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The 2011 European Short Sale Ban on Financial Stocks: A Cure or a Curse?*

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Abstract

Did the August 2011 European short sale bans on financial stocks accomplish their goals? In order to answer this question, we use stock options' implied volatility skews to proxy for investors' risk aversion. We find that on ban announcement day, risk aversion levels rose for all stocks but more so for the banned financial stocks. The banned stocks' volatility skews remained elevated during the ban but dropped for the other unbanned stocks. We show that it is the imposition of the ban itself that led to the increase in risk aversion rather than other causes such as information flow, options trading volumes, or stock specific factors. Substitution effects were minimal, as banned stocks' put trading volumes and put-call ratios declined during the ban. We argue that although the ban succeeded in curbing further selling pressure on financial stocks by redirecting trading activity towards index options, this result came at the cost of increased risk aversion and some degree of market failure.

Keywords: Short-selling, ban, financial stocks, implied volatility skew, risk aversion
JEL Classification Codes: G01, G28

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1. Introduction

During the height of the financial market crisis of 2008, short sale bans were introduced in the US, Europe and several other countries. The ban on covered short sales of financial stocks was kept in place in the US for less than a month, ending on October 8, 2008. Similar bans on covered short sales were maintained for much longer periods in other countries. For instance, Australia, Ireland, Norway, the Netherlands, and South Korea kept their bans in place until the second quarter of 2009. Beyond that, the 2008 short sale bans resulted in broad and permanent prohibitions of naked short-selling, i.e., short-selling without first borrowing the security. The ban on naked short sales became permanent in the US on September 17, 2008 (SEC order 34-58572).

On August 11, 2011, the Euro currency members Belgium, France, Italy, and Spain once again imposed short sale bans. The European Securities and Markets Authority (ESMA) stated on August 11, 2011, that the reason for the short sale ban was to curb market abuse and the spread of false rumors [1]. Of course, the spread of false rumors is dangerous because it provokes indiscriminate selling of assets. When selling decisions are no longer rational, herd behavior and one-sided market activity may generate fire sales and an increased risk of contagion, thereby endangering financial stability, which ultimately is the main condition that regulators want to protect.

Recent academic studies provide evidence that short-selling bans, at best, do not impact stock price levels and, at worst, contribute to their decline. Boehmer et al. (2013) conclude that it is unclear whether the 2008 SEC's imposition of short-selling bans achieved the goal of providing a floor for US equity markets. Beber and Pagano (2013) investigate the impact of the 2008 bans on stock markets in 30 different countries and find that stocks that were banned underperform stocks not included in the bans. However, it proves to be non-trivial to assess the true impact of the 2008 short-selling ban because it was introduced at the same time as the announcement of the TARP (Troubled Asset Relief Program) and other US governmental programs to support the financial sector.

Given the difficulty of assessing to what extent market declines are driven by news flow rather than short-selling bans, several studies have focused on the impact of bans on market quality rather than on the level of stock prices. Boehmer et al. (2013) find for large caps during the 2008 ban much poorer conditions for price impact, realized bid-ask spreads, and intra-day volatility. They argue that one reason why liquidity dried up during this period was that high-frequency traders were not exempt from the ban.

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[1] ESMA's statement on August 11, 2011,was: "*European financial markets have been very volatile over recent weeks. The developments have raised concerns for securities markets regulators across the European Union. [....] While short-selling can be a valid trading strategy, when used in combination with spreading false market rumors this is clearly abusive. [...] Today some authorities have decided to impose or extend existing short-selling bans in their respective countries. They have done so either to restrict the benefits that can be achieved from spreading false rumors or to achieve a regulatory level playing field, given the close inter-linkage between some EU markets.*"

Many high-frequency traders act as market makers, but only informally, and thus were not exempt from the ban as formal market makers were. Beber and Pagano (2013) note that the ban on naked short sales led to an increase in bid-ask spreads due to market participants' inability to sell short, making inventory management more difficult for market makers.

Investors may be able to obtain economic short exposure to banned stocks with the means of a derivatives-based strategy that replicates the payoff of a stock's short sale. Hence, selling pressure on these instruments may even increase when a ban is imposed. Such a "substitution effect", characterized by a migration of trading volume from one instrument to another, is supported by numerous academic studies examining the relocation of trading activity from the equity-cash market to derivatives markets in contexts other than that of a short-selling ban. For instance, Figlewski and Webb (1993) show that the introduction of options creates a channel for investors who are prohibited from short-selling to indirectly build short exposure to securities. In particular, such investors may buy puts and write calls as a substitute for selling a stock short. Danielsen and Sorescu (2001) propose that stock prices are expected to decrease when options are introduced, as investors prohibited from short sales implement their bearish views through options. Blau and Wade (2013) show that when short-sale constraints become more binding, informed traders migrate from the stock market to the options market. In the case of a short sale ban, such substitution effects would in some degree undermine the effectiveness of the ban, as selling pressure on a banned security is not reduced but merely diverted to other instruments such as options.

However, as Battalio and Schultz (2011) show, during the 2008 US ban bid-ask spreads in options markets also increased substantially. The authors argue that bid-ask spreads increased significantly more for options on banned stocks than for options on other stocks, causing a considerable increase in the number of put-call parity violations. Bid-ask spreads widen because market makers, formerly hedged, now try to protect themselves by keeping their inventories unchanged. Changes in inventories and eventual active positions are undesirable when the cash market is inaccessible because hedging becomes more difficult.

Contrary to the hypothesized substitution effect, Battalio and Schultz (2011) find no evidence that potential short sellers of financial stocks migrate to options markets during bans. The authors report that the ratio of the volume of options-to-stocks is comparable for banned and unbanned stocks throughout the pre-ban and ban period. In the same vein, Grundy et al. (2012) suggest that short-selling at the start of the 2008 US ban was not replaced by bearish put option strategies. They argue that substitution does not occur because bid-ask spreads increased significantly, especially for derivatives on banned stocks. The wider spreads prohibited investors from trading puts, causing trading volume on these instruments to decrease considerably. Grundy et al. (2012) speculate that the reason for the light volumes is the higher trading cost. They conclude that, despite the fact that the ban is imposed only on short-selling of individual stocks,

it is also effective in curbing synthetic shorting activity, as the number of parties willing to write puts decreases.

Our paper's approach to analyzing the impact of the 2011 European short-selling ban of financial stocks differs from the analyses in the existing literature. We use the implied volatility skew, computed as the difference between the implied volatilities of out-of-the-money (OTM) and at-the-money (ATM) puts on individual shares, to assess how the ban affects risk aversion levels. The rationale for this approach is based on Bates (1991), Rubinstein (1994), and Jackwerth and Rubinstein (1996), who argue that the implied distribution of equity market expected returns from index options has changed considerably since the 1987 market crash. Their findings demonstrate that since the crash, probabilities implied by options prices show a large shift in market participants' beliefs. Before the crash, the probability of large negative stock returns was fairly close to that suggested by the normal distribution. In contrast, just prior to the 1987 crash, the probability of large negative returns implied by options prices rose considerably. The left tail of the implied return distribution became considerably fatter and thus negatively skewed with increased kurtosis. The fatness of the left tail was caused by OTM puts becoming more expensive than suggested by the standard option pricing model based on normally distributed returns. Investors often use OTM puts to hedge tail risks in equity portfolios. The high price of OTM puts since the 1987 crash is thus attributed to a higher demand for portfolio insurance. An increased demand for hedging against tail risk events suggests a change in attitude towards risk, with investors forgoing upside on equity markets by buying put options to hedge against the risk of negative returns, i.e., investors have become more risk averse.

The implied volatility skew is an appealing measure of risk aversion because it captures the cost of OTM options relative to that of ATM options. OTM puts, by embedding more leverage, have greater downside hedging capacity than ATM puts. Consequently, the implied volatility skew, hereafter volatility skew, measures the willingness of investors to pay for additional leverage to hedge their downside risk. Hence, the size of the volatility skew is a good indicator of risk aversion. Bakshi et al. (2003) argue that a higher volatility skew represents a higher level of risk aversion, especially when measured in the index options markets. The index options market exhibits this property because portfolio insurance is typically implemented through this market. Volatility skews of single stock options are also informative about risk aversion levels because these skews are linked to those from index options through correlation arbitrage. Such an arbitrage strategy, also called dispersion trading, occurs when implied volatilities of index and individual options diverge considerably. Branger and Schlag (2004) and Fengler et al. (2012) show that correlation arbitrage forces implied volatilities in these two markets to converge. Hence, we consider the bottom-up volatility skew, and thus skew measured for single stock options, to be a conservative measure of risk aversion with the consequence that our conclusions are likely to be conservative as well.

