assets traded. Specifically, we compute liquidity costs around bond exclusions from the Barclay Capital (formerly Lehman) investment-grade corporate bond index. In this natural experiment, index trackers (the sellers) request immediacy from the dealers (the buyers) in order to minimize their tracking error. Moreover, mechanical index rules, not fundamentals, dictate the decision to trade, so that dealers do not have to worry about information motivating the trades. This last observation ensures that the dealer's bid reflects the cost of providing immediacy, rather than the adverse selections problem of dealing with unwanted informed traders (Easley and O'hara, 1987).

Our empirical analysis shows that the decrease in aggregate inventories that took place after the financial crisis has lead to higher transaction costs,[2] and provides support for standard theories of market maker inventories. For safe bonds, which are quickly turned over again by dealers, the cost of immediacy has approximately doubled, while for more risky bonds, the cost has more than tripled. The increase in transaction costs offsets the impact of previous regulations in the corporate bond market that specifically aimed at lowering the cost of trading through increased transparency (Bessembinder, Maxwell, and Venkataraman, 2006; Edwards, Harris, and Piwowar, 2007; Goldstein and Hotchkiss, 2008).

We infer the cost of immediacy by computing an inter-temporal bid-ask spread, which we define as the difference between the post-exclusion ask price and the pre-exclusion bid price. This measure captures the essence of the dealer's role, who uses her inventory to absorb the selling pressure generated by the index trackers unloading their positions, and then resells the bonds to restore the desired level of inventory. In order to control for systematic movement in the corporate bond market around the exclusion, we also compute a measure of abnormal bond performance using the methodology proposed by Bessembinder, Kahle, Maxwell, and Xu (2009). Finally, we use a special version of the TRACE database, which we obtained directly from FINRA, to compute dealer specific bond positions around the exclusions. All these

[2]On average, the estimated bid-ask spreads in this study are comparable to those of Edwards, Harris, and Piwowar (2007) and Feldhütter (2012).

measures point to the same conclusion that the cost of providing immediacy has increased in the post-crisis, low-inventory regime.

Before measuring the transaction costs around the index exclusion, we verify that these exclusions are indeed events during which index trackers request immediacy. Our analysis reveals that the traded volume of bonds exiting the index peeks during the day of the exclusion, and it is at least five times higher than in the weeks proceeding and following the exclusion. The peek in trading volume is consistent with index trackers attempting to minimize their tracking errors by trading close to the index exclusion date. Blume and Edelen (2004) show that stock index trackers display a similar desire to transact on the exact exclusion date. We expect that the desire to trade at the exclusion date shifts the bargaining power in favor of the dealers, which should explain the positive event bond returns that this paper documents (see also Duffie, Gârleanu, and Pedersen (2007)).

Having established the existence of a demand for immediacy, we verify that dealers offer to absorb the selling pressure by increasing their inventories. Dealers slowly increase their inventories several days before the exclusion, with the increase significantly intensifying at the exclusion day. The speed with which bonds are sold in the weeks following the index exclusion depends on the nature of the exclusion: for index exclusions due to bonds nearing maturity, the sales take place relatively quickly; for index exclusions due to the bond rating falling below investment-grade, the bond sales tend to occur over a longer period.

Dividing the sample in three sub-periods shows that dealers' behavior has changed after the crisis. Our analysis of the cumulative change in inventories demonstrates that dealers' willingness to hold the bonds in their inventories has declined in the new regulatory regime. While before (and even during) the crisis dealers kept most of the downgraded bonds for at least one hundred days, after the crisis dealers are eager to get rid of the bonds they purchased at the exclusion date. For downgraded bonds, the inventories return to pre-exclusion levels within 20 trading days. For bonds maturing within less than one year, the selling starts soon after the exclusion date, and inventories are back to normal within two weeks. We note that, during the crisis, the cumulative change in inventories for the short-maturity becomes negative within a day of the exclusion, probably because selling these liquid bonds was the easiest way to raise cash. We also note that the dealer behavior for the downgraded bonds were very similar before and during the crisis where a large part of the bonds stayed

on the dealers inventory. It is not until after the crisis when dealers should be less constrained than during the crisis that the dealer behavior changes. This leads us to conclude that the change in dealer behavior is induced by regulation concerns and not limited risk bearing capacity in a more traditional sense.

In addition to contributing to the literature on corporate bond liquidity, this paper occupies a natural place in the literature connecting regulations to financial market efficiency. The debate on the repercussions of the Dodd-Frank act on financial system is still ongoing, with positions that view the regulatory changes as harmful (Duffie, 2012) as well as beneficial (Richardson, 2012). Despite the multitude of opinions on welfare effects of the regulatory changes that took place after the credit crisis, few empirical investigations exist. In a recent paper, Trebbi and Xiao (2015) argue that the Dodd-Frank act has not had negative welfare consequences, since their breakpoint testing technique cannot detect any "breakpoints in market liquidity for fixed-income asset classes and across multiple liquidity measures, with special attention given to the corporate bond market." However, we have already argued these liquidity measures (such as the one shown in Figure 1, Panel B) are the outcome of market participants' optimization problems, and a large-scale policy change alters the rules of the game, that is the parameters of that optimization. By focusing on an homogenous, information-free event in which agents cannot arrange alternative trading strategies both before and after the policy change, our analysis is able to uncover the adverse effect that the new regulatory regime has had on corporate bond liquidity.

Our paper also contributes to the literature on index revisions, which is quite large when it deals with stock index revisions (Harris and Gurel (1986); Shleifer (1986); Beneish and Whaley (1996); Hegde and McDermott (2003); Denis, McConnell, Ovtchinnikov, and Yu (2003); Chen, Noronha, and Singal (2004); Greenwood (2005)). Bond index revisions have also been studied in Newman and Rierson (2004) and Chen, Lookman, Schürhoff, and Seppi (2010), but both studies have focused on special one-time announcement effects, months before the actual index revision date. Newman and Rierson (2004) look at a large and unique issuance event for European telecom companies. Chen, Lookman, Schürhoff, and Seppi (2010) look at the effect of a unique rating rule change for the Lehman index. Different from those studies, the empirical part of this paper looks at the trading very close to the actual index revision dates. At the exclusion date index trackers which seek to minimize their

tracking error do demand immediacy and dealers then provide the needed liquidity.

Lastly, the finding of our paper have bearing on the literature studying liquidity provision around predictable trades. Bessembinder, Carrion, Tuttle, and Venkataraman (Forthcoming) show that traders engaged in predictable transactions, that do not reveal information about the fundamentals of the traded asset, need not face predatory trading (Brunnermeier and Pedersen, 2005). In fact, disclosing information about the timing and attributes of the transaction mitigates its adverse price impact (Admanti and Pfleiderer, 1991). Our results indicate that the finding of Bessembinder, Carrion, Tuttle, and Venkataraman (Forthcoming) on the periodic portfolio re-balancing by USO (a commodity ETF) are valid in a more general market setting.

1 Corporate bond index tracking

Exclusions from the Barclay Capital (formerly Lehman) corporate bond index provide an ideal natural experiment for studying the cost of immediacy over time. Each month corporate bond index trackers demand immediacy from dealers when they seek to sell bonds exactly when the bonds exit the index.

The rules for bonds entering or exiting the index are both transparent and mechanical which makes the monthly exclusion events information-free and homogeneous over time. Bonds exit the index for three main reasons; they are excluded if the time to maturity falls below 1 year; they are excluded if the index rating goes from investment grade to speculative grade; or they are excluded when they are called. The index is rebalanced once a month on the last trading day of the month at 3:00 PM EST and all bonds that are no longer index eligible are excluded at this point in time. Hence, the actual downgrade of a bond which may or may not contain information (Ambrose, Cai, and Helwege (2011)) takes place before the bond exclusion from the index.

The objective of the index trackers is to minimize tracking error between the return on their portfolio and that of the index. Blume and Edelen (2004) show that index trackers following the S&P 500 index are transacting on the exact day that the index is rebalanced, even though they then sacrifice potential profit by doing so (Beneish and Whaley (1996)). Low tracking error is a signal to investors that the index tracker is in fact committed to tracking the index and thus resolves an agency problem. Figure 3 shows that corporate bond index trackers, like the S&P 500 index

trackers, also seek to transact as close as possible to the exclusion date. Day 0 in the graph represents the last trading day of the month in which the bond is excluded and is thus the event day. Panel A of Figure 3 shows the average event trading activity aggregated over bonds excluded from the index because of low maturity. Panel B of the same Figure shows average event trading activity for bonds excluded because of a recent downgrade to speculative grade. In both cases, trading activity spikes at the exclusion date. A similar trading pattern can be seen around revisions of the S&P 500 (Shleifer (1986); Harris and Gurel (1986); Chen, Noronha, and Singal (2004) and others), the Nikkei 225 (Greenwood, 2005) and the FTSE 100 (Mase, 2007).

Since corporate bonds trade over-the-counter, index trackers cannot be certain to transact at the desired date which is why activity is also high right before and after the exclusion date. Figure 3 clearly confirm that some investors are in fact tracking the index and that they seek to minimize their tracking error as is expected from index trackers.

Bond index trackers are different from stock index trackers in the way they track the target index. Stock index trackers use an exact-replication strategy (Blume and Edelen, 2004), whereas bond index trackers use a sampling strategy (Schwab, 2009; Vanguard, 2009). Exact-replication implies that the investor holds a position in each asset member of the index. For corporate bond index trackers, such a strategy would generate massive transaction costs because the index is large, the market is illiquid, and the index is rebalanced each month. Instead, bond index trackers sample the index by holding only a selection of the bonds currently in the index. This portfolio is then designed to match the index with respect to duration, cash flows, quality and callability. As an example, the Vanguard Total Bond Market Index Fund held 3,731 out of 9,168 bonds in the Barclay Capital US aggregate bond index on December 31, 2008. All the large bond index funds, e.g. Vanguard, Schwab and Fidelity, have similar guidelines for tracking an index by sampling. The typical rule is to have 80% for their assets invested in bonds currently in the index and the remaining 20% invested outside the index. The outside investments are usually in more liquid instruments such as futures, options and interest rate swaps but could also be in non-public bonds or lower rated bonds. The 80% rule followed by index funds is not per se binding but still gives yet another reason why index trackers are selling out close to the exclusion date as we saw in Figure 3. Lehman has also given guidelines on how to track the index using only liquid derivatives (Dynkin, Gould, and Konstantinovsky,

2006) but that is not the way bond index funds are tracking the index.

The criteria for how to invest the last 20% outside the index are rather loose (Schwab, 2009; Vanguard, 2009) so it is not possible to know exactly which assets the funds have on their balance sheets. The lack of transparency makes it even more important for the funds to keep a low tracking error as a way to signal sane investments (Blume and Edelen, 2004). Looking at the Vanguard Total Bond Market Index Fund again, they have had an yearly average absolute return tracking error on their shares compared to the target index of 23.5 bps over 1995-2009. This track record can be compared to that of Barclays Global Investors fund that tracks the S&P 500 index with a tracking error of only 2.7 bps per year (Blume and Edelen, 2004).

Summing up, exclusions from the Barclay Capital corporate bond index provide a natural experiment where the index trackers request immediacy from the dealers in order to minimize their tracking error. The following section shows how the cost of immediacy has evolved over time and in particular as a function of the dealers' willingness to take on new inventory and thus provide immediacy.

2 Data

2.1 Sample Construction

This study uses a unique and complete transaction level dataset for US corporate bonds provided to us by FINRA. The dataset is identical to the Enhanced TRACE dataset available on the Wharton Research Data Services (WRDS), except that we also have anonymized counterparty identifiers for each transaction. This allow us to track the changes in individual dealer inventories around the exclusion events.

The bond sample consists of all bonds exiting the Barclay Capital corporate bond index (formerly the Lehman corporate bond index) between July, 2002 and November, 2013. The exclusions are fairly equally scattered over time as seen in Figure 2. As of July, 2005, the index contains all US corporate bond issues with an investment grade rating by at least two of the three major rating agencies (Standard and Poor's, Moody's and Fitch). Furthermore, the issuance size must be at least $250 millions and time to maturity must be above 1 year[3]. Bonds leave the index for the three

[3]There are certain more qualitative rules for being index eligible. See index rules at

reasons mentioned earlier; they are excluded if the time to maturity falls below 1 year, if they are called or if the index rating[4] goes from investment grade to speculative grade. On the other end, bonds enter the index for two main reasons; if they are newly issued and index eligible or if the index rating goes from speculative grade to investment grade. These rules result in an index which covers a very large fraction of the entire market.

Table 1 gives characteristics of the excluded bonds. A large number of bonds have been excluded from the index for "other" reasons. The average issuance size of these bonds is far less than for the rest of the sample. Most of these exclusions have been generated by an increase over time in the lower index limit on issuance size, once in October, 2003 and again in June, 2004. At the end of 2009 the index contained more than 3,400 bonds.

The TRACE data is cleaned up before usage following the guidelines in Dick-Nielsen (2009). We then remove residual price outliers as in Rossi (2014).