Our paper is the first to elucidate how investors, through their attitudes towards risk, differentiated between banned and unbanned stocks upon the introduction of the 2011 European short-selling ban. We employ a dataset on daily OTM and ATM implied volatilities of puts for all optionable European stocks listed in Belgium, France, Italy, and Spain. These data allow us to analyze the volatility skew cross-sectionally and thus compare the effects on banned and unbanned stocks. We also gain insight into risk aversion at the overall market level from a bottom-up perspective. By using data on put option trading volume, we assess the presence of "substitution effects" on banned stocks via the option market. We conjecture that if the ban has caused investors' risk aversion to deteriorate and did not prevent further selling pressure on banned stocks, it may have harmed, rather than protected stability in the financial sector. In such circumstance, the ban might have been a curse, rather than a cure.

The main contributions of our paper are threefold. First, we provide evidence that the ban increases investors' risk aversion levels, especially when considering financial stocks. This finding is important because, if indiscriminate selling of equities and financial stocks can be triggered by large shifts in risk aversion, the short-selling ban itself may contribute to financial contagion. Earlier literature on short-selling bans, such as Boehmer et al. (2013) and Beber and Pagano (2013), focus on the impact of a ban on stock market prices and market quality aspects. Their analysis, however, does not take into account potential reinforcing loops of a crisis, such as large shifts in risk aversion. According to Kumar and Persaud (2002), a shift in risk appetite constitutes a channel, beyond local or international economic factors, for transmission of financial contagion. In line with Allen and Gale (2000) and Bae et al. (2003) financial contagion occurs when a relatively small shock, which initially affects only one or few institutions, sectors or countries, propagates to the rest of the financial sector or economy or other countries.

Second, we confirm that no substitution effect occurred between regular short-selling and synthetic shorting through single stock puts during the 2011 European short-selling ban. This result for the 2011 European ban ties in with conclusions on the 2008 US ban reached by Battalio and Schultz (2011) and Grundy et al. (2012). They find that short-selling bans are effective in curbing further selling pressures on options on banned stocks. Therefore, even if net short positions in options are not explicitly prohibited by regulators, the ban by itself restricts these flows. A welcome consequence of such an automatic restriction on derivatives markets is that speculators are prevented from betting on further financial stock declines, which may avert potential destabilizing effects in the financial sector. On the other hand, holders of financial stocks interested in hedging their positions may suddenly be required to pay more for protection or be unable to hedge at all, implying market failure.

A third contribution of our paper is to recognize the explicit finding that, upon imposition of the ban, there was a migration towards the EuroStoxx 50 index option market. Investors appear to have

switched from single stock puts to index puts due to valuation and flight-to-liquidity incentives. Such indirect migration is a new finding, not previously documented in the literature on short-selling bans. We hypothesize that this type of migration does not jeopardize the efficacy of a short-selling ban, as it diversifies selling pressure initially concentrated in financial stocks across a larger share of the stock market. One positive consequence of this selling pressure diversification is a reduction in the likelihood of bank runs and financial contagion.

Thus, our finding that the ban restricts further selling pressure on financial shares, both in the spot and in the derivatives market, suggests that the current format of short sale bans does indeed protect financial stability. However, such a cure comes at a cost. The ban increases investors' risk aversion levels and thus causes some degree of market failure.

The remainder of this paper is organized as follows. Section 2 discusses the 2011 European short-selling ban on financial stocks. Section 3 describes the data and methodology employed in this study. Section 4 presents our empirical findings. Section 5 concludes.

2. The 2011 European Short-Selling Ban

The 2011 short-selling ban on financial stocks in the Euro member countries Belgium, France, Italy, and Spain was established by a coordinated act of the European Securities and Market Authority (ESMA) and the national financial market regulators of these countries on August 11, 2011. The announcement was made via a public statement issued by the ESMA (reference ESMA/2011/266) and was followed by publications the same day by the Belgian Financial Services and Markets Authority (FSMA), the French Autorité Des Marchés Financiers (AMF), the Italian Commissione Nazionale per le Societá e la Borsa (Consob), and the Spanish Comision Nacional Del Mercado de Valores (CNMV). Table 1 provides an overview of the banned financial stocks. The ban entered into effect on August 12, 2011 and specifically targeted covered short-selling.

< Please insert Table 1 about here >

Naked short-selling had already been prohibited in these European markets since 2008. The ban on covered short-selling not only prohibited the creation of new net short positions but also banned increases in existing ones, including intra-day operations. Positions arising from formal market making activities were exempted from the ban. The ban targeted not only public markets but also OTC markets. In terms of scope, the announcements differed. The FSMA announced that the ban applied to net economic short positions of any kind, while the AMF communicated that derivatives could only be used to hedge, create or extend net long positions. For the Consob, the ban covered only shares and not ETFs or any

derivatives, while the CNMV imposed the ban on all trades in equities or indices, including cash equities transactions and derivatives markets.

During the ban, holders of financial stocks could still use single stock derivatives or simply sell their holdings to hedge their portfolios. Investors exposed to stocks were allowed to hedge their overall equity market exposure by trading index or single stock derivatives. What was prohibited was the short-selling of banned stocks, not hedging them or reducing equity market risk. The creation or extension of marginal net short positions in banned securities as a result of hedging equity market risk was still allowed by the ban. New flows into funds following a policy of being short in an equity index did not constitute a violation of the ban, according to the Spanish CNMV. In such a case, responsibility for compliance with the ban would lie with the fund investor, who, as the end-user, should not create or increase a net short position on banned stocks. The ban did not prohibit any specific product or activity nor did it prohibit offerings by market makers to clients of any specific product. Thus, investors and not intermediaries were the ones banned from creating or increasing net short positions.

In contrast, the Belgian FSMA allocated some of the responsibility for enforcement of the ban to market makers. In particular, the FSMA specified that qualified intermediaries were obliged to take reasonable measures to ascertain that their clients did not breach the ban by engaging in prohibited transactions. The August 11, 2011 European short-selling ban was initially intended to be in place for the next 15 days only, with the exception of Belgium, which announced that the ban would remain in effect indefinitely. Nevertheless, the ban was extended by the Spanish CNMV, the French AMF, and the Italian Consob several times. On February 13, 2012, both the FSMA and AMF announced the lifting of the ban with immediate effect in Belgium and with retroactive effect, on February 11, 2012, in France. On February 15, 2012, the CNMV announced the lifting of the Spanish ban from February 16 onwards. Finally, on February 24, 2012, the Italian ban expired. New short-selling bans were re-imposed by Spain and Italy later in 2012.

3. Data and Methodology

We use the daily implied volatility skews of individual European equities as our measure of investor's risk aversion. The implied volatility skew is calculated as the difference between the implied volatility of three-month OTM listed puts at the 80 percent moneyness level and ATM puts with the same maturity for every stock in our sample. We obtain implied volatilities from Bloomberg, using 16:00 hours closing mid-prices (Bloomberg, 2008) by reverse engineering the Black-Scholes model[2].

[2] Bloomberg implied volatilities are calculated assuming that interest rates are constant and that dividends are discrete. Interpolation within the implied volatility term structure and smile is used to calculate the implied volatility at a fixed level of moneyness and at a fixed time to maturity.

Our sample covers the period from February 15, 2008 to March 27, 2012 and includes 1,073 trading days. It consists of all stocks that had listed options as of February 2012 on the Belgian (Brussels Stock Exchange/Euronext Brussels), French (Paris Bourse or Euronext Paris), Italian (Milan Stock Exchange or Borsa Italiana), and Spanish (Bolsa de Madrid) stock exchanges. Overall our sample comprises 185 stocks, of which 105 are included in these stock exchanges' main indices, i.e., the Belgian BEL20, the French CAC40, the Italian MID, and the Spanish IBEX35.

Daily short stock positions (utilization rates) and costs of short-selling (simple average fee, simple average rebate, and cost of borrow score) were kindly provided by Markit Securities Finance, former Data Explorers[3]. The short utilization rate is calculated as follows:

$$Utilization = 100 * \left(\frac{ValueOnLoan}{InventoryValue} \right),$$

where *ValueOnLoan* is the beneficial owner value of the loan and *InventoryValue* is the beneficial owner inventory value. *Utilization* measures the value of a stock utilized for securities lending against the total value of inventory available for lending so that it indicates the short-selling demand, which ranges from zero to 100 percent.

From Bloomberg we source daily trading volumes and numbers of shares outstanding per stock, trading volumes for listed puts and calls, and put-call volume ratios for listed options. Prices are collected for every stock going back to February 14, 2007, one year before the start of the regular sample period. Trading volumes for listed puts on the EuroStoxx50 index, the V2X index (implied volatility index from EuroStoxx 50 index), and generic series of five-year sovereign credit default swaps (CDS) for Belgium, France, Italy, and Spain are also downloaded from Bloomberg.

We construct two indices of implied volatility skew by equally averaging the stock specific volatility skew of the constituents of each index. The banned index's constituents are the stocks that were prohibited from short sales in 2011. Our unbanned index's constituents are the remaining stocks in our sample. Next, we construct a daily excess volatility skew measure by subtracting the unbanned index from the banned index. We call this new index the B-U index or, simply, the excess skew. We also calculate single country versions of the banned, unbanned, and B-U index for Belgium, France, Italy, and Spain, respectively

Table 2 presents descriptive statistics such as average, median, standard deviation, skew, kurtosis, and the Jarque-Bera normality test statistic for the volatility skew and excess skew indices. Statistics are calculated using the entire history. They are provided for the overall and single country levels and also for

[3] Data Explorers Limited (2011) mention that their database captures "stock loan trading information from over 100 participants and approximately 85 percent of the OTC securities lending market".

the daily differences of excess skew. Panel A shows that the average and median volatility skews for banned stocks are higher than for unbanned stocks, an observation that pertains not only to the overall numbers but also to each country individually. The standard deviation of the volatility skew is mostly higher for banned stocks. The distributions of the volatility skew are all positively skewed, a pattern that was expected, as skew tends to be bounded at zero. Most distributions of the volatility skew are leptokurtic. As a consequence of these characteristics, all volatility skew distributions reported here have fat right tails and are not normal, according to their Jarque-Bera statistics.

< Please insert Table 2 about here >

Panel B reports statistics, from the B-U index, for the excess skew. All average and median excess skews are positive, while all average and median daily differences in the excess skew, measured in volatility points, are close to zero. The highest median daily difference is 0.016 volatility points for Belgium, and the highest daily difference average is 0.004 volatility points for France. The distributions of the excess skew are except for France leptokurtic and most are positively skewed. All distributions of levels and differences of the excess skew are not normal, according to their Jarque-Bera statistics.

In order to make statistical inferences we apply a non-parametric Mann-Whitney U-test for medians, instead of a student's *t*-test for averages. We use a non-parametric test because the distributions of both the volatility skew and the excess skew are not normal. More specifically, we use the Mann-Whitney U-test to determine whether the median volatility skews or the median excess skews from different periods differ statistically from one another. The null hypothesis is that there is no difference between measures from two distinct periods[4].

4. Discussion of Results

Figure 1 shows that the imposition of the 2011 European ban strongly affects the short-selling of stocks in Belgium, France, Italy, and Spain. Short-selling levels, measured by utilization rates, fall for banned stocks from 32 percent to 27 percent in the months of August and September 2011, especially after the ban announcement on August 11, 2011. This drop in short-selling utilization is widespread across the four countries. For Belgium and Italy, short-selling utilization drops from 29 percent to 23 percent and 24 percent, respectively. For France, it remains unchanged at approximately ten percent during this period. Finally, for Spain it drops by 8 percent from 53 percent on ban announcement day to 45 percent per

[4] Following Mann and Whitney (1947), we use the normal approximation of the U statistic, given the large number of observations available for the estimation of medians. Via this approximation, we transform the U-values into Z-values and compare the obtained statistics with Z-critical values at the one, five, and ten percent levels of significance.

September 30, 2011. We find that such drops in the utilization rate come from the decrease in value of short-selling, the numerator of the utilization rate, as inventories of stocks available for lending in the four countries remain relatively unchanged. The decreasing utilization rates indicate that the ban was effective in reducing short-selling, despite the fact that market makers were still allowed to short banned stocks.

< Please insert Figure 1 about here >

The reduction in short-selling of financial stocks is especially noteworthy when utilization rates for banned and unbanned stocks are compared. Figure 1 shows that the utilization rate for unbanned stocks increases on average over all four countries from 16 percent to 18 percent during the months of August and September 2011, an increase observed across all four Euro countries. In Belgium and France utilization rises from 12 percent to 14 percent, in Italy from 18 percent to 20 percent, and in Spain from 26 percent to 28 percent

During the months of August and September 2011, we observe that short-selling in banned financial stocks far exceeds the level measured in unbanned stocks. In August, average short-selling utilization for financial stocks is twice the level reported for stocks of other sectors (32 percent versus 16 percent, see Figure 1). This difference indicates that by August 2011, short-sellers were betting on further deterioration of financial stocks more heavily than on a potential weakness of the average stock. This dichotomy suggests that in August 2011, the short-selling activity was concentrated in financial stocks, which could have posed a threat to financial stability.

Our data on short-selling positions confirm that financial stocks were under attack in 2011. For Belgium, the utilization rate for banned stocks was 29 percent, compared to 14 percent for unbanned stocks, whereas for France short interest in banned stocks was less pronounced. For Italy, the measure for financial stocks (29 percent) was closer to that for all stocks (20 percent) and that for unbanned stocks (20 percent). Finally, investors' short interest in optionable Spanish financial stocks was on average much higher (53 percent) than for all stocks (20 percent) or optionable unbanned stocks (26 percent) on ban announcement day. Additionally, around the time of the ban announcement, utilization rates for the overall market were at their highest levels since 2010 for the four countries. Interestingly, for Italy and Spain, short selling activity was concentrated in mid-caps. This is observed especially when the overall supply of loans is compared to that of large cap stocks, as the supply is larger for large caps. This confirms a large short-selling interest in Italian and Spanish banks, as most of these institutions are mid-caps.

Nevertheless, the decrease in the utilization rate for banned stocks after the ban announcement occurred in tandem with a rising utilization rate for optionable unbanned stocks in the four countries analyzed and historically high utilization rates. This finding adds to the evidence that the decrease in

short-selling of banned stocks occurred in an environment of high demand for short-selling broadly. Such a result implies that the ban was effective in reducing short-selling of financial stocks.

4.1 Volatility Skews

Figure 2 depicts the historical behavior of our proxy for risk aversion, the average volatility skew, for banned and unbanned stocks. The ban period is highlighted, with the beginning of the shadowed part representing the ban announcement day. Risk aversion jumps just prior to announcement of the ban in Belgium, France, Italy, and Spain for both banned and unbanned stocks. Such spikes in risk aversion occur during the day of August 11, 2011, whereas the ban was officially announced only after the market close. The increase in the average volatility skew on August 11, 2011, for banned stocks is equivalent to 2.16 volatility points, while for unbanned stocks it is equivalent to 1.05 volatility points. Both differences exceed the 99th percentile of all daily volatility skew changes in our sample.

On August 12, 2011, the average skew continued to rise sharply, by 0.78 volatility points for banned stocks, a movement exceeding the 94th percentile of all daily skew changes in our sample. On that same day, the volatility skew for unbanned stocks rose by 0.55 volatility points, exceeding the 96th percentile. We observe that jumps in the volatility skews around ban announcement day are clearly outliers in our sample. More importantly, the rise in the volatility skew for banned stocks is much more pronounced than for unbanned stocks. The daily difference in the B-U index on August 11, 2011, is 1.11, exceeding the 97th percentile, and 0.23 on August 12, 2011, exceeding the 73rd percentile.

< Please insert Figure 2 about here >

It is unclear whether any information on the upcoming short-selling ban leaked before the market closed on August 11. However, given that a ban on covered short-selling on all stocks was already introduced in Greece on August 8, 2011, the extension of the ban to other European countries might have been expected by some market participants. Such expectations and potential information leakage together may have been responsible for the strong jump in risk aversion on August 11, 2011.

We have observed in Table 1 that between 2008 and 2012, spikes in average volatility skews well above their mean coincide with periods of market turmoil. Figure 2 shows that the first hump in volatility skews in 2008 starts around the Lehman collapse and wanes after the market trough of March 2009. In 2010, volatility skews jump on April 27, the day that Greek government bonds were downgraded by Standard and Poor's to "junk" status (first member of EMU to have this status). The volatility skew then strongly reverses on October 18, 2010, when a task force of European leaders agreed on a package to improve the European Union's economic governance in order to tackle the financial crisis. The 2011 jump

in volatility skews in Figure 2 coincides with the short-selling ban announcement day on August 11, 2011. The ban announcement was not accompanied by any major event related to the European financial crisis, to equity markets in general or to the financial sector. We observe that on all three occasions, i.e., the Lehman collapse, the downgrade to non-investment of Greek sovereign bonds, and the short-selling ban announcement, the skew of financial stocks exceeded the skew for unbanned stocks. This comes as no surprise, as these volatility skew humps corresponded with crises in which the financial sector was deeply involved.