2.2 Intertemporal bid-ask spreads

Calculating corporate bond returns is a challenge because most bonds trade infrequently. In order to determine an abnormal return the following procedure is applied to all bonds. First, a daily price is formed on each day with trading by taking the volume weighted average price over all trades above $100,000 in nominal value (Bessembinder, Kahle, Maxwell, and Xu (2009)). Second, bonds may not have had transactions on all days surrounding the event date. To circumvent this problem the return is calculated using the last available price before or on the event date and the first available price after the event date. The return is then calculated as the logarithmic difference between these two prices (Cai, Helwege, and Warga (2007); Ambrose, Cai, and Helwege (2011)). In order to limit any information bias caused by the non-trading days, the sample is restricted to bonds where the prices are observed within plus or minus five days of the event date. Both Cai, Helwege, and Warga (2007) and Ambrose, Cai, and Helwege (2011) show that this return calculation method is robust to an even larger window. Third, the abnormal return is formed by subtracting the

`https://ecommerce.barcap.com/indices/index.dxml`

[4]Each bond has an index rating defined as the middle rating from Standard and Poor's, Moody's and Fitch. If only two ratings are available, the lower and more conservative rating is used. If only one rating agency provides a rating, then that is the index rating. Before July 1st, 2005 Fitch was not used in the index rating.

return of a benchmark index (Barber and Lyon (1997)). The benchmark is a portfolio of bonds matched on duration, rating, and other characteristics with returns calculated from the TRACE data.

The method from Cai, Helwege, and Warga (2007); Ambrose, Cai, and Helwege (2011) is extended to allow for cumulative abnormal returns (CAR). Let the event date be noted by 0, one day after the event by 1, and one day before the event by day -1, etc. Assume for some bond that a price can be formed on day -8, -6, -3, 0, 1, 2, 5, 8. The CAR from day -5 to 5 is then calculated as the logarithmic price difference between the price on day -6 and day 5. Day -6 is the closet price before or on the early target date (day -5) and day 5 is the closest price after or on the late target date (day 5). The benchmark CAR is then also the return over day -6 to 5. The abnormal CAR is only defined if there exist prices within a five day window of the target dates.

The cost of immediacy is defined as the return on the transaction as seen from the dealer's viewpoint. Therefore the bid-ask spread is included into the return in the following way. The before-price is calculated using only buy-side prices and the after prices is calculated using only sell-side prices. This method resembles the return to the dealer who first buys the bonds from the index trackers and then sells them on to other investors. The rest of the study uses the following terminology. When the benchmark return is subtracted from the raw return it is called an abnormal return, and when the benchmark return is not subtracted it is called an inter-temporal bid-ask spread. The latter method is also used as the event return in Goldstein and Hotchkiss (2008), whereas the the former method is used as the event return in Cai, Helwege, and Warga (2007) and Ambrose, Cai, and Helwege (2011).

3 Event study of index exclusions

3.1 Dealer inventory

Index trackers demand immediacy at the index exclusions. This section shows that dealers take the bonds on inventory when providing this immediacy. Since the dealers' attitude towards taking on new inventory shifts over the period, it is expected that the cost of immediacy for the index trackers also shifts - consistent with inventory theories.

Figure 3 shows that the trading activity is highly elevated at the exclusion events

indicating that index trackers get rid of the bonds. Figure 4 shows the corresponding dealer inventories in the bonds excluded because of low maturity and because of a recent downgrade. The inventories are cumulative and with a chosen benchmark of \$0 at 100 trading days before the event. The daily change in inventory is calculated as the total volume in dealer buys minus the sales. Consistent with the story of index trackers demanding liquidity or immediacy at the exclusions, the dealer inventories on average increase in the days leading up to the exclusion and particularly on the event day. Hence, dealers use their inventory actively when providing liquidity. For the low maturity bonds, we see the increase starting around 3 days prior to the exclusion date whereas the buildup for the downgraded bonds starts earlier but also increases in magnitude approximately 3 days prior to the event. The buildup in the downgraded bonds from day -23 up to day -4 is caused by a buy up from the dealers on the actual downgrade date. On the downgrade date itself other investors, different from index trackers, demand liquidity because many firms have an investment policy where they are not allowed to hold speculative grade assets. This sell out on the downgrade date happens despite a grace period of up to two month in which the institutional investors are allowed to hold on to these bonds (see eg. Ellul, Jotikasthira, and Lundblad (2011) and Ambrose, Cai, and Helwege (2011)). However, we will show later that in terms of immediacy, the downgrade date is a smaller event than the exclusion date. At the downgrade date, the dealers are more brokers who match buy and sell-side demand compared to providing immediacy and taking the bonds on inventory.

After the exclusion event, Figure 1a shows that the dealers sell off all or part of their newly acquired inventory. After 2 weeks the inventory of the low maturity bonds has been sold off again. For the downgraded bonds only 60% of the bonds has been sold again after 100 days. The two events thus differ in the way dealers use their inventory. Since the dealers on average cannot or will not sell one-third of the buildup again within 100 days, the decrease in the general willingness to hold inventory is expected to have affected the transaction cost of the downgraded bond the most.

3.2 Dealer behavior before and after the credit crisis

Figure 5b and 5a show the change in dealer inventories around the event before, during, and after the crisis. The before period is from 2002Q3 to 2007Q2, the crisis

period is from 2007Q3 to 2009Q2, and the after period is from 2009Q3 to 2013Q4. The dealer behavior in the short maturity bonds has changed from before to after the crisis in that the dealers on average provide twice as much immediacy after the crisis than before. But they decrease the inventory to 0 over the same time interval. Hence, the absolute speed with which they sell off again has doubled. The fact that the dealers provide more immediacy after the crisis could be due to index tracking becoming more popular.

For the downgraded bonds there is a clear shift in dealer behavior from before and during the crisis to after the crisis. Before and during the crisis the dealer keep a large fraction of the inventory increase on their books. However, after the crisis they decrease the relative position to 0 after around 21 days. Since the shift in behavior happens after the crisis and not during the crisis, it suggests that the shift is not driven by limited risk-bearing capacity by the dealers. The dealers were more financially constrained during the crisis than after the crisis (almost by definition). Measures of dealer risk-bearing capacity such as dealer leverage, or the VIX index are all lower after the crisis than during the crisis. Since the shift cannot be motivated by financial constrains it seems very likely that the shift is due to anticipated tighter regulation. After the crisis aggregate dealer inventories have stayed low and we can see the same tendency in our graphs.

3.3 The cost of immediacy

Since the dealers actively use their inventories and thus act as counterparties and liquidity providers for the index trackers it is expected that the dealers make a positive return on average. The following section shows that dealers are compensated for providing liquidity which indirectly is the cost of immediacy for the index trackers. The costs are higher for the downgrade event compared to the low maturity event as would be expected, since the downgraded bonds are both more risky and kept longer on inventory.

Table 2 and 3 show the dealer returns at the two exclusion events. Returns are either inter-temporal bid-ask spreads or abnormal dealer returns. Each of these are either equally weighted or value-weighted. The value-weighted returns (VW1) are weighted by the aggregate positive inventory built in the particular cusip on the event date and over the previous three days. Hence, those bonds where the dealer increased

inventory and thus provided immediacy are weighted higher. The bonds where the inventory build up is negative are given a weight of 0. The other weighting scheme assumes that the excluded bonds are near perfect substitutes and accumulated the inventory across bonds for the particular dealer. Dealer that were net-sellers at the event receive a weight of 0, the other dealers are weighted by their inventory build-up.

Looking at the abnormal dealer returns (VW1) for the bonds excluded because low maturity, we can see that the 5 day return is 3.63 bps before the crisis (not annualized), 43.59 bps during the crisis, and 10.79 bps after the crisis. After the crisis we can see that the returns are uniformly higher than before the crisis. The cost of immediacy has thus gone up significantly . This is also illustrated in Figure 6c.

For the downgraded bonds the 5 day abnormal dealer returns (VW1) are 131 bps before, 869 bps during, and 312 bps after the crisis. Hence, in addition to being reluctant to hold inventory, dealers also charge a higher price for providing the immediacy. As for the low maturity bonds, we can see that the returns are uniformly higher after the crisis than before the crisis. Hence, the cost of immediacy is higher today than before the crisis. This is also illustrated in Figure 6d.

4 Regression analysis of the cost of immediacy

In Section 3, we have shown a remarkable increase in the price of immediacy (proxied by intertemporal bid-ask spread) taking place since the onset of the credit crisis. In this section, we relate the higher returns earned by dealers to the quantity of bonds transacted, and other variables likely to affect the supply of immediacy.

4.1 Setup

Because the price and quantity of immediacy are jointly determined in the market, regressing the compensation for immediacy to its quantity subjects the econometrician to simultaneous equation bias, since we do not know if such relation describes a supply function or a demand function. More formally, the empirical model to consider is given

by the system of equations:

$$
\begin{aligned}
Q_t^D &= \alpha_0 + \alpha_1 P_t + e_t && (1)\\
Q_t^S &= \beta_0 + \beta_1 P_t + u_t && (2)\\
Q_t^D &= Q_t^S = Q_t, && (3)
\end{aligned}
$$

where e_t , u_t contain both observable and unobservable supply shifters, and the last equation imposes market clearing. In order to obtain unbiased and consistent estimates of the slopes, a two-stage least squares (2SLS) is normally used. See Choi, Getmansky, Henderson, and Tookes (2010) for a recent application to this methodology to the analysis of issue proceeds and underpricing for convertible bonds.

The premise of this study is that indexers are impatient around bond exclusion events, and our empirical analysis so far suggests that their price demand elasticity around these events is extremely low. Therefore, the exclusion restriction that we impose is to set $\alpha_1 = 0$ in Equation (1). Chacko, Jurek, and Stafford (2008) impose a similar restriction in their theoretical model of the price of immediacy, but in the context of a limit order book.

In summary, setting $\alpha_1 = 0$ identifies the relation between prices and quantities as a supply relation. We expect this restriction to hold for downgrade exclusions, since the urgency of removing a junk bond from a portfolio supposed to track an investment grade index is high. On the other hand, for maturity exclusions, the urgency is somewhat mitigated by the fact that bonds are still investment grade and that they will mature eventually in less then one year, which is another way of getting rid of the bond.

Table 4 provides descriptive statistics of the explanatory variables used in the regression analysis.

4.2 Cost of immediacy before and after the crisis

Table 5 and 6 report coefficient estimates of regressions of cumulative abnormal bond returns on the natural log of a measure of liquidity provision (Q) and other factors likely to influence liquidity provision. To obtain Q, we start by calculating the aggregate dealer inventory imbalance for each dealer from day -3 to 0 across all excluded bonds at the event (downgrade and maturity separately). We then drop all

dealers with a net negative inventory imbalance. Assuming that the excluded bonds are close substitutes, then these dealers did not provide immediacy beyond possibly matching customers (a simple broker service). For each bond, we then add up the aggregate dealer inventories for those dealers who provided immediacy in a given bond (i.e. those dealers who had a positive inventory buildup in that bond). The resulting bond-specific measure captures how stretched the dealers providing immediacy in that bond were. We interact Q with three dummies indicating wether the observation takes place before, during, or after the credit crisis.

As can be seen from Table 5, the increase in the price of immediacy for the maturity exclusions that we document in the paper is not related to Q. This finding essentially shows that, dealers are seeking additional compensation for providing liquidity for the short-maturity, investment-grade bonds exiting the index. The reason is twofold. On one hand, the price demand elasticity of immediacy might not be zero (which would warrant a 2SLS procedure), since the indexers can keep the bonds in the portfolio and simply wait for maturity; on the other hand, it is possible that the additional cost of providing immediacy due to regulation is offset by the dealers' change in their business model. In particular, it is possible that dealers move away from the the business of providing liquidity for the risky junk bonds, and use their scarce capital for bonds in the investment-grade universe.

The estimation results on downgrade exclusions in Table 6 provide support for the second explanation (change in business model). As can be seen from the table, the price of providing liquidity is increasing the amount of liquidity transacted, making the relation reminiscent of a supply curve. Comparing the interaction of Q with the post-crisis dummy to the interaction of Q with the pre-crisis dummy reveals that the supply curve is relatively steeper. In conclusion, providing immediacy in less liquid and more risky bonds has become more costly after the crisis, and, consequently, dealers require higher returns for providing immediacy.

5 Robustness checks

5.1 Are downgrades and downgrade exclusions separate events?

The returns for the downgraded bonds could in theory be affected by a slow post-downgrade price adjustment (see e.g. Katz (1974) and Grier and Katz (1976). Also

see Norden and Weber (2004) for a review of other rating change studies). In order to verify that this is not the case we look at dealer behavior at the actual downgrade date.

Figure 7a and 7b show that the downgrade date itself also see a lot of trading activity. However, the average turnover is of the same size as that on the exclusion date. Also, the inventory build up on the downgrade itself is far smaller than that on the exclusion date. Where inventory peaked at the exclusion date and then decreased, here the peak is delayed. The delay is consistent with an inventory build up at the exclusion date.

Figure 8 show both the downgrade date and the exclusion date for events with a fixed number of days between the exclusion and the downgrade. The fixed intervals of 4, 11, and 17 days are chosen because these are the days with most turnover on the downgrade date. The volume figures clearly shows to spikes in trading activity, first on the downgrade date and then on the exclusion date. The inventory graphs show that there sometimes is an inventory increase at the downgrade date but that there always is a second increase at the exclusion date. After this second spike the inventory immediately starts to decrease.

In summary, the analysis verifies that the downgrade event and the exclusion event are two separate events. There may be information on the downgrade date itself, but there should not be little or no information on the exclusion date. Also note that the trading activity for the downgrade date is also highly concentrated on the downgrade itself. The downgrade event is thus fairly short lived.

5.2 Alternative weighting scheme

Table 5 and 6 present regression estimates obtained by giving equal weight to each exclusion. However, it is possible that the provision of immediacy is crucial only for those bonds that are experiencing a massive sell-off by index trackers. In Table 9 and 10, we replicate Table 5 and 6, by weighting the bonds experiencing dealer purchases (costumers' sales) more heavily. As can be see, the results are robust to this alternative weighting scheme.