Figure 2 also suggests that after the announcement of the short-selling ban, the volatility skew levels for both banned and unbanned stocks tended to hover at an elevated level for several weeks. During the entire ban, the volatility skew of banned stocks remained relatively high, whereas the volatility skew for unbanned stocks slowly declined to pre-ban levels. This large increase and persistence in risk aversion indicates that the ban did not diminish market participants' concerns regarding future European financial stocks. On the contrary, the ban was seen as reason for more concern. Therefore, at first glance, it appears that the short-selling ban's effect on investors' risk aversion with respect to financial stocks differed from that intended by regulators.

According to Kumar and Persaud (2002), a shift in investors' risk aversion may constitute the basic component of what they call 'pure contagion'. Pure contagion occurs when the main channel for transmission of contagion is a reduction in investors' appetite for risk rather than local or international economic shocks. A reduction in investors' risk appetite causes contagion by reducing investors' capacity to bear risk. In other words, investors start to require higher compensation for taking risk. In the context of an international portfolio, a crisis in one country, which causes risk aversion to rise, causes investors to reduce their exposure to risky assets in other countries. The authors argue that such rebalancing of portfolios may also be triggered by liquidity requirements. Thus, if one country (or region or institution) is heavily financed by investors who must suddenly raise capital to meet liquidity requirements, then financial contagion may occur. Broner et al. (2006) refers to such a rebalancing of funds as the 'portfolio channel of contagion'. They show that deteriorating risk aversion stimulates portfolio flows towards underexposed countries that have outperformed overexposed countries. These findings help explain why some countries are affected by financial crises even when they do not have weak fundamentals or characteristics in common with the country that initiated the crisis.

Kyle and Xiong (2001) argue that financial contagion can also occur through a wealth effect closely linked to risk aversion. When financial intermediaries suffer trading losses, their capacity to bear risk diminishes, motivating them to liquidate positions in other financial market segments. As a result, market liquidity declines, price volatility rises, and correlations rise, which leads to financial contagion. Obviously, this mechanism is closely linked to the portfolio channel of contagion described above. A link

between increasing risk aversion and contagion is also identified by González-Hermosillo (2008) and Caceres et al. (2010). Aharony and Swary (1996) and Allen and Gale (2000) have shown that financial contagion is undesirable because it may provoke bank failures, restrict credit, and lead to periods of low growth and even recession. Moreover, Hibbert et al. (2008) argues that large increases in risk aversion lead to a more negative and asymmetric return-volatility relationship. This relationship entails that negative returns are correlated with positive innovations in volatility, with the effect more asymmetric when returns decline or volatility increases.

In the following analysis, we distinguish five sub-periods: (1) the US recession period (February 15, 2008 to June 30, 2009); (2) the period of the 2009/2010 stock market rally (July 1, 2009 to April 26, 2010); (3) the European crisis period (April 27, 2010 to August 10, 2011), initiated by Standard and Poor's downgrade of Greece's sovereign bonds to "junk" status; (4) the ban period (August 11, 2011 to February 16, 2012); (5) the post-ban period, from February 17, 2012, one day after the short-selling ban was lifted in Belgium, to March 27, 2012, when our data sample ends. Table 3 presents the corresponding medians for the whole period and for the five sub-periods individually.

< Please insert Table 3 about here >

The results in Table 3 show that the sub-periods 1, 3, and 4 have the highest volatility skews. They also roughly match the periods of market turmoil and volatility humps highlighted in Figure 2: the global financial crisis, the European sovereign debt crisis, and the 2011 European ban period. The median volatility skew for banned stocks, 7.34, is much higher during the ban period than before it, when it was 6.05. For unbanned stocks, the median volatility skew during the ban period, 6.05, is only slightly higher than during the European crisis, when it was 5.78. Moreover, the median skew during the European crisis period is also higher than during the preceding period, the period of the stock market rally. Medians for these skews are statistically different from each other at the one percent level, based on the Mann-Whitney U-test.

Median skews during the ban period, for both banned and unbanned stocks, are the highest among all other sub-periods in our sample. Furthermore, the median skew for banned stocks during the ban period rises much more than that for unbanned stocks. The median skew for banned stocks during the ban period is also the highest across all periods. Overall, we can observe that investors' risk appetite towards banned stocks during the ban deteriorated much more profoundly than for unbanned stocks.

A similar rise in the median volatility skew for banned stocks is observed in France and Italy, when we look at the 4 Euro countries separately. For Belgium, the median volatility skew drops, although its new level is not statistically different from the previous one, which might be related to the small

number of only four cross-sectional observations. For Spain, the median volatility skew for banned stocks remains unchanged. For unbanned stocks listed in Belgium, France, and Italy, the median volatility skews also increase, albeit to a lesser extent than for banned stocks. Table 3 shows that for unbanned Spanish stocks, by contrast, the median volatility skew drops. We note that the sub-period with the highest median volatility skew is also the ban period for Belgium, France, and Italy. Almost all these empirical findings suggest that the ban contributes to an increase in risk aversion, especially with respect to banned stocks. Conversely, once the ban is lifted, volatility skews drop. For banned and unbanned stocks, the post-ban period records volatility skews that are statistically smaller than during the ban period.

Figure 2 appears to indicate that the volatility skew for banned stocks is greater than that for unbanned stocks in most periods. Panel B shows that the B-U index has a positive median value of 0.71 volatility points across the entire sample. Similar results are observed for the country-specific excess skew indices. More importantly, overall median excess skew is higher during the period of the short-selling ban than during any other period, reaching 1.18 in comparison to 0.68 during the pre-ban European crisis and 1.15 during the post-ban period.

We also find that the excess skew medians in the ban period and pre-ban period differ significantly from each other, which holds for both the overall analysis and at the individual country level. On the other hand, overall median excess skew for the ban period and post-ban period are not statistically different. When we compare median excess skews during the ban and post-ban period across the four countries, Panel B of Table 2 indicates that the evidence is somewhat conflicting. Belgium and Italy undergo a statistically significant decrease in excess skew. For France, the excess skew rises slightly, but the change is not statistically significant, while Spain suffers a strong and statistically significant escalation of excess skew after the ban is lifted.

Our impression from the data examined thus far is that the ban fails to improve investors' risk appetite during the European financial crisis. An improvement in risk appetite at the time of the introduction of the short-selling ban should have caused volatility skews to recede. However, we find strong evidence that volatility skews jumped instantly when the ban was introduced and remained high during the period of the ban, especially for banned stocks. Presumably, these effects were undesired by regulators, as the purpose of the ban was to prevent market instability. At that time, just after financial stocks had plummeted 25 percent in only one month, market stability was to be safeguarded by an improvement in investors' risk appetite with respect to financial stocks, not the opposite.

A potential flaw in the empirical analysis so far is that large movements in the volatility skew, observed during the ban or at the time of its announcement, may have been contemporaneous to the dissemination of other relevant information. If so, one cannot draw a clear connection between the ban announcement and volatility skew behavior. In particular, movements in volatility skews may have been

driven by news flow rather than by the short-selling ban itself, as observed by Boehmer et al. (2013) and Beber and Pagano (2013) when analyzing the 2008 US short-selling ban and the US 2008 TARP announcement. In the following we therefore assess the informational backdrop against which the short-selling ban was announced by using proxies for the relevant information flow.

The European financial crisis is related to country-specific issues. Solvency and liquidity conditions of national governments strongly influenced regional stock market movements during the crisis. Consequently, we use spreads on sovereign credit default swaps (CDS) to proxy the country-specific information flow. The benefit of using CDS spreads instead of spreads based on Treasury yields is that the latter are occasionally distorted by pick-ups in "flights-to-liquidity" to German Bunds, as Beber et al. (2009) note. We adopt the V2X, the European counterpart of the VIX (the implied volatility index for S&P500 index options), as a proxy for the European equity market information flow. Figure 3 plots the implied volatility skew for banned and unbanned stocks against sovereign CDS and V2X during the ban period.