6 Conclusion

The aggregate primary dealer inventory in corporate securities has decreased during the crisis from $281 bn to $100 bn in early 2009. Since then the inventory has decreased even further in anticipation of tighter regulation i.e. the Basel III and especially the Volcker Rule. This study suggests that the tighter regulation may have led to an increase in the cost of immediacy. The higher transaction costs can be seen as compensation to the dealer for using inventory which is more costly under the new regulation.

The study thus adds to the ongoing debate about the possible effects of the new regulation. In a study on behalf of SIFMA, regarding the impact of the Volcker Rule on market liquidity, Wyman (2012) concluded that the rule would represent a significant risk for market liquidity. Both Johnson (2012) and Richardson (2012) argued against this conclusion and gave several reasons why this might not be the case. The findings suggest that market liquidity in general has not gone down when looking at the liquidity measure from e.g. Dick-Nielsen, Feldhütter, and Lando (2012). However, the cost of immediacy has increased as predicted in Duffie (2012). Hence, time constrained traders now pay a higher premium for trading than before the decline in dealer inventories.

The study uses the information-free and time-homogenous event of exclusions from the Barclay Capital corporate bond index. Index trackers seeking to minimize tracking error demand immediacy at these monthly events and the dealers then provide the needed liquidity. Two types of exclusions are investigated, exclusions because of low maturity and exclusions because of a recent downgrade to speculative grade.

The cost of immediacy has uniformly increased after the crisis and regulation has thus had the side-effect of lowering market liquidity and, consequently, market efficiency.

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Table 1: Barclay Capital corporate bond index exclusion statistics

The statistics are accumulated from July 2002 to November 2013 for the Barclay Corporate Bond Index (formerly Lehman). Market value in $1,000 is the average market value at the time of the index revision. The table show four reasons for being excluded. The maturity of the bonds can fall below 1 year during the month. The bond can be called. The bond can be downgraded from investment grade to speculative grade during the month. Finally, there can be various other reasons for being excluded. Most of these exclusions are due to revisions of the general index rules, mainly that the size requirement has been increased twice over the period. In all cases the bonds are excluded at the end of the month (last trading day).

Reason	N	Market Value ($1,000)	OA Duration	Coupon
Maturity< 1	3,102	645,374	0.92	5.7
Called	392	461,354	0.52	7.1
Downgrade	1,078	484,269	5.1	6.8
Other	2,119	358,501	6.0	6.5

Table 2: Intertemporal bix-ask spreads: maturity exclusions

This table shows the returns of bond excluded from the Barclay Corporate Bond Index because of low maturity. Returns are calculated as log price changes between day 0 (the exclusion date) and day t after the exclusion. The returns are calculated as seen from the dealers perspective. First, the intertemporal bid-ask spread is calculated using the dealer-buy price at day 0 and the dealer-sell price at day t. Second, the abnormal return is the intertemporal bid-ask spread subtracted the return on a matched portfolio. The portfolio is matched on rating and duration. EW returns are equally weighted across all excluded bonds. VW1 is weighted by the aggregate inventory build-up for dealers with a net positive inventory change between day -3 to 0. VW2 is weighted by the aggregate buying volume in the specific cusip for all dealers with a positive inventory build-up in the bond. The three time periods are 2002Q3-2007Q2, 2007Q3-2009Q4, and 2010Q1-2013Q4.

Table 2 (continued)

		Intertemporal Bid-Ask			Abnormal Returns		
$[0,t]$	N	EW	VW1	VW2	EW	VW1	VW2
Period 1							
1	833	7.62	5.84	5.96	2.43	1.26	1.59
		(10.18)***	(8.66)***	(8.88)***	(2.03)**	(1.48)	(1.69)*
2	798	9.25	8.19	8.10	1.56	0.74	1.07
		(9.39)***	(8.81)***	(7.99)***	(1.44)	(0.79)	(1.08)
3	782	10.80	9.50	9.84	1.64	0.73	1.37
		(8.78)***	(10.09)***	(9.74)***	(1.33)	(0.63)	(1.25)
4	780	13.14	11.12	11.46	1.29	-0.79	0.33
		(10.23)***	(12.34)***	(13.01)***	(0.93)	(-0.69)	(0.30)
5	767	14.67	12.02	11.96	0.25	-2.64	-1.65
		(11.97)***	(11.87)***	(11.09)***	(0.17)	(-2.17)**	(-1.28)
10	733	19.47	18.02	17.93	-5.34	-7.67	-5.68
		(12.66)***	(13.07)***	(11.80)***	(-2.20)**	(-4.01)***	(-2.64)***
20	690	31.43	32.74	31.28	-18.86	-20.96	-17.98
		(13.32)***	(11.95)***	(13.30)***	(-4.76)***	(-6.62)***	(-5.00)***
30	683	46.04	45.83	44.14	-24.86	-30.00	-26.84
		(14.65)***	(12.27)***	(12.20)***	(-6.40)***	(-8.61)***	(-7.20)***
Period 2							
1	273	56.54	46.43	45.02	41.60	30.71	31.29
		(8.37)***	(8.19)***	(7.96)***	(6.47)***	(6.14)***	(5.40)***
2	258	64.37	48.02	47.22	45.78	31.69	32.83
		(7.03)***	(6.28)***	(6.76)***	(6.62)***	(4.85)***	(4.29)***
3	234	65.33	55.09	53.61	42.08	37.23	28.02
		(7.69)***	(7.34)***	(7.16)***	(5.11)***	(3.76)***	(3.45)***
4	238	68.80	53.32	53.34	45.77	40.71	36.32
		(7.78)***	(7.67)***	(7.48)***	(5.08)***	(4.34)***	(4.74)***
5	232	74.95	64.42	66.12	46.31	39.44	42.89
		(8.26)***	(8.41)***	(7.94)***	(4.98)***	(3.66)***	(4.65)***
10	211	84.12	73.44	77.78	27.83	23.38	29.87
		(7.77)***	(9.11)***	(6.44)***	(2.31)**	(2.07)**	(2.55)**
20	214	115.67	103.90	101.71	18.88	30.35	38.88
		(6.96)***	(4.99)***	(4.28)***	(1.01)	(1.29)	(1.65)*
30	208	145.20	128.66	126.21	-5.28	-26.27	-1.51
		(5.50)***	(4.27)***	(4.05)***	(-0.23)	(-1.31)	(-0.08)
Period 3							
1	1,079	13.79	11.36	13.16	11.74	9.75	11.04
		(10.29)***	(9.69)***	(8.19)***	(7.88)***	(6.61)***	(7.53)***
2	1,047	15.16	12.95	14.36	11.60	9.96	11.47
		(11.05)***	(10.38)***	(8.78)***	(7.14)***	(5.47)***	(5.82)***
3	1,038	15.37	12.79	14.80	10.91	8.46	10.14
		(10.34)***	(10.39)***	(6.29)***	(6.97)***	(5.27)***	(5.49)***
4	989	16.32	13.49	15.88	10.90	8.49	10.58
		(9.95)***	(9.58)***	(6.67)***	(6.74)***	(5.58)***	(5.78)***
5	983	17.03	14.76	17.32	9.78	8.06	10.60
		(10.27)***	(8.20)***	(6.73)***	(7.31)***	(4.27)***	(4.91)***
10	950	21.38	18.10	20.82	8.98	5.73	9.92
		(8.38)***	(7.87)***	(6.05)***	(5.90)***	(2.86)***	(3.04)***
20	859	25.78	21.47	24.89	2.73	-0.73	5.54
		(7.43)***	(5.92)***	(4.61)***	(1.17)	(-0.26)	(1.04)
30	812	32.15	25.12	35.29	0.71	-5.65	8.43
		(7.27)***	(6.44)***	(3.40)***	(0.27)	(-1.92)*	(0.71)

Table 3: Intertemporal bix-ask spreads: downgrade exclusions

This table shows the returns of bond excluded from the Barclay Corporate Bond Index because of downgrade from investment grade to speculative grade. Returns are calculated as log price changes between day 0 (the exclusion date) and day t after the exclusion. The returns are calculated as seen from the dealers perspective. First, the intertemporal bid-ask spread is calculated using the dealer-buy price at day 0 and the dealer-sell price at day t. Second, the abnormal return is the intertemporal bid-ask spread subtracted the return on a matched portfolio. The portfolio is matched on rating and duration. EW returns are equally weighted across all excluded bonds. VW1 is weighted by the aggregate inventory build-up for dealers with a net positive inventory change between day -3 to 0. VW2 is weighted by the aggregate buying volume in the specific cusip for all dealers with a positive inventory build-up in the bond. The three time periods are 2002Q3-2007Q2, 2007Q3-2009Q4, and 2010Q1-2013Q4.

Table 3 (continued)

$[0,t]$	N	Intertemporal Bid-Ask			Abnormal Returns		
		EW	VW1	VW2	EW	VW1	VW2
Period 1							
1	244	100.74	107.76	91.70	39.81	28.42	10.69
		(4.77)***	(4.80)***	(6.37)***	(3.17)***	(0.81)	(0.65)
2	246	149.11	207.20	181.77	38.54	35.23	11.66
		(3.03)***	(3.20)***	(3.20)***	(2.79)***	(0.96)	(0.62)
3	244	168.44	256.85	215.31	25.59	23.82	-12.57
		(3.30)***	(4.18)***	(3.87)***	(1.28)	(0.40)	(-0.36)
4	235	177.16	242.64	216.32	48.55	70.28	36.48
		(4.28)***	(5.86)***	(5.49)***	(2.68)***	(1.60)	(1.76)*
5	229	203.93	278.99	259.63	52.83	38.97	13.85
		(3.99)***	(4.87)***	(5.60)***	(2.58)***	(0.93)	(0.59)
10	227	232.72	371.70	295.16	48.77	83.48	20.19
		(2.94)***	(4.51)***	(4.08)***	(2.03)**	(1.42)	(0.76)
20	215	255.84	319.06	274.72	-49.97	-47.00	-91.19
		(4.66)***	(4.61)***	(5.62)***	(-1.53)	(-0.62)	(-1.78)*
30	210	277.82	322.58	280.44	-134.3	-171.0	-199.2
		(2.62)***	(2.13)**	(2.88)***	(-2.33)**	(-1.25)	(-1.88)*
Period 2							
1	113	139.25	77.57	108.35	103.19	81.05	77.52
		(1.62)	(0.75)	(1.00)	(1.97)**	(1.29)	(1.02)
2	111	64.96	-20.88	111.44	4.04	-33.68	38.88
		(0.55)	(-0.08)	(0.88)	(0.09)	(-0.27)	(0.70)
3	108	12.53	-195.3	89.26	18.27	-169.0	51.58
		(0.08)	(-0.48)	(0.60)	(0.46)	(-0.78)	(1.27)
4	98	33.36	127.18	202.69	-4.88	-29.79	64.75
		(0.24)	(0.61)	(1.35)	(-0.07)	(-0.34)	(1.91)*
5	93	163.98	-94.69	322.61	93.38	-111.3	193.66
		(0.71)	(-0.17)	(1.48)	(1.40)	(-0.38)	(1.77)*
10	93	324.71	278.12	464.16	143.83	92.18	213.05
		(1.30)	(1.04)	(2.13)**	(1.07)	(0.64)	(1.92)*
20	81	596.39	686.26	612.26	290.37	308.24	286.82
		(1.40)	(1.84)*	(1.97)**	(1.00)	(1.04)	(1.26)
30	78	409.98	355.59	412.78	-200.1	-179.5	-21.60
		(0.92)	(1.31)	(1.62)	(-0.77)	(-0.63)	(-0.09)
Period 3							
1	206	138.48	140.01	132.20	69.15	79.56	67.78
		(2.22)**	(1.89)*	(2.32)**	(3.22)***	(2.57)**	(3.05)***
2	203	229.78	272.86	224.37	100.44	138.33	91.61
		(2.53)**	(2.71)***	(2.92)***	(3.25)***	(3.19)***	(3.13)***
3	188	316.27	357.37	307.71	162.71	189.45	141.87
		(2.27)**	(2.50)**	(2.65)***	(3.00)***	(3.76)***	(3.88)***
4	179	361.33	376.15	342.36	167.80	167.57	147.48
		(2.17)**	(2.31)**	(2.48)**	(2.63)***	(3.95)***	(3.44)***
5	181	400.63	400.80	385.62	196.98	165.09	164.90
		(2.35)**	(2.12)**	(2.47)**	(2.89)***	(2.65)***	(2.92)***
10	174	314.98	218.72	280.63	217.72	146.58	195.98
		(2.54)**	(1.75)*	(2.76)***	(2.23)**	(1.49)	(2.68)***
20	174	503.13	508.78	521.87	265.44	289.01	298.38
		(2.12)**	(1.94)*	(2.18)**	(2.18)**	(2.43)**	(2.69)***
30	158	697.28	715.60	737.70	165.64	103.22	149.24
		(2.42)**	(2.25)**	(2.51)**	(1.74)*	(1.16)	(2.04)**

Table 4: Sample descriptive statistics

This table presents descriptive statistics for the independent variables used in the regression analysis. The statistics is divided into the whole sample, the downgrade sample, and the low maturity sample. Term spread is the yield difference between a 10-year and a 5-year constant maturity treasury bond. TED spread is the difference between the 3-month LIBOR rate and the 3-month T-bill rate. VIX is the CBOR volatility index derived from the implied volatility on S&P 500 index options. Coupon is the nominal annualized coupon on the corporate bond. Issue size is the offering amount for the bond in millions. Year to maturity is the remaining time to maturity of the bond. Log Quantity is the logarithm of the aggregate dealer imbalance for those dealers who provided immediacy in the bond. A-, BBB-,B-,C-rated are dummies used to indicate the current rating of the bond.