< Please insert Figure 3 about here >

Figure 3 indicates that our volatility skew measures rise despite the absence of any negative shocks to our information flow proxies. Around the ban announcement date of August 11, 2011, the information flow for the four countries is relatively benign. We observe that CDS levels remain unchanged and V2X even decreases after showing a large spike in the preceding days. Equity market movements at that time reiterate such positive information flow. The EuroStoxx 50 index rose by 2.86% on August 11 and by 4.15% on August 12, whereas the EuroStoxx Banks index rose by 2.96% and 5.26%, respectively. Moreover, no other major announcement (e.g., of a long-term refinancing operation by the ECB) was made during these days. At the same time, the volatility skews spike strongly and remain at elevated levels. Evidently, upon the ban announcement, investors' risk aversion rises, although no apparent bad news could justify it. This divergence suggests that the reason for pessimism is the short-selling ban announcement itself. The ban appears to have catalyzed a deterioration in investors' risk appetites. Thus, the evidence adds to the other negative effects of short-selling bans in options markets, such as worsening market quality, which got observed by Battalio and Schultz (2011). Events that cause a large deterioration in investors' risk appetites are harmful because they may spark further uncertainty among market participants and potentially cause financial contagion, as discussed in Kumar and Persaud (2002) and Caceres et al. (2010).

The data on sovereign CDS may also help to put into perspective the observed cross-country differences in the volatility skews after the ban was lifted. The short-selling ban was lifted on February 13,

2012, for Belgium and France, February 15, 2012, for Spain, and February 24, 2012, for Italy. Around this time, a large drop in excess skew is documented for Belgium and Italy, whereas an increase is observed for Spain. Excess skew for France remains relatively unchanged. Figure 3 shows that these moves match very well the sovereign CDS spread behavior for these countries. After the lifting of the ban, CDS spreads moved sideways for Belgium, France, and Italy, while those for Spain rose. This divergence can be explained by the fact that on February 13, 2012, Spain's sovereign debt rating was downgraded by Moody's by two notches, from A3 to A1, much more severely than the rating changes for the other three countries. As part of the same rating adjustment by Moody's, France's sovereign rating was kept at triple-A, the highest, although its outlook turned negative, Italy was downgraded by one notch from A3 to A2, while Belgium remained unchanged. Afonso et al. (2012) find that CDS spreads respond significantly to changes in both assigned credit ratings and rating outlooks, with an especially strong reaction to negative rating announcements. These findings are in line with our interpretation of the behavior of Spanish CDS after February 13, 2012.

4.2 Trading Activity

In this section, we study an additional variable that could potentially shed light on our analysis of investors' risk aversion: trading activity. Given supply-demand imbalances in the options market, Bollen and Whaley (2004) suggest that the volatility skew might be closely linked to trading activity in the market. They argue that changes in the shape of the volatility function are directly related to net buying pressure on options from end-users' public order flow. End-users trade options for portfolio insurance, agency, and speculative reasons, rather than for market making reasons. This conclusion is confirmed by Gârleanu et al. (2009), who find that the size of the volatility skew is positively and significantly related to demand pressures. They show that volatility skews are most impacted by institutional investors seeking portfolio insurance in the index option market rather than the individual stock option market. Nevertheless, their results suggest that trading pressure on single stock options also influences the shape of the bottom-up implied volatility skew. Thus, demand pressure on single stock puts also causes the volatility skew for single stock options to become steeper.

We inspect daily put and call trading volumes as well as the put-call volume ratio as proxies for trading pressure, as suggested by Dennis and Mayhew (2002). Volume is measured as the average number of contracts traded on a specific day for all stocks in the sample[5]. The put-call volume ratio is the number of put contracts traded on a specific day divided by the number of calls traded . An overall put-call volume ratio is obtained by averaging the stock-specific contracts. We calculate median trading volumes and the

[5] Evidence that OTM put options have the heaviest trading volume among puts (see Bollen and Whaley, 2004) supports our approach.

median put-call volume ratio for banned and unbanned stocks for the five periods identified in our dataset: the US recession period (February 15, 2008 to June 30, 2009); the 2009/2010 stock market rally period (July 1, 2009 to April 26, 2010); the pre-ban European crisis period (April 27, 2010 to August 10, 2011); the ban period (August 11, 2011 to February 16, 2012); and the post-ban period (February 17, 2012 to March 27, 2012).

The results in Table 4 indicate that the median number of single stock puts traded per day decreases significantly from 1,905 during the pre-ban European crisis period to 1,727 during the short-selling ban period. However, the volume remains higher than the median value of 1,690 for the overall period. For unbanned stocks, the median volume of puts also drops, from 1,157 during the pre-ban period to 943 during the ban. The median number of options (puts and calls) traded during the ban period relative to the pre-ban period remains relatively constant for banned stocks, dropping only slightly from 3,756 to 3,526. For unbanned stocks, the median number of options traded significantly decreases, from 2,325 to 1,950.The median put-call volume ratio for unbanned stocks significantly increases during the ban, from 6.3 to 8.7, whereas the median put-call volume ratio for banned stocks remains nearly the same.

< Please insert Table 4 about here >

Our findings from Table 4 provide no evidence that individual stock options affected by the ban (especially puts) experienced a large rise in trading activity. Thus, we find no evidence of a substitution effect of short-selling of common stock into single stock put options. Nor, however, does trading activity completely dry up during the ban period. Banned stocks' put options record a statistically significant decrease in trading activity, once the ban is introduced, but we do not observe a total collapse in trading activity. This result is in line with Grundy et al. (2012), who find that the overall volume of options trading dropped during the 2008 US short-selling ban. This behavior of trading volumes suggests that during the ban, the volatility skew does not increase as a result of increased selling pressure, as originally suggested by Bollen and Whaley (2004) and Gârleanu et al. (2009). Given the apparent inconsistency between these studies and our empirical findings (higher volatility skew combined with lower trading activity), we next delve deeper into the supply and demand dynamics of the single stock put options market in Europe.

We assume that once short-selling activity in banned stocks diminishes, the demand for synthetic shorts via put options should increase. When analyzing the supply side of the market, we first take the perspective of informal market makers in options. Such agents are typically high frequency traders and hedge funds that make money by writing puts for the market. We suggest that, as these market participants can no longer hedge by short-selling stocks, they become less willing to sell protection. Boehmer et al.

(2013) notes that about 50 percent of all options trading is currently undertaken by such informal market makers. Thus, we assume that the ban must have impaired the offering of put options normally provided by these market participants. For formal market makers, given that they are still allowed to short-sell stocks to hedge their short put inventories, the ban does not place a hard constraint on their put-writing capabilities. Indeed, as securities lending programs would be in less demand by short-sellers during the ban, it should become even cheaper to borrow stocks, which should increase market makers' willingness to write puts.

We study three common measures of borrowing costs: the simple average fee, the simple average rebate, and the daily cost of borrow score, all provided by Markit Securities Finance. In unreported results, we find that all three measures show a slight reduction in borrowing costs for banned stocks, from the date the ban was introduced until the end of September 2011. However, borrowing costs constitute only one component of hedging costs, and, depending on market circumstances, not necessarily the largest one. Costs incurred by bid-ask spreads and price impact may easily outpace borrowing costs in times of market distress and thin trading activity. For example, Beber and Pagano (2013) illustrate that the 2008 US ban is associated with an increase in bid-ask spreads ranging between 1.64 and 1.98 percentage points in a sample of international stocks where the average bid-ask spread is 3.93 percentage points. For instance, on August 11, 2011, the European short-selling ban announcement day, the fee for borrowing the Spanish bank Santander was only 51 bps per annum. Therefore, at the start of the ban period, lower borrowing costs may not have helped much in instigating market makers to write puts.

Market makers do hedge short options not only by short-selling stocks but also by trading other options. However, as noted by Battalio and Schultz (2011) and Grundy et al. (2012), bid-ask spreads on options on banned stocks also rose significantly during the 2008 US short-selling ban. Thus, hedging with options may also have become more expensive during the 2011 European short-selling ban.

One additional explanation for a smaller supply of puts during the ban is that options-sellers may become more sensitive to demand following equity market declines, as noted by Gârleanu et al. (2009). The authors find that end-users have a net long-position in equity index options with a corresponding large net position in OTM puts. Conversely, market makers are short in OTM puts. Therefore, market makers face significant un-hedged risk and, following a market decline, experience losses and become more risk averse. In becoming more risk averse, they become more reluctant to expand trading inventories further and write additional puts. At the end of July 2011, days before the introduction of the European short-selling ban, equity markets strongly corrected on the back of an intensifying European financial crisis. Therefore, it is not difficult to envision high-risk aversion among market makers during the ban. A low trading volume in OTM puts may have caused market makers to raise their volatility quotes.