Exclusions	Variable	Obs.	Mean	St. Dev.	p1	p25	p50	p75	p99
All	Bond Mkt Vol - B/L	141	0.11	0.11	0.03	0.05	0.07	0.12	0.69
All	Bond Mkt Vol - B/M	141	0.07	0.07	0.02	0.03	0.04	0.09	0.33
All	Bond Mkt Vol - B/S	141	0.07	0.10	0.01	0.02	0.04	0.08	0.51
All	Bond Mkt Vol - BB/L	141	0.08	0.07	0.02	0.04	0.06	0.09	0.36
All	Bond Mkt Vol - BB/M	141	0.06	0.05	0.01	0.03	0.04	0.06	0.26
All	Bond Mkt Vol - BB/S	141	0.05	0.05	0.01	0.02	0.03	0.06	0.25
All	Bond Mkt Vol - C/L	141	0.24	0.19	0.06	0.13	0.18	0.26	0.97
All	Bond Mkt Vol - C/M	141	0.14	0.15	0.02	0.06	0.09	0.15	0.70
All	Bond Mkt Vol - C/S	141	0.15	0.14	0.05	0.08	0.10	0.15	0.80
All	Bond Mkt Vol - IGS	141	0.01	0.02	0.00	0.00	0.01	0.01	0.07
All	Term Spread	137	1.82	1.11	-0.38	1.14	1.98	2.69	3.38
All	TED Spread	137	0.44	0.60	0.06	0.17	0.23	0.38	3.12
All	VIX	137	20.77	9.04	10.91	14.55	17.83	24.51	55.28
All	Dealer Lev. Growth	137	-0.01	0.20	-0.98	-0.03	0.02	0.04	0.65
All	Coupon	3,016	5.78	1.66	1.38	4.88	5.88	6.89	9.38
All	Issue Size (MIO)	3,016	700.34	589.53	185.00	300.00	500.00	900.00	3000.0
All	Years to Maturity	3,016	2.98	6.07	0.90	0.93	0.95	0.99	28.12
All	Log Quantity (Q)	3,016	16.30	1.30	12.73	15.50	16.33	17.21	18.95
All	A-rated	3,016	0.37	0.48	0.00	0.00	0.00	1.00	1.00
All	BBB-rated	3,016	0.24	0.43	0.00	0.00	0.00	0.00	1.00
All	B-rated	3,016	0.01	0.09	0.00	0.00	0.00	0.00	0.00
All	C-rated	3,016	0.01	0.12	0.00	0.00	0.00	0.00	1.00
All	Log Issue Size	3,016	13.21	0.67	12.13	12.61	13.12	13.71	14.91
Downgrade	Coupon	693	6.61	1.30	3.50	5.75	6.63	7.50	10.00
Downgrade	Issue Size (MIO)	693	685.70	609.53	150.00	300.00	500.00	750.00	3000.0
Downgrade	Years to Maturity	693	9.82	9.99	1.10	3.64	6.50	9.78	34.20
Downgrade	Log Quantity (Q)	693	16.64	1.44	12.45	15.78	16.69	17.69	19.55
Downgrade	B-rated	693	0.03	0.18	0.00	0.00	0.00	0.00	1.00
Downgrade	C-rated	693	0.06	0.24	0.00	0.00	0.00	0.00	1.00
Downgrade	Log Issue Size	693	13.18	0.71	11.92	12.61	13.12	13.53	14.91
Maturity	Coupon	2,323	5.54	1.67	1.25	4.50	5.63	6.70	8.90
Maturity	Issue Size (MIO)	2,323	704.71	583.50	200.00	300.00	500.00	998.75	3000.0
Maturity	Years to Maturity	2,323	0.94	0.02	0.90	0.92	0.95	0.96	1.00
Maturity	Log Quantity (Q)	2,323	16.20	1.24	12.73	15.44	16.25	17.07	18.63
Maturity	A-rated	2,323	0.48	0.50	0.00	0.00	0.00	1.00	1.00
Maturity	BBB-rated	2,323	0.32	0.46	0.00	0.00	0.00	1.00	1.00
Maturity	Log Issue Size	2,323	13.22	0.66	12.21	12.61	13.12	13.81	14.91

Table 5: Liquidity provision before and after the crisis: maturity.

This table presents regression coefficients for a series of regressions. The dependent variable is the bond specific abnormal dealer return over the period from the exclusion day 0 to day t after the exclusion. Returns are for the bonds excluded because of low maturity. Issue size is the offering amount for the bond in millions. A-, BBB-rated are dummies used to indicate the current rating of the bond. The benchmark rating is thus a AAA/AA-rating bond. Term spread is the yield difference between a 10-year and a 5-year constant maturity treasury bond. TED spread is the difference between the 3-month LIBOR rate and the 3-month T-bill rate. VIX is the CBOR volatility index derived from the implied volatility on S&P 500 index options. Q times the period is a period dummy times the logarithm of the aggregate dealer imbalance for those dealers who provided immediacy in the bond. The periods are 2002Q3-2007Q2, 2007Q3-2009Q4, and 2010Q1-2013Q4. The regressions all include period fixed effects and cluster robust standard errors clustered by bond issuer.

Event Window: (0,t]	1	2	3	4	5	10	20	30
Q*Postcrisis	-2.16	-1.28	-0.84	-0.43	-0.66	-0.43	-2.68	-3.50
	(-2.34)**	(-1.15)	(-0.97)	(-0.37)	(-0.70)	(-0.34)	(-1.54)	(-1.52)
Q*Precrisis	-2.69	-0.82	-0.44	0.15	-1.09	-1.83	0.04	-3.28
	(-1.81)*	(-0.59)	(-0.37)	(0.11)	(-0.99)	(-1.13)	(0.02)	(-0.87)
Q*Crisis	-10.19	-12.44	-6.87	-9.93	-5.43	-13.18	-1.73	-25.19
	(-3.16)***	(-3.85)***	(-1.65)*	(-2.43)**	(-1.18)	(-1.68)*	(-0.18)	(-2.25)**
A-rated	2.41	3.51	5.82	3.33	4.52	2.07	-1.68	4.58
	(1.10)	(1.58)	(2.80)***	(1.38)	(2.03)**	(0.51)	(-0.27)	(0.85)
BBB-rated	8.83	9.20	10.04	9.83	12.81	10.99	9.12	11.86
	(3.36)***	(3.27)***	(4.06)***	(3.13)***	(4.43)***	(2.66)***	(1.48)	(1.93)*
Log Issue Size	2.31	0.94	-0.97	-1.84	-0.09	3.07	4.84	4.03
	(1.48)	(0.46)	(-0.53)	(-0.80)	(-0.05)	(1.16)	(1.24)	(0.77)
Bond Mkt Vol.	0.23	0.35	0.34	0.43	0.25	0.39	0.29	0.64
	(2.58)***	(2.40)**	(3.71)***	(2.94)***	(3.54)***	(2.95)***	(1.64)	(1.89)*
Dealer Lev. Growth	10.61	2.15	11.22	3.38	8.73	42.15	10.77	53.64
	(1.23)	(0.24)	(0.76)	(0.23)	(0.57)	(2.49)**	(0.57)	(1.78)*
VIX	1.23	0.96	0.84	0.74	0.85	0.27	0.05	-0.29
	(4.79)***	(2.93)***	(2.91)***	(2.15)**	(3.16)***	(0.76)	(0.13)	(-0.35)
TED Spread	-0.08	-0.16	-0.16	-0.23	-0.13	-0.32	-0.09	-0.29
	(-1.23)	(-2.32)**	(-2.82)***	(-3.18)***	(-2.40)**	(-3.07)***	(-0.72)	(-1.82)*
Number of Observations	2323	2275	2261	2243	2215	2120	2019	1987
Adjusted R-Square	0.2120	0.2244	0.1830	0.1766	0.1328	0.1081	0.04204	0.07112

Table 6: Liquidity provision before and after the crisis: downgrades.

This table presents regression coefficients for a series of regressions. The dependent variable is the bond specific abnormal dealer return over the period from the exclusion day 0 to day t after the exclusion. Returns are for the bonds excluded because of downgrade to speculative grade. Issue size is the offering amount for the bond in millions. B-,C-rated are dummies used to indicate the current rating of the bond. The benchmark rating is thus a BB-rating bond. Term spread is the yield difference between a 10-year and a 5-year constant maturity treasury bond. TED spread is the difference between the 3-month LIBOR rate and the 3-month T-bill rate. VIX is the CBOR volatility index derived from the implied volatility on S&P 500 index options. Q times the period is a period dummy times the logarithm of the aggregate dealer imbalance for those dealers who provided immediacy in the bond. The periods are 2002Q3-2007Q2, 2007Q3-2009Q4, and 2010Q1-2013Q4. The regressions all include period fixed effects and cluster robust standard errors clustered by bond issuer.

Event Window: (0,t]	1	2	3	4	5	10	20	30
Q*Postcrisis	23.14	55.76	73.09	92.53	62.30	16.07	39.45	47.54
	(1.23)	(2.43)**	(2.09)**	(2.13)**	(1.52)	(0.27)	(0.58)	(0.59)
Q*Precrisis	-6.99	4.37	-1.10	-0.57	-36.77	-4.19	-71.01	-95.22
	(-0.45)	(0.26)	(-0.05)	(-0.02)	(-1.47)	(-0.11)	(-1.66)*	(-1.90)*
Q*Crisis	8.34	70.73	122.96	118.13	78.90	376.39	234.28	359.50
	(0.13)	(0.88)	(1.01)	(1.07)	(0.62)	(2.37)**	(1.64)	(2.09)**
B-rated	58.38	-28.03	-8.25	-10.20	25.04	16.44	46.35	-60.84
	(1.06)	(-0.58)	(-0.10)	(-0.11)	(0.25)	(0.12)	(0.25)	(-0.26)
C-rated	-21.68	220.21	438.43	541.39	633.73	-763.8	-1907	-1338
	(-0.11)	(0.90)	(0.63)	(0.80)	(0.92)	(-0.88)	(-1.61)	(-0.78)
Log Issue Size	-35.58	-80.76	-72.57	-81.11	-31.31	-50.32	21.95	65.61
	(-0.97)	(-1.89)*	(-1.18)	(-1.32)	(-0.47)	(-0.54)	(0.30)	(0.67)
Bond Mkt Vol.	0.50	0.43	0.39	0.23	0.41	0.96	1.66	2.69
	(3.66)***	(3.00)***	(1.30)	(0.71)	(1.24)	(1.86)*	(2.38)**	(3.29)***
Dealer Lev. Growth	-228.2	-407.1	-606.3	-699.0	-782.8	-333.1	-639.5	-1165
	(-1.91)*	(-2.61)***	(-2.82)***	(-3.20)***	(-3.38)***	(-0.92)	(-1.61)	(-1.93)*
VIX	-4.50	-9.10	-12.19	-13.15	-15.50	-8.50	-17.31	-30.33
	(-1.36)	(-2.25)**	(-2.14)**	(-2.09)**	(-2.20)**	(-0.97)	(-1.17)	(-1.31)
TED Spread	1.42	2.35	3.74	3.85	4.49	3.79	1.77	1.79
	(3.04)***	(3.50)***	(3.34)***	(3.23)***	(3.13)***	(2.00)**	(0.70)	(0.50)
Number of Observations	689	686	667	651	648	637	599	584
Adjusted R-Square	0.2670	0.3156	0.2358	0.1949	0.2409	0.1761	0.1477	0.2616

Table 7: Return to predation: maturity exclusions

This table shows the returns of bond excluded from the Barclay Corporate Bond Index because of low maturity. Returns are calculated as log price changes between day 0 (the exclusion date) and day t after the exclusion. The returns are calculated as seen from the dealers perspective. First, the intertemporal bid-ask spread is calculated using the dealer-buy price at day 0 and the dealer-sell price at day t. Second, the abnormal return is the intertemporal bid-ask spread subtracted the return on a matched portfolio. The portfolio is matched on rating and duration. EW returns are equally weighted across all excluded bonds. VW1 is weighted by the aggregate inventory build-up for dealers with a net positive inventory change between day -3 to 0. VW2 is weighted by the aggregate buying volume in the specific cusip for all dealers with a positive inventory build-up in the bond. The three time periods are 2002Q3-2007Q2, 2007Q3-2009Q4, and 2010Q1-2013Q4.