Hence, diminished willingness of market makers to sell puts should have caused the supply of puts to significantly decrease. As a consequence, single stock volatility skew appears to have increased for this reason rather than because of further selling pressure on financial stocks. In a setting where market makers turn more risk averse and market quality in the equity and option market is poor, large upward movements in the volatility skew could be caused by relatively small volumes of trading in OTM puts. On the other hand, the fact that holders of financial stocks interested in hedging their positions suddenly must pay much higher prices to buy protection (leaving aside the high bid-ask spread) entails some degree of market failure.

We further conjecture that a substitution effect via index options may also have occurred upon the imposition of the ban. We raise this hypothesis for two reasons. First, equity index options are very liquid instruments, generally far more liquid than the average single stock option. Second, as hedging of equity market risk was allowed under the ban, trading in such instruments for hedging purposes should not have characterized an attempt to curb the ban. As such, a potential 'indirect' substitution effect might have been created by trading index options. To investigate this effect, we examine trading volumes of EuroStoxx 50 index puts.

On the ban announcement day, the puts trading volume was 2,573,868, which is the second highest daily trading volume for this instrument in our sample. The heaviest trading in EuroStoxx50 puts took place on October 10, 2008, when the Belgian bank Dexia was bailed out, with 2,604,185 contracts traded. Interestingly, V2X, our proxy for market-wide information flow, documents no substantial shocks on August 11, 2011, that could justify such a high trading volume. During the ban period, investors apparently shifted some of their demand from single stock puts to index puts. Such migration of trading flow did not characterize financial contagion of index puts though. Similarly to the V2X, no significant shock was experienced by the volatility skew of EuroStoxx 50 index options on the ban announcement day. In fact, the volatility skew for EuroStoxx 50 index options dropped on both August 11 and 12, 2011.

Thus, our analysis suggests that during the ban, a supply shift caused a decline in both the volume of single stock puts traded and puts-call ratios for banned stocks. As a consequence, speculators wanting to bet on further declines in financial stocks were deterred from doing so. Such observations suggest that a substitution effect of short-selling of stocks by single stock put options did not occur during the ban. An 'indirect' substitution effect of short-selling of stocks by index puts seems to have occurred though.

4.3 Panel Regression Analysis

To further assess whether trading migrated from single stock options to index options, we run a panel regression analysis with volatility skew as the dependent variable. This regression allows us to isolate the relationship between volatility skew and banned stocks by controlling for other determinants

such as information flow and idiosyncratic factors. We use the following firm specific control variables: daily turnover, systematic risk, and firm size. We use turnover as a proxy for stock liquidity, following Dennis and Mayhew (2002). We calculate an individual stock's daily turnover by dividing its daily trading volume by its number of shares outstanding. The stock's beta is our control variable for systematic risk. The market return is assumed to be the equal-weighted average daily return for all stocks in our sample. The daily estimation of beta uses a rolling window of one year's worth of data, where the data begin one year before the first sample-date. Firm size is calculated as the number of shares outstanding on a specific day multiplied by the stock price.

It is common to find highly correlated control variables within a set of factors, as noted by Engle and Mistry (2008) for size and beta. Hence, we estimate correlation matrices using cross-sectional and time-series approaches (unreported here). Under the cross-sectional approach, the highest correlation we find between beta and turnover is 54 percent. The correlations between beta and size and between turnover and size are mostly close to zero or slightly negative. When employing an averaged time-series correlation approach, the highest correlation we find is between beta and turnover with just ten percent. Beta and size as well as turnover and size are negatively correlated.

We employ de-trended levels of sovereign CDS spreads for Belgium, France, Italy, and Spain and the V2X volatility index as a control variable for country-specific and equity market information flows. Based on the Johansen cointegration test, we find no cointegration between the four countries' de-trended CDS spreads and the V2X index at the five percent significance level. Additionally, we proxy firm-specific information flows with daily stock returns.

Single stock put option trading volume is computed as the average daily trading volume of puts divided by 1,000. Put trading volume is not used as an additional cross-sectional factor, as data are available for a limited set of stocks only (122 out of 186). Finally, we use the daily trading volume of puts on EuroStoxx50 divided by 1,000,000 to capture the potential indirect substitution effect of trading pressure on single stocks' puts by index puts. Our resulting model 1 is specified as follows:

$$\begin{aligned} VolSkew_{i,t} &= c + V2X_t + CountryCDS_{i,t} + StockRt_{i,t} + Turnover_{i,t} + Size_{i,t} + Beta_{i,t} + \ldots \\ &+ D_t^{BanPeriod} + D_t^{BannedStock} + D_t^{BanPeriod} * D_i^{BannedStock} + D_t^{PostbanPeriod} + D_t^{PostBan} * D_i^{BannedStock} + \ldots \\ &+ PutVolume_t + E50PutVolume + \varepsilon_{i,t} \end{aligned} \quad , \qquad (1)$$

where *VolSkew* is the volatility skew, *V2X* is the EuroStoxx50 implied volatility index, *CountryCDS* is the de-trended level of sovereign CDS spreads, *StockRt* is the daily stock return, *Turnover* is the daily stock turnover as a percentage of outstanding shares, *Size* is firm size, and *Beta* is systematic stock risk. $D_t^{BanPeriod}$ is a dummy variable equal to one if the date is within the ban period (August 11, 2011 until February 16, 2012) and zero otherwise. $D_t^{BannedStock}$ is a dummy variable equal to one if the underlying

stock is a banned stock and zero otherwise. $D_t^{PostBan}$is a dummy variable equal to one if the date is after the lifting of the ban (from February 17, 2012 onwards) and zero otherwise. An additional dummy variable is created as an interaction term for these two dummies, $D_t^{BanPeriod} * D_t^{BannedStock}$. This variable captures the effect on the volatility skew when two conditions — that the stock is banned and that the ban is in place — hold. The joint dummy $D_t^{PostBan} * D_t^{BannedStock}$ captures the relation between the volatility skew and banned stocks in the post-ban period. *PutVolume* is the average daily trading volume of single stock puts, and *E50PutVolume* is the daily trading volume of puts on the EuroStoxx50 index.

Time series data for variables with the subscripted index *i* are specific to each individual cross-sectional analysis. Variables with the subscripted index *t* only use time series data; therefore, such series are common for all cross-sectional analyses (e.g., the V2X index). Further, we use as our estimation method the Generalized Least Squares (GLS) approach instead of standard Ordinary Least Squares (OLS) in order to account for potential serial correlation in the residuals.

We estimate our panel regression over three different periods: (a) the full period, ranging from February 15, 2008 to March 27, 2012; (b) the period that starts on April 27, 2010, when the European sovereign crisis is deemed to have begun, to March 27, 2012, and (c) the ban period, ranging from August 11, 2011 to February 16, 2012. Model 1 is estimated using these three periods, to test whether the relationships encountered during the European crisis and the ban period are in line with the ones found for the full sample. Table 5 reports estimates for model 1.

< Please insert Table 5 about here >

The results in Table 5 indicate that over the full sample period (column a) all coefficients are statistically significant at the one percent level, except for the joint dummy variable $D_t^{PostBan} * D_t^{BannedStock}$. The *V2X* and country CDS spreads are positively related to the volatility skew and to the systematic risk component. *Turnover* is inversely related to volatility skew. These results are in line with results reported in the literature and with our expectations. We expected V2X to be positively related to volatility skew, as investors' risk aversion priced for individual stocks is likely to increase with equity market volatility. Both Dennis and Mayhew (2002) and Engle and Mistry (2008) also find that the individual stock volatility skew is positively related to aggregate volatility. Further, we expected CDS spreads to be positively related to volatility skew because country credit risk must be positively associated with investors' risk aversion. Our estimated beta parameter is consistent with Duan and Wei (2009), who document a positive relationship between systematic risk and volatility skew. This relation is intuitive, as systematic risk may constitute a risk factor that is priced into options. The negative relationship we document between turnover and skew is also in line with the findings by Duan and Wei (2009). One would indeed expect

investors' risk aversion to be higher for more illiquid stocks. Contrary to our expectations, stock returns and size are positively related to volatility skew. Nevertheless, our size-skew estimates are in line with the results reported in Engle and Mistry (2008). They suggest that size proxies for beta, warranting a positive relationship between size and skew.