Table 7 (continued)

$[0,t]$	N	Intertemporal Bid-Ask			Abnormal Returns		
		EW	VW1	VW2	EW	VW1	VW2
Period 1							
1	696	-5.12	-2.95	-3.67	-10.31	-7.59	-8.26
		(-3.76)***	(-2.57)**	(-2.90)***	(-8.21)***	(-6.73)***	(-6.72)***
2	621	-4.86	-2.53	-2.93	-13.23	-10.53	-10.86
		(-3.01)***	(-2.17)**	(-2.45)**	(-10.16)***	(-9.68)***	(-9.46)***
3	601	-3.83	-2.31	-2.85	-13.94	-11.93	-12.41
		(-2.52)**	(-1.90)*	(-2.54)**	(-11.48)***	(-12.04)***	(-12.99)***
4	596	-3.20	-1.68	-2.65	-16.18	-14.36	-14.81
		(-1.81)*	(-1.04)	(-1.67)*	(-10.80)***	(-11.06)***	(-10.34)***
5	593	-2.96	-0.00	-1.20	-18.50	-15.70	-16.27
		(-1.48)	(-0.00)	(-0.69)	(-10.60)***	(-11.55)***	(-11.60)***
10	566	3.06	6.41	3.92	-23.27	-20.38	-20.83
		(1.16)	(2.83)***	(1.50)	(-9.76)***	(-11.33)***	(-9.43)***
20	609	16.21	20.38	17.82	-36.00	-34.78	-33.28
		(5.23)***	(5.76)***	(5.49)***	(-8.19)***	(-9.99)***	(-8.74)***
30	555	28.85	34.22	31.43	-45.59	-43.90	-42.83
		(7.81)***	(8.00)***	(7.41)***	(-10.69)***	(-12.52)***	(-11.41)***
Period 2							
1	209	-31.85	-26.56	-29.71	-47.71	-42.29	-43.34
		(-8.55)***	(-5.72)***	(-5.26)***	(-8.08)***	(-7.67)***	(-7.59)***
2	198	-34.33	-28.32	-33.92	-52.05	-41.95	-45.08
		(-6.63)***	(-4.37)***	(-4.17)***	(-7.72)***	(-5.91)***	(-7.41)***
3	189	-33.53	-31.58	-29.39	-57.85	-47.69	-53.20
		(-5.78)***	(-3.07)***	(-3.38)***	(-6.01)***	(-4.77)***	(-6.05)***
4	180	-31.77	-34.45	-31.09	-57.77	-46.65	-49.34
		(-4.00)***	(-2.34)**	(-3.09)***	(-5.00)***	(-4.27)***	(-5.44)***
5	172	-30.20	-25.68	-28.06	-63.77	-53.78	-51.90
		(-4.38)***	(-3.08)***	(-2.92)***	(-5.21)***	(-4.11)***	(-5.54)***
10	181	-13.56	-17.54	-15.86	-71.08	-65.92	-59.22
		(-1.40)	(-1.89)*	(-1.75)*	(-5.39)***	(-4.53)***	(-5.74)***
20	182	7.72	-1.70	-4.68	-80.42	-69.12	-56.12
		(0.53)	(-0.09)	(-0.21)	(-4.66)***	(-3.38)***	(-3.53)***
30	172	34.60	28.34	19.02	-125.7	-131.3	-106.1
		(1.12)	(0.88)	(0.54)	(-7.09)***	(-7.64)***	(-5.75)***
Period 3							
1	893	-14.74	-12.25	-13.42	-16.73	-13.59	-15.53
		(-10.60)***	(-9.28)***	(-9.27)***	(-12.17)***	(-11.63)***	(-9.08)***
2	861	-14.28	-12.13	-13.05	-18.07	-15.26	-16.42
		(-8.84)***	(-7.80)***	(-7.79)***	(-10.22)***	(-11.70)***	(-13.36)***
3	846	-14.33	-11.67	-12.76	-19.11	-16.15	-17.74
		(-8.67)***	(-7.62)***	(-7.76)***	(-9.30)***	(-10.35)***	(-10.51)***
4	828	-13.53	-11.36	-12.03	-19.70	-16.59	-17.75
		(-8.96)***	(-7.60)***	(-7.89)***	(-9.68)***	(-11.04)***	(-11.09)***
5	824	-13.25	-11.91	-12.79	-21.61	-18.78	-19.82
		(-8.93)***	(-7.58)***	(-8.33)***	(-10.51)***	(-11.46)***	(-12.38)***
10	838	-8.40	-7.74	-10.61	-21.69	-20.21	-21.60
		(-3.86)***	(-3.42)***	(-4.20)***	(-9.55)***	(-9.82)***	(-8.99)***
20	821	-3.40	-5.14	-8.36	-26.78	-26.96	-27.76
		(-1.34)	(-1.60)	(-2.92)***	(-10.56)***	(-9.85)***	(-11.19)***
30	781	1.31	-2.83	-4.12	-30.40	-33.37	-31.22
		(0.47)	(-0.85)	(-1.25)	(-9.71)***	(-11.54)***	(-10.05)***

Table 8: Return to predation: downgrade exclusions

This table shows the returns of bond excluded from the Barclay Corporate Bond Index because of downgrade from investment grade to speculative grade. Returns are calculated as log price changes between day 0 (the exclusion date) and day t after the exclusion. The returns are calculated as seen from the dealers perspective. First, the intertemporal bid-ask spread is calculated using the dealer-buy price at day 0 and the dealer-sell price at day t. Second, the abnormal return is the intertemporal bid-ask spread subtracted the return on a matched portfolio. The portfolio is matched on rating and duration. EW returns are equally weighted across all excluded bonds. VW1 is weighted by the aggregate inventory build-up for dealers with a net positive inventory change between day -3 to 0. VW2 is weighted by the aggregate buying volume in the specific cusip for all dealers with a positive inventory build-up in the bond. The three time periods are 2002Q3-2007Q2, 2007Q3-2009Q4, and 2010Q1-2013Q4.

Table 8 (continued)

$[0,t]$	N	Intertemporal Bid-Ask			Abnormal Returns		
		EW	VW1	VW2	EW	VW1	VW2
Period 1							
1	227	-18.42	28.53	3.44	-85.47	-49.71	-75.49
		(-1.36)	(1.19)	(0.37)	(-4.52)***	(-1.24)	(-3.36)***
2	221	31.87	133.03	109.08	-83.98	-40.35	-64.65
		(0.80)	(1.98)**	(2.09)**	(-4.72)***	(-1.16)	(-2.78)***
3	219	50.22	180.52	139.80	-100.4	-52.50	-92.98
		(1.20)	(3.11)***	(2.88)***	(-3.34)***	(-0.81)	(-2.17)**
4	212	53.20	150.14	120.33	-83.88	-18.86	-55.07
		(1.64)	(4.05)***	(3.61)***	(-3.80)***	(-0.38)	(-2.04)**
5	210	68.48	197.98	173.63	-95.31	-41.69	-72.30
		(1.75)*	(3.60)***	(3.87)***	(-3.73)***	(-0.98)	(-2.96)***
10	210	102.77	301.91	220.92	-80.51	12.18	-59.34
		(1.56)	(3.77)***	(3.19)***	(-3.59)***	(0.21)	(-2.20)**
20	185	167.24	254.60	211.97	-170.8	-125.6	-169.9
		(3.25)***	(3.63)***	(4.33)***	(-5.29)***	(-1.56)	(-2.90)***
30	192	175.09	269.29	226.27	-244.3	-225.5	-267.4
		(1.71)*	(1.82)*	(2.56)**	(-3.50)***	(-1.52)	(-2.29)**
Period 2							
1	97	-132.8	-208.1	-104.3	-152.7	-194.8	-134.6
		(-1.37)	(-1.21)	(-0.94)	(-2.50)**	(-1.67)*	(-1.44)
2	93	-132.9	-283.6	-88.63	-176.3	-275.5	-139.0
		(-0.85)	(-0.96)	(-0.56)	(-2.65)***	(-1.57)	(-1.49)
3	90	-200.2	-285.4	-74.63	-199.6	-267.0	-117.7
		(-0.92)	(-0.71)	(-0.35)	(-2.65)***	(-1.21)	(-1.19)
4	79	-170.4	-26.81	87.82	-193.4	-184.3	-57.67
		(-0.73)	(-0.09)	(0.36)	(-2.33)**	(-1.13)	(-0.55)
5	79	-109.1	40.46	122.31	-160.7	-136.1	-18.96
		(-0.43)	(0.14)	(0.50)	(-2.45)**	(-0.85)	(-0.21)
10	76	44.72	30.39	260.93	-132.0	-143.2	2.76
		(0.14)	(0.09)	(1.04)	(-0.70)	(-0.65)	(0.02)
20	73	274.70	365.53	401.74	-46.44	13.42	74.20
		(0.61)	(1.01)	(1.38)	(-0.16)	(0.05)	(0.35)
30	70	371.61	288.42	376.31	-142.9	-241.4	-37.92
		(0.63)	(0.76)	(0.87)	(-0.43)	(-0.70)	(-0.13)
Period 3							
1	188	40.05	43.80	31.45	-42.78	-26.16	-42.61
		(0.65)	(0.70)	(0.60)	(-1.45)	(-1.25)	(-1.60)
2	195	121.15	160.58	115.34	-16.92	20.43	-23.85
		(1.26)	(1.92)*	(1.56)	(-0.44)	(0.44)	(-0.56)
3	189	177.00	214.51	176.13	22.91	49.99	6.29
		(1.42)	(2.02)**	(1.76)*	(0.52)	(1.87)*	(0.23)
4	177	218.98	274.14	216.68	21.25	60.08	16.69
		(1.30)	(1.67)*	(1.59)	(0.33)	(1.58)	(0.50)
5	170	277.62	303.91	297.14	69.84	62.89	58.37
		(1.47)	(1.58)	(1.62)	(0.92)	(1.06)	(0.92)
10	157	208.53	206.52	195.23	103.28	115.66	95.62
		(1.81)*	(2.44)**	(2.09)**	(1.18)	(2.09)**	(1.65)*
20	158	429.52	393.32	423.72	172.77	154.27	169.28
		(1.73)*	(1.57)	(1.65)*	(1.67)*	(1.45)	(1.53)
30	158	619.87	657.40	667.40	86.17	47.54	74.44
		(1.95)*	(1.98)**	(2.22)**	(0.86)	(0.49)	(1.14)

Table 9: Weighting by volume: maturity.

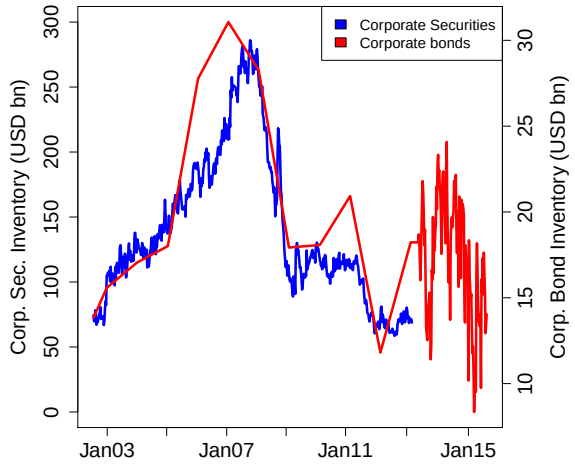
This table replicates Table 5, except that the returns are weighted (WLS) by aggregated buying volume for the specific cusip. We only consider the buying volume of dealers who were net supplier of immediacy in that bond.

Event Window: (0,t]	1	2	3	4	5	10	20	30
Q*Postcrisis	-1.54	-2.13	-1.11	-1.82	-1.41	-1.56	-3.42	-4.76
	(-1.54)	(-2.00)**	(-1.25)	(-1.47)	(-1.24)	(-1.20)	(-1.60)	(-2.07)**
Q*Precrisis	-0.88	-0.48	-0.34	-0.31	-1.28	-0.39	-0.47	-1.14
	(-1.44)	(-0.68)	(-0.41)	(-0.38)	(-1.40)	(-0.36)	(-0.46)	(-0.66)
Q*Crisis	-1.54	-2.99	-0.06	1.35	2.79	-2.98	-3.90	-4.38
	(-0.72)	(-1.21)	(-0.02)	(0.41)	(0.94)	(-0.63)	(-0.82)	(-0.73)
A-rated	2.61	4.01	6.19	3.91	4.84	1.94	-2.48	4.25
	(1.17)	(1.74)*	(2.93)***	(1.61)	(2.22)**	(0.46)	(-0.40)	(0.77)
BBB-rated	8.77	9.26	10.11	9.82	12.90	9.23	9.18	9.51
	(3.27)***	(3.04)***	(3.85)***	(2.88)***	(4.23)***	(2.14)**	(1.41)	(1.42)
Log Issue Size	-0.62	-0.48	-1.82	-2.17	-0.77	0.92	4.85	-0.68
	(-0.51)	(-0.35)	(-1.16)	(-1.29)	(-0.49)	(0.38)	(1.62)	(-0.18)
VIX	1.65	1.72	1.49	1.63	1.31	0.80	0.71	0.76
	(7.54)***	(8.06)***	(6.13)***	(6.35)***	(4.77)***	(2.89)***	(1.68)*	(1.37)
TED Spread	0.08	0.06	0.09	0.06	0.07	0.04	0.10	0.28
	(1.40)	(0.85)	(0.99)	(0.62)	(0.85)	(0.40)	(0.78)	(1.37)
Term Spread	-0.01	-0.02	-0.02	-0.02	-0.01	-0.00	-0.04	-0.04
	(-1.93)*	(-2.78)***	(-1.62)	(-1.48)	(-1.48)	(-0.28)	(-2.33)**	(-1.71)*
Number of Observations	2323	2275	2261	2243	2215	2120	2019	1987
Adjusted R-Square	0.1788	0.1654	0.1409	0.1215	0.1122	0.06585	0.03197	0.02878

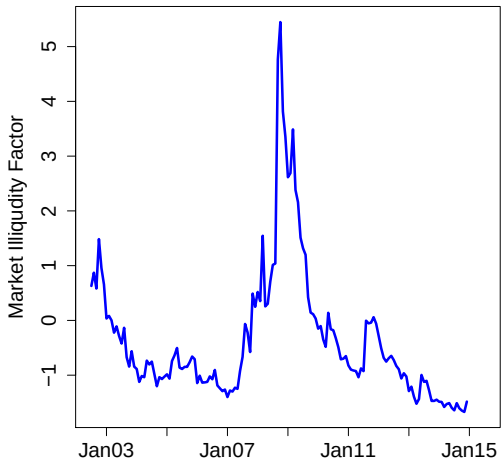
Table 10: Weighting by volume: maturity.

This table replicates Table 6, except that the returns are weighted (WLS) by aggregated buying volume for the specific cusip. We only consider the buying volume of dealers who were net supplier of immediacy in that bond.

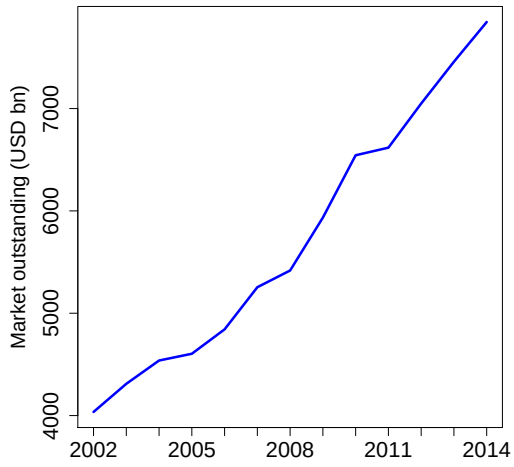
Event Window: (0,t]	1	2	3	4	5	10	20	30
Q*Postcrisis	33.09	50.07	81.72	119.89	130.46	85.62	138.32	123.87
	(1.68)*	(1.84)*	(2.39)**	(2.81)***	(2.93)***	(2.01)**	(2.20)**	(1.65)*
Q*Precrisis	6.87	17.67	9.35	9.61	12.48	23.81	9.68	12.58
	(0.94)	(1.85)*	(0.82)	(0.75)	(0.85)	(0.87)	(0.36)	(0.37)
Q*Crisis	14.48	68.78	101.06	106.11	122.72	223.65	235.97	490.29
	(0.46)	(1.63)	(1.44)	(1.61)	(1.78)*	(2.27)**	(2.19)**	(2.41)**
B-rated	73.99	15.45	62.03	75.40	92.48	135.38	126.58	91.28
	(1.17)	(0.31)	(0.64)	(0.77)	(0.99)	(1.01)	(0.86)	(0.41)
C-rated	504.31	636.37	856.18	827.26	1009.0	93.81	-437.6	807.56
	(2.35)**	(2.61)***	(1.68)*	(1.75)*	(1.95)*	(0.16)	(-0.40)	(0.52)
Log Issue Size	-24.04	-47.42	-17.64	-29.96	-28.14	27.01	45.42	116.47
	(-0.82)	(-1.57)	(-0.39)	(-0.57)	(-0.50)	(0.28)	(0.78)	(1.09)
VIX	4.16	2.44	1.46	0.57	1.21	8.02	13.01	28.76
	(1.09)	(0.56)	(0.25)	(0.09)	(0.18)	(1.11)	(1.35)	(1.76)*
TED Spread	0.94	1.07	1.80	1.33	1.80	2.79	0.01	-2.80
	(1.60)	(1.83)*	(1.70)*	(1.22)	(1.34)	(1.63)	(0.00)	(-0.70)
Term Spread	0.01	0.01	0.04	-0.09	-0.09	0.25	-0.31	-0.90
	(0.09)	(0.05)	(0.15)	(-0.28)	(-0.28)	(0.69)	(-0.54)	(-1.06)
Number of Observations	689	686	667	651	648	637	599	584
Adjusted R-Square	0.2274	0.2868	0.2210	0.1855	0.2350	0.1458	0.1039	0.2006



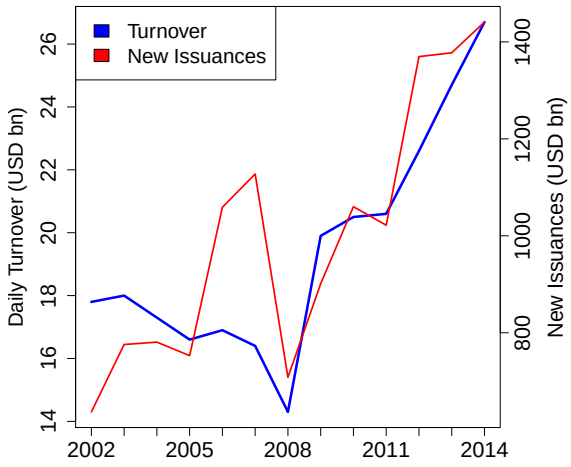
(a) Primary dealer inventory



(b) Market Illiquidity Factor



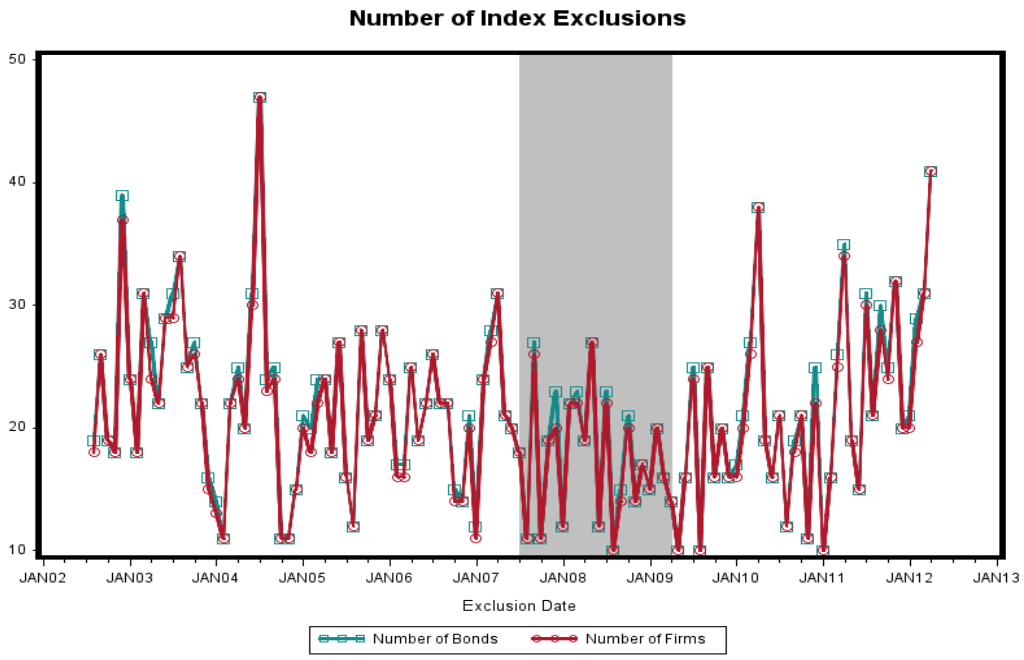
(c) Market Size



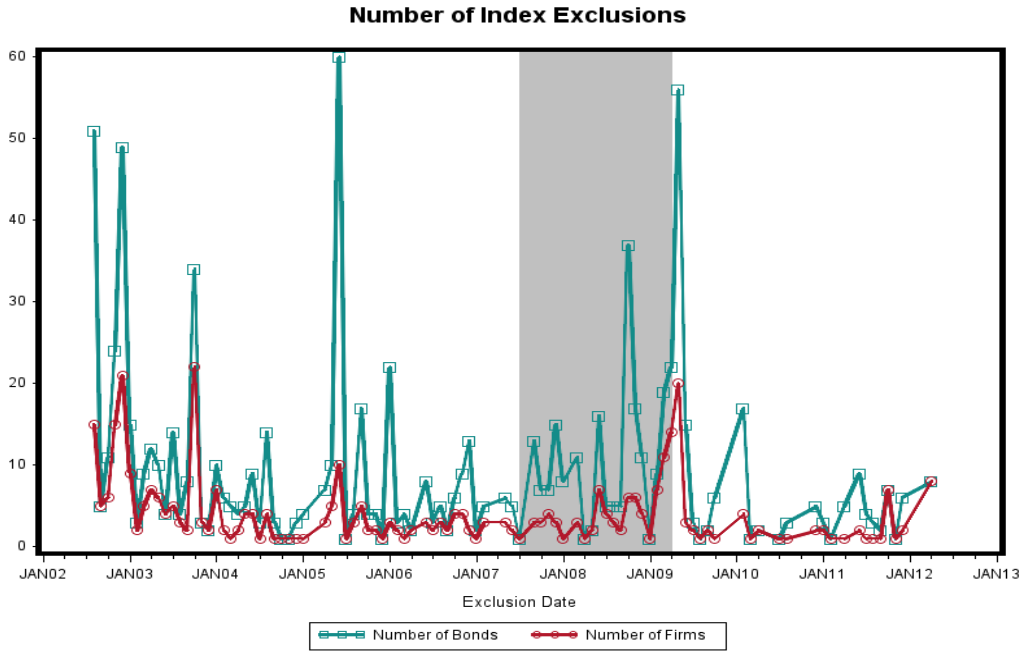
(d) Market Turnover

Figure 1: Corporate bond market statistics

Panel A shows the primary dealer inventories in corporate securities (investment grade above 1 year in maturity) and in corporate bonds. The first series can be retrieved from the New York Fed statistics on primary dealer holdings. The second graph can be retrieved from the same place after March 2003. The numbers prior to that date are backfiling by Goldman Sachs using yearly SEC-filings from the primary dealers. Panel C shows total nominal corporate bond market size. Panel D shows total market trading volume and the number of total size of new issuances. Data for panel C and D are retrieved from SIFMA.



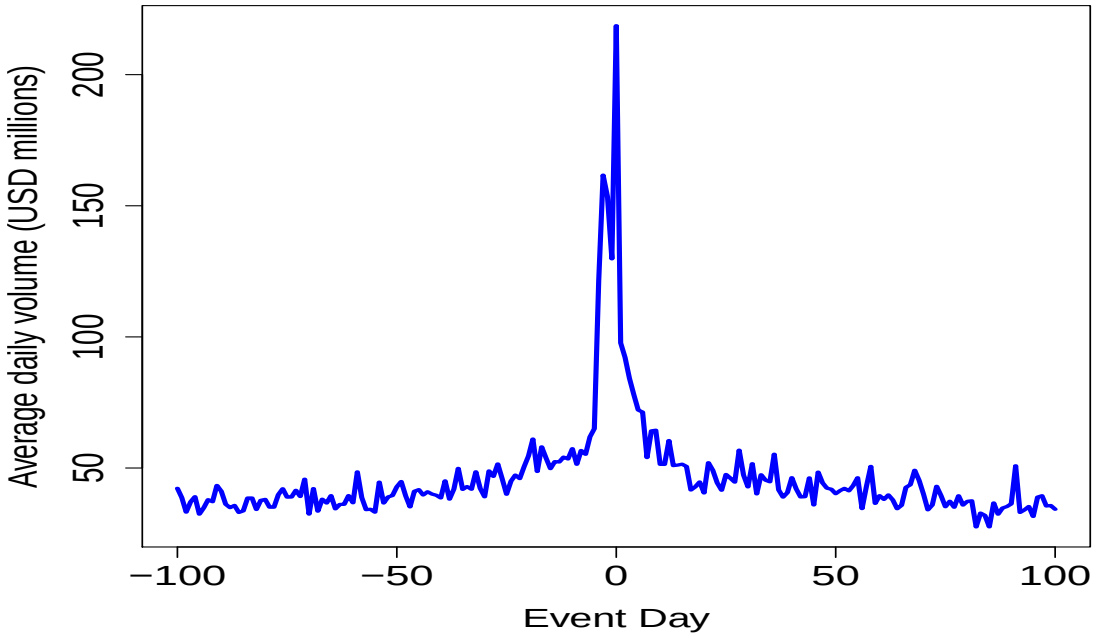
(a) Maturity < 1 Year



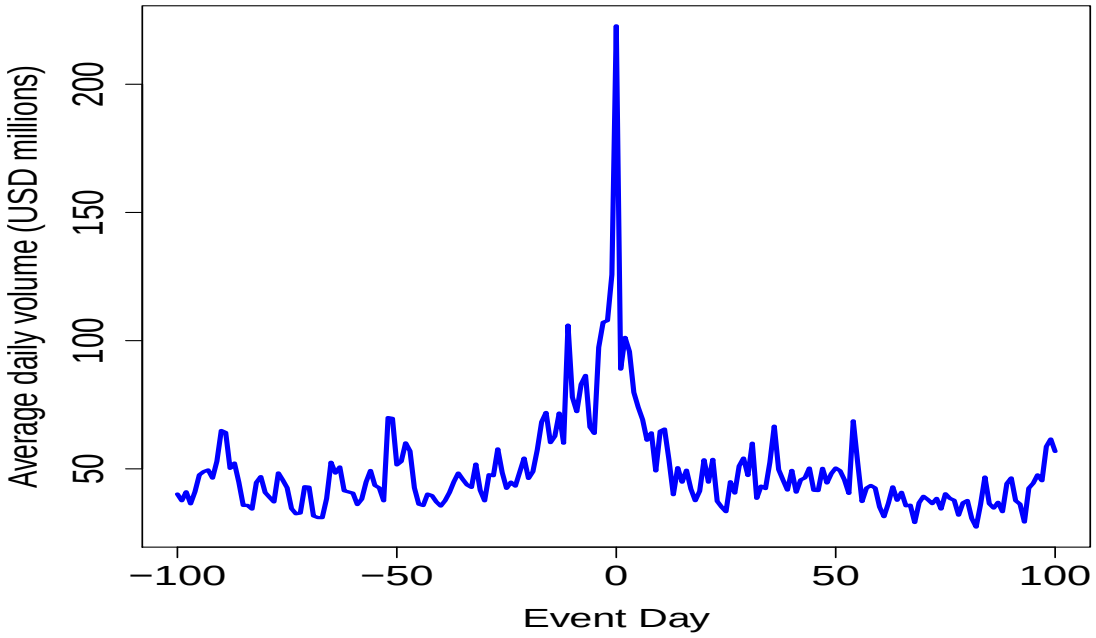
(b) Rating Less Then Investment Grade

Figure 2: Index Exclusions Over time

This figure plots the number of bond (square) and firm (circle) exclusions from the Barclay's Investment Grade Index. The top panel presents the exclusions due to maturity; the bottom panel presents the exclusions due to rating deterioration. The shaded area represents the sub-prime crisis.