The results obtained from our dummy variables over the full sample period (column a) confirm that the short-selling ban positively affected the volatility skew for banned stocks: $D_t^{BanPeriod} * D_t^{BannedStock}$ has a positive sign and is statistically significant. This is a strong result, given the large set of control variables used. This finding suggests that the volatility skew for banned stocks during the European short-selling ban was abnormally high compared to that for unbanned stocks and that for banned stocks in other periods. The fact that $D_t^{BannedStock}$ has a positive sign and is significant implies that financial stocks have, on average, higher excess skew than other stocks, a finding that is consistent with insights provided by our descriptive statistics (Table 2). The three dummy estimates confirm that the volatility skew for all stocks was higher during the short-selling ban and that the effect was more pronounced for banned stocks.

Further, column a of Table 5 reports that *PutVolume* is positively related to volatility skew at the one percent significance level. This finding confirms the hypothesis of Bollen and Whaley (2004) and Gârleanu et al. (2009) that buying pressure on puts positively affects the skew. We also find that *E50PutVolume* is negatively linked to volatility skew. Apparently, a high trading volume in index puts is associated with a low skew. One possible explanation for this finding is that the assets underlying the two metrics are substitutes. The EuroStoxx 50 index contains several large-cap companies from Belgium, France, Spain and Italy, such as Total, Sanofi, Banco Santander, BNP Paribas, Telefonica, Anheuser-Bush Inbev, and Eni. Therefore, trading volume generated by the demand for put options may be spread interchangeably between puts on the EuroStoxx 50 index and puts on single European stocks. High demand for EuroStoxx 50 put options could potentially be associated with less demand for a basket of single stock puts.

Table 5 shows that our empirical results change somewhat when we estimate Model 1 over the two different sub-periods. During the Euro crisis pre-ban period, from April 27, 2010 to March 27, 2012, column b displays that all parameter estimates have identical signs and comparable statistical significance levels compared to the results obtained in estimating Model 1 over the full period (column a). The dummies $D_t^{BanPeriod}$, $D_t^{PostBan}$ and $D_t^{PostBan} * D_t^{BannedStock}$ also have the same signs as those obtained in our estimation for the full period but are now statistically significant. The value for $D_t^{BanPeriod}$ suggests that the volatility skew for stocks was on average reduced during the short-selling ban, while the estimate for $D_t^{PostBan}$ indicates that the lifting of the ban occasioned a fall in skew for the average stock. This relationship suggests a potentially undesirable effect of the short-selling ban on the skew, implying that market participants may have become less risk averse across the entire options market once the ban was

lifted. Further, the coefficient on *PutVolume* becomes positive but insignificant when data for the European crisis period are used in the regression. The parameter for *E50PutVolume* remains negative and statistically significant.

The empirical results change more dramatically when we run Model 1 for the 2011 European short-selling ban period, from August 11, 2011 to February 16, 2012. Column c of Table 5 shows that all control variables still have the same signs and the results are strongly statistically significant. But, because we use such a short period, the dummies $D_t^{BanPeriod}$, $D_t^{PostBan}$, $D_t^{Ban}*D_t^{BannedStock}$, $D_t^{PostBan}*D_t^{BannedStock}$ are no longer applicable. The estimate of $D_t^{BannedStock}$ is no longer statistically significant. This outcome suggests that, within the ban period, banned financial stocks are no longer associated with higher volatility skews relative to the average stock. However, the presence of a large positive coefficient for beta in Model 1 (see Table 5, column c) concomitant with a large average beta for financial stocks during the ban (i.e. 1.30 relative to 0.9 for unbanned stocks) indicates that the lack of significance of $D_t^{BannedStock}$ may be connected to cross-correlation between these two variables. Additionally, *PutVolume* becomes negative and significant, whereas *E50PutVolume* turns positive and significant. These new results suggest that a rise in skew during the ban period was associated with a lower volume of single stock puts and a higher volume of index puts. These results differ from those found with other samples and contradict the findings of Bollen and Whaley (2004) and Gârleanu et al. (2009). Volatility skew for single stock options should increase when high trading activity occurs in the single stock put market, not the other way around. However, the volatility skew was likely driven by a supply shift rather than a change in demand during the ban. In such a setting, large upward movements in skew could be caused by low trading volumes in OTM puts, which explains the negative relationship between *PutVolume* and *VolSkew.*

One explanation for the positive relationship between *Euro50PutVolume* and *VolSkew* is that, after the imposition of the ban, the skew from stock options relative to index options became too costly. The spread between the skew from Eurostoxx 50 index put options and single stock puts was exceptionally tight during the ban. Such a spread, which is normally highly positive, was just marginally positive during the ban, even reaching zero in December 20, 2011. These low skews meant that single stock puts were almost as expensive as index puts. Because index puts are far more liquid than single stock puts, a liquidity premium no longer existed and a migration from single stock puts to index puts seemed logical. As such, the above-noted increase in the volume of index puts traded, in parallel with the rise in the volatility skew during the ban, explains the positive relationship between *Euro50PutVolume* and *VolSkew* in our regression.

A final explanation for the association between the observed increased demand for index puts, the decreased demand for single stock puts, and a high bottom-up volatility skew is the "flight-to-liquidity" argument. Acharya and Pedersen (2005) suggest that investors are mostly concerned about tradability

during market downturns. As a consequence, under adverse market conditions, investors migrate from illiquid instruments to comparable but more liquid instruments. Because index options are more liquid than single stock options, investors would migrate to the index option market. Moreover, during such a flight-to-liquidity episode, market makers most likely refrain from offering instruments that are relatively difficult to hedge, such as single stock puts.

A ban may be considered to be ineffective when selling pressure migrates from banned securities to alternative instruments. However, in the case of the 2011 European short-selling ban, such a conclusion may be premature. The migration of selling pressure from financial stocks to puts on European indices seems not to have jeopardized the efficacy of the short-selling ban. As a result of the migration, the ban diverted selling pressure initially concentrated in financial stocks to a larger share of the market. Thus, selling pressure on shares in troubled banks was most likely reduced. When the short-selling ban was introduced on August 11, 2011, following the reasoning by Allen and Gale (2000) and Bae et al. (2003) any further selling pressure on financial stocks could have led to a destabilizing shock and financial contagion. At that point, after European banks' shares had already fallen by approximately 20 percent in the preceding month[6], a shock of this type was what regulators wanted to prevent. Because both the volatility skew and the excess skew rose as a result of lower trading volume, not through a substitution effect, our assessment is that the banned stocks were protected by the ban. The high level of skew during the ban period caused OTM put prices to increase dramatically, preventing speculators from betting on further declines in financial stocks. Hence, the European 2011 short-selling ban helped to curb synthetic shorting activity and thus potentially prevent further destabilization in the financial sector.

On the other hand, our finding that holders of financial stocks interested in hedging their positions were suddenly required to pay a much higher price for protection (leaving aside the higher bid-ask spread) entails some degree of market failure. To illustrate, three-months 80 percent moneyness OTM puts on financial stock on average became 16 percent more expensive on August 11, 2011, compared to the previous trading day[7]. One can argue that the imposition of the short-selling ban led to a non-optimal reallocation of capital by transferring wealth from hedgers and other liquidity takers (including speculators) to market makers and other parties willing to write puts during the ban.

4.4 Robustness Tests

In the above regression Model 1, we observed shifts in the signs of *PutVolume* and *E50PutVolume* across different sample periods. Hence, we now run an additional GLS panel regression as a robustness

[6] More precisely: during the preceding 21 trading days.

[7] We employ the Black-Scholes model for the valuation of this put option. We use as inputs: (1) the average implied volatility for the stocks for August 10 and for August 11, 2011; (2) the three-month Euribor rate at the time as risk-free rate; (3) 63 days as time to expiration; (4) 80 as hypothetical strike price; and (5) 100 as hypothetical stock price . Dividends are assumed to be zero.

check in order to control for any influence of the short-selling ban. We estimate a reduced form of Model 1 that excludes all dummies related to the ban, while using pre-ban data only. Thus, our Model 2 is specified as follows:

$$VolSkew_{i,t} = c + V2X_t + CountryCDS_{i,t} + StockRt_{i,t} + Turnover_{i,t} + Size_{i,t} + Beta_{i,t} + \ldots + PutVolume_t + Euro50PutVolume_t + \varepsilon_{i,t} \quad , (2)$$

where the variables are defined as in Model 1. We estimate the panel regression Model 2 for the entire pre-ban period and for three different sample periods: (a) the pre-ban period (February 15, 2008 to August 10, 2011); (b) the US recession period (February 15, 2008 to June 30, 2009); (c) the ensuing stock market rally (July 1, 2009 to April 26, 2010); and (d) a sample that starts on April 27, 2010, when the European sovereign crisis is deemed to have begun, and runs through August 10, 2011, the last trading day before the short-selling ban got introduced.