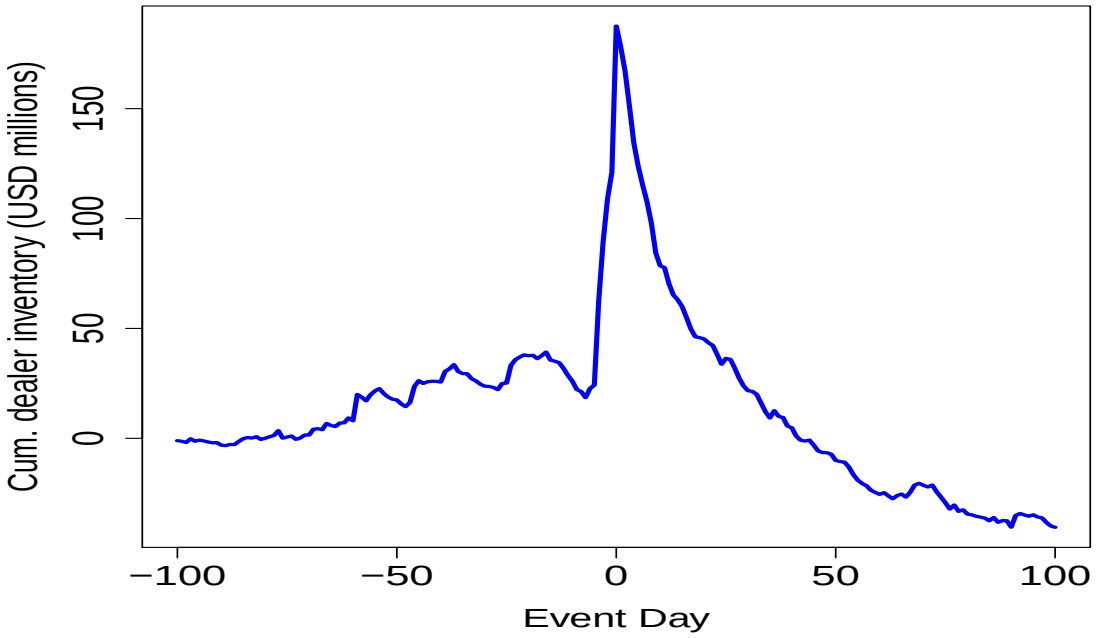
(a) Maturity < 1 Year



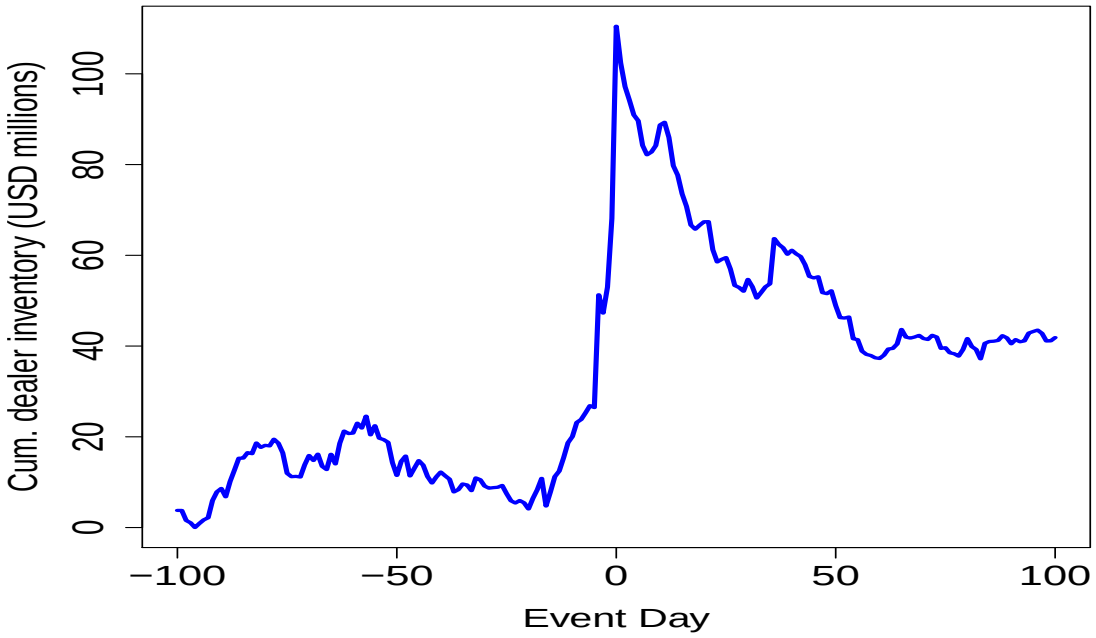
(b) Rating Less Then Investment Grade

Figure 3: Trading activity around the event.

This graphs show the average trading volume around the monthly exclusions. Panel A shows the trading volume for the bonds excluded because of low maturity. Panel B is for the bonds excluded because of a downgrade to speculative grade. Trading volume is aggregated across all the bonds excluded at a given event date and then averaged across all event dates.

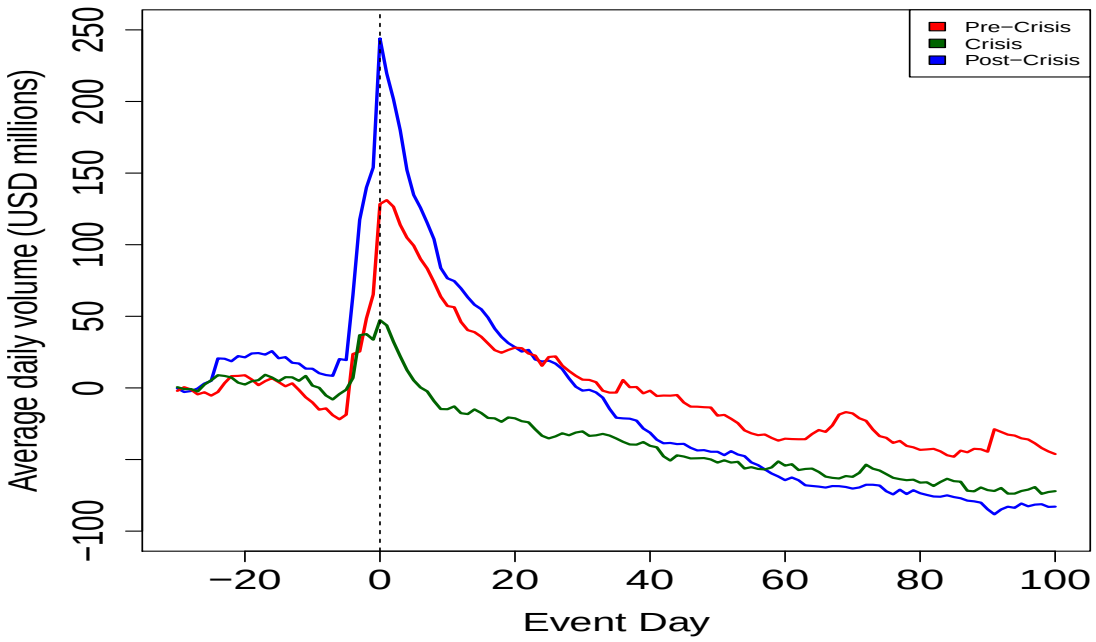


(a) Maturity < 1 Year

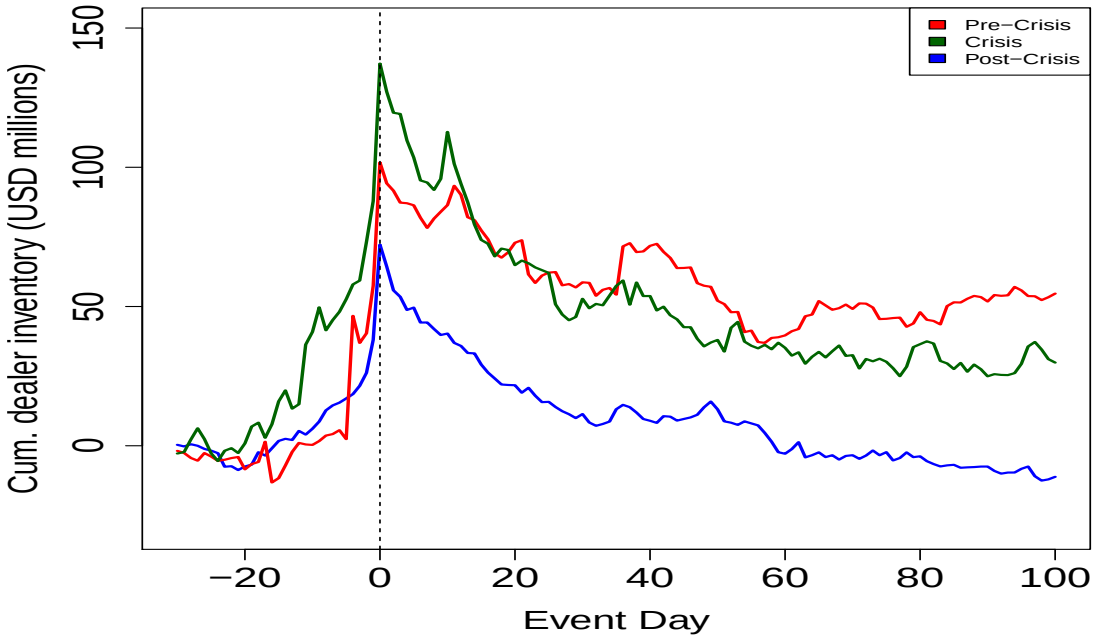


(b) Rating Less Then Investment Grade

Figure 4: Cumulative dealer inventory around the event date.
This graphs show the average cumulative dealer inventory around the monthly exclusions. Panel A shows the inventory for the bonds excluded because of low maturity. Panel B is for the bonds excluded because of a downgrade to speculative grade. Cumulative inventory is found by subtracting dealer sells from dealer buys and cumulating the imbalance over time. The dealer inventory is relative to the arbitrarily chosen starting point at event day -100. Inventory is aggregated across all the bonds excluded at a given date and then averaged across all the event dates.



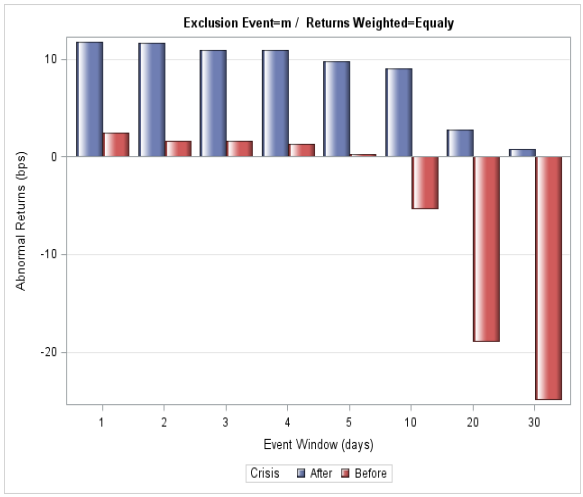
(a) Maturity < 1 Year



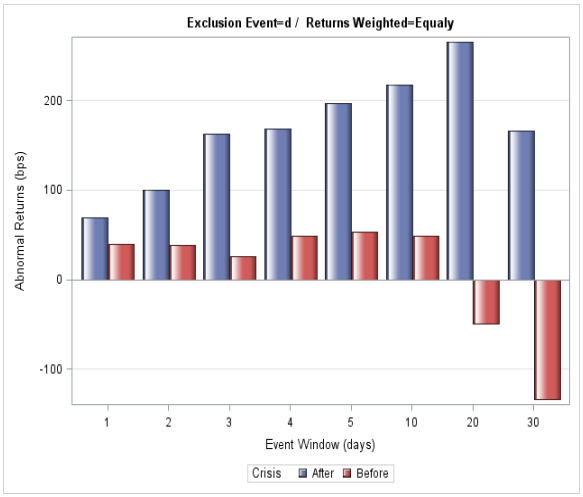
(b) Rating Less Then Investment Grade

Figure 5: Cumulative dealer inventory around the event date for sub-periods.

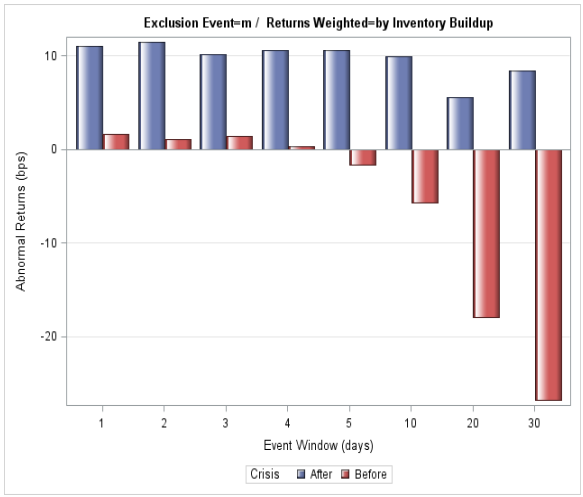
This graphs shows the cumulative dealer inventories for three periods. Pre-crisis: 2002Q2 to 2007Q2, Crisis: 2007Q3 to 2009Q1, and Post-crisis: 2009Q2 to 2013Q4. The cumulative inventory and the two panels are calculated as in Figure 4, except that the referencing point is now event day -30.