The Model 2 results are presented in Table 6 (Panel A). Column a shows that the Model 2 estimates for the pre-ban period are consistent with the Model 1 estimates (Table 5, column a) for the full sample period from February 15, 2008, to March 27, 2012: *V2X,* CDS spreads*,* stock returns, systematic risk, and size are all positively related to the volatility skew, whereas *Turnover* is inversely related to the skew. All coefficients are statistically significant. *PutVolume* is positively related to the volatility skew, while *E50PutVolume* is negatively related to it. Hence, we find that increased trading activity in single stock puts is linked to a high skew of single stock options. This relation confirms the findings of Bollen and Whaley (2004) and Gârleanu et al. (2009).

< Please insert Table 6 about here >

Column b shows that the estimates of the Model 2 parameters during the US recession period have the same signs and statistical significance levels as those attained over the full pre-ban period (column a). The *E50PutVolume* variable is still negatively connected to the skew and is statistically significant. The control variable estimates of Model 2 over the equity market rally period, reported in column c, exhibit the same signs and statistical significance as those calculated over the pre-ban period. Finally, when Model 2 is estimated using only the Euro crisis period, column d shows that all signs and statistical significance for the constant and all control variables remain the same as in prior estimations. The coefficient for *E50PutVolume* is statistically significant and has a negative sign.

The above reported results in Table 6 suggest robustness in the relationship between the volatility skew and the control variables. Our findings remain stable across various time periods and in two different models. The results also imply less robustness of the relationships between *PutVolume, E50PutVolume*

and volatility skew. Both the lack of statistical significance of *PutVolume* and *E50PutVolume*over specific sample periods and the changes in signs are evidence of the weakness of the relationships between these two variables. However, the weakness is mostly perceived for the 2009-2010 stock market rally period. During strong market rallies, demand for puts is low, and trading pressure may exert a less of an influence on volatility skew than under normal market circumstances.

More importantly, the relationships among *PutVolume, E50PutVolume* and volatility skew estimated by Model 2 are in line with those for Model 1 using the full period. These findings are opposite to the relationships observed during the ban. As such, we confirm that the relationships among *PutVolume, E50PutVolume,* and volatility skew were quite exceptional during the ban.

In another robustness check, we re-estimate Model 1 without the Belgian share observations since all four banned Belgian financial stocks were targets of strong government intervention. For instance, Ageas, previously Fortis Holdings, was bailed out on September 28, 2008, while Dexia came into government ownership on October 11, 2011. Panel B of Table 6 indicates that the estimates do not change much when compared to Table 5, which shows the outcomes of our main regressions. The most noteworthy difference between the outcomes from the two Model 1 estimates that include and exclude the four Belgian stocks are related to the joint dummy variable $D_t^{PostBan} * D_t^{BannedStock}$. In the regression that includes Belgium over the full period between February 15, 2008 and March 27, 2012, this dummy is not significant. When Belgium is excluded from the sample, the coefficient for $D_t^{PostBan} * D_t^{BannedStock}$ becomes significant at the five percent level. The reason for the lack of statistical significance of this dummy when the four Belgian stocks are used seems to be the large spike in the skew for Dexia on March 26, 2012, when it jumped from 7.8 to 38.7 points. Belgian shares seem to add noise to the estimation instead of information. Our conclusion is that the regressions results are robust without the Belgian data.

Previously, we found no evidence that the volatility skew increased due to news flows regarding the introduction of the short-selling ban. As a final robustness check, we analyze next whether the volatility skews for stocks in other European countries increased around the date of the short-selling ban announcement. Such an increase could be evidence of potential financial contagion effects. If so, the steep rise in investors' risk aversion would also be observed in other European countries that were vulnerable to or already hit by the financial crisis. European countries that fit such criteria are Greece, Ireland, and Portugal, as suggested by Obstfeld (2011) and Grammatikos and Vermeulen (2011). We compile implied volatility skew data for only Ireland and Greece because Portugal does not have a public equity options market. Moreover, the single stock option markets for Ireland and Greece are small. Only 12 stocks in Ireland and four stocks in Greece have listed options. Out of these 16 stocks, three are financial stocks (two in Ireland and one in Greece). We compute the average volatility skew indexes for the overall group of ex-financial stocks and for financial stocks, in the same way as in our main empirical analysis.

In unreported results we find no indication that investors' risk aversion for these stocks materially changes when the ban is introduced. The skew for the ex-financial stocks changes little on August 11 and 12, 2011, from –1.93 on August 10 to –1.95 and –2.15 on August 11 and 12, respectively. The skew remains pretty much at the same level on subsequent days. For the three financial stocks analyzed, the volatility skew drops on August 11, 2011, from 4.63 to 2.95, after which it rises on August 12, 2011, to 6.5. The volatility skew for financial stocks keeps drifting lower on subsequent days, from 4.30 to negative territory, before it bottoms out at –2.88 on September 5, 2011. These observations strengthen our earlier conclusion that the rise in the level of investors' risk aversion on the day of the ban announcement is connected to the short-selling ban itself, as opposed to an exogenous factor such as financial contagion.

5. Conclusions

Recent research suggests that the short sale bans introduced during the 2008 crisis may have reduced market quality around the world, perhaps even to the extent that the ban's benefits were outpaced (see Battalio and Schultz, 2011; Grundy et al., 2012; Boehmer et al., 2013 and Beber and Pagano, 2013). Nevertheless, European market regulators in Belgium, France, Italy, and Spain re-introduced a short sale ban on financial stocks in August 2011 to combat the European financial crisis. We use the stock options' implied volatility skews as a proxy for investors' risk aversion to analyze the impact of those recent European short sale bans. We find that on the day of the ban announcement, investors' risk aversion levels for both banned and unbanned stocks show a significant jump. These jumps are clearly outliers within the distributions of daily changes in risk aversion. For the banned stocks, risk aversion tends to increase even more than for other stocks. Furthermore, during the imposition of the ban, the banned stocks' average volatility skews remain at an elevated level, whereas this metric drops for the other stocks. During the ban, the median volatility skew for both the banned and unbanned stocks, as well as the excess skew, reached their highest levels when compared to any other period in the sample. Thus, the short-selling bans themselves seem to increase the risk aversion levels, especially for the banned stocks, even after controlling for information flow, stock specific factors, and options trading volume.

Nevertheless, for the banned stocks, trading volume for both single stock puts and puts-call ratios decline during the ban period. These declines in trading volume happen due to the reluctance of the market makers to sell put options as they become more risk averse and as hedging costs increase. As a consequence, speculators wanting to bet on further declines in financial stocks are prevented from taking such action. The OTM single stock puts become too expensive, thus the European 2011 short-selling ban helped curbing synthetic shorting activity in financial stock and reduced the risk of bank runs. In contrast, holders of financial stocks trying to hedge their positions are no longer able to do so without paying a steep price. Obviously, this effect entails some degree of market failure. As a result, the short-selling ban

transfers wealth from the hedgers and other liquidity takers to liquidity providers. Moreover, even though the volatility skew does not rise as a result of increased trading volume in single stock puts, the shift in investors' risk aversion provoked by the ban could have acted as a reinforcing loop of the crisis.

While the short-selling ban is effective in restricting both outright and synthetic shorts (e.g., through options) on banned stocks, we do find some evidence of trading migration to the index option market. Trading volumes in puts on the EuroStoxx50 index reach an extreme level upon introduction of the short-selling ban. Investors seem to switch from single stock puts to index puts because of valuation and "flight-to-liquidity" incentives. This migration of selling pressures from financial stocks to European equity indices does not seem to jeopardize the efficacy of the short sale ban. The selling pressure is diverted from the financial stocks to a larger share of the stock market, thereby potentially reducing the destabilizing effects in the financial sector such as bank runs and financial contagion.

Overall, our findings suggest that the current format of short sale bans does serve the intended purpose, though at a cost. The bans restrict further selling pressures on selected financial shares, both in the spot and in the derivatives market. At the same time, the short-selling ban allows market participants to continue trading in the equity index derivatives markets. Although a degree of market failure is documented, our results show that the index option markets continue to function, while financial sector stability seems to benefit from the bans.

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Table 1. Overview of banned financial stocks

This table lists the financial stocks banned from short-selling on August 11, 2011 in the Euro member countries Belgium, France, Italy and Spain