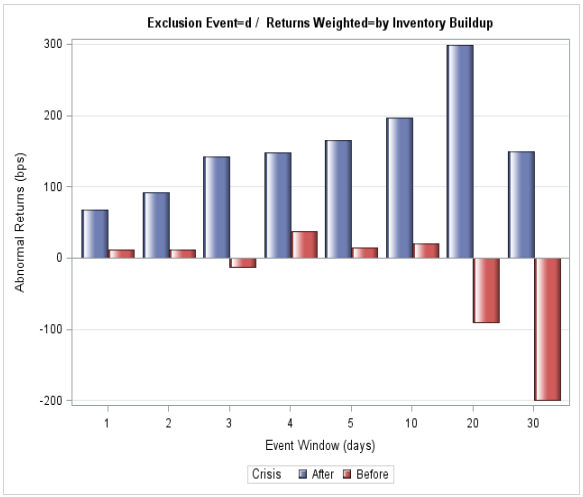
(a) Maturity (EW)



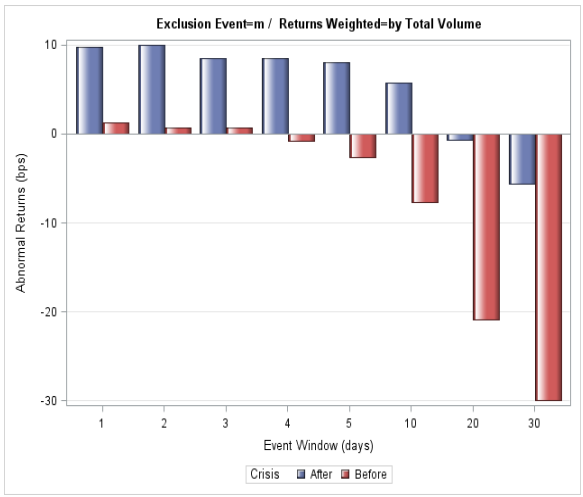
(b) Downgrade (EW)



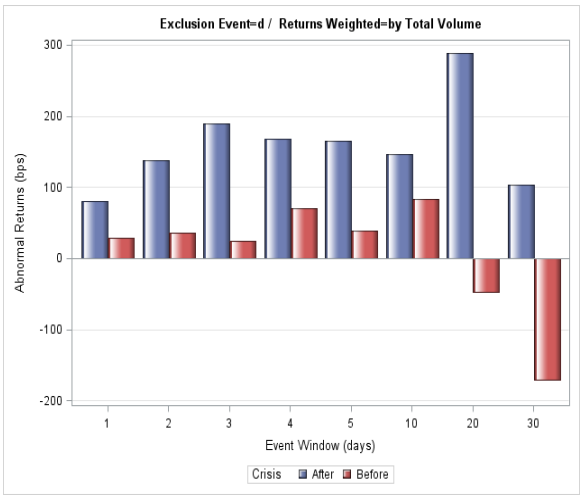
(c) Maturity (VW1)



(d) Downgrade (VW1)



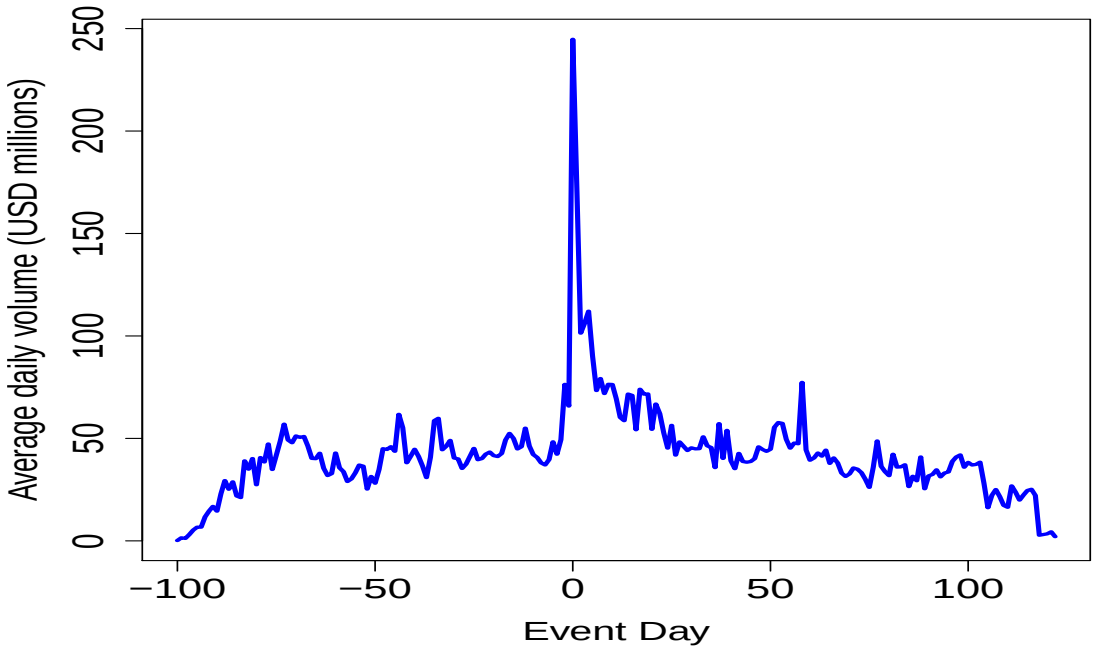
(e) Maturity (VW2)



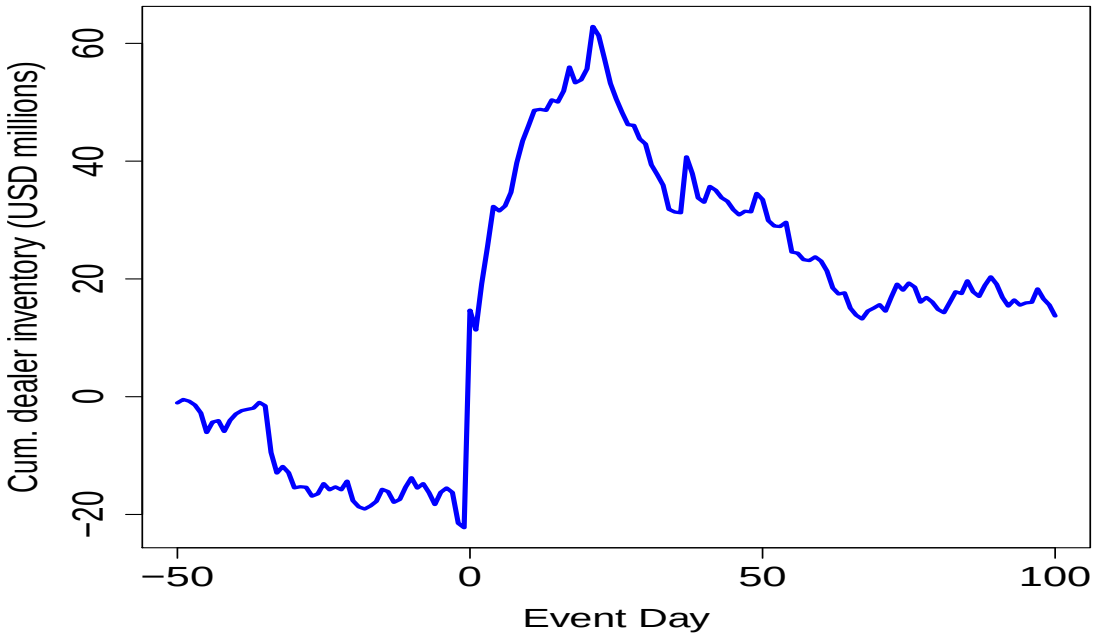
(f) Downgrade (VW2)

Figure 6: Cost of immediacy before and after the credit crisis

The figure provides a graphical representation of the estimates from the last three columns (abnormal returns) in Table 2 (left graphs) and Table 3 (right graphs).

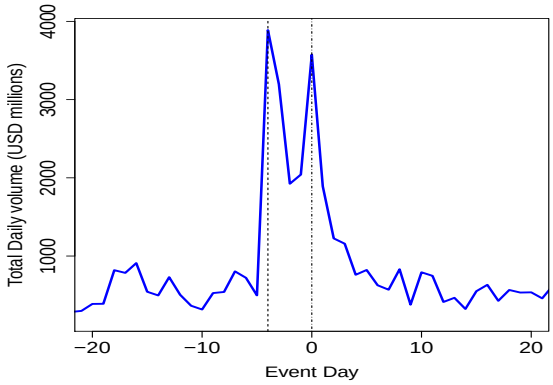


(a) Volume at downgrade date

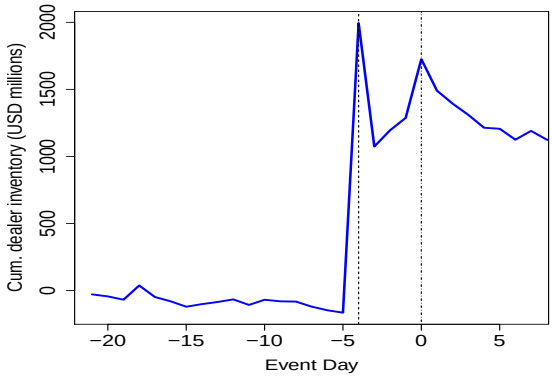


(b) Cumulative inventory at downgrade date

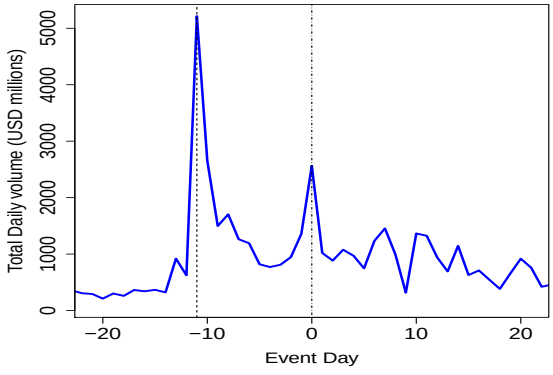
Figure 7: Trading activity and inventory around the downgrade date.
This graphs show the average trading volume around and cumulative dealer inventory around the downgrade date. The downgrade date is the date at which the bond changes index rating from investment grade to speculative grade. Trading volume is aggregated across all the downgraded bonds. The cumulative inventory is calculated as in Figure 4, except that the referencing point is now event day -30 and event time is now relative to the downgrade date.



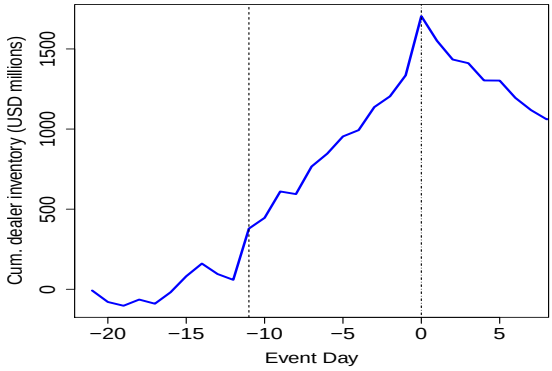
(a) Volume: 4 days lag



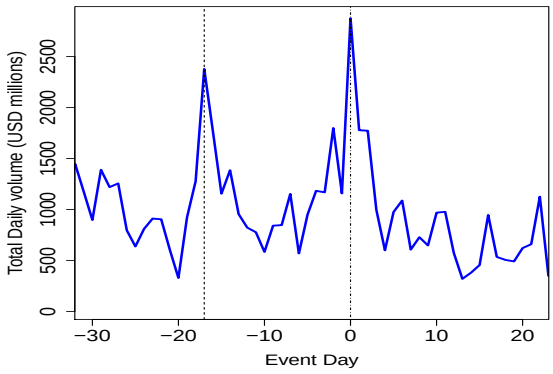
(b) Inventory: 4 days lag



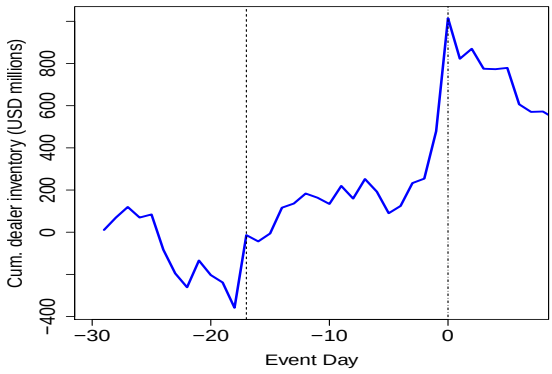
(c) Volume: 11 days lag



(d) Inventory: 11 days lag



(e) Volume: 17 days lag



(f) Inventory: 17 days lag

Figure 8: Trading activity and inventory for specific downgrade constellations

The graphs show trading activity (calculated as in Figure 3) and cumulative inventory (calculated as in Figure 4). Event time in these graphs are relative to the index exclusion date (the right vertical line). The left vertical line is the downgrade date. In each pair of graphs the time lag between downgrade date and index exclusion is kept constant at either 4, 11, or 17 days. Volume and inventory are not averaged as in the former graphs. Furthermore, these time lags have been chosen because they are the ones with the highest aggregated trading activity at the downgrade date (among all time lags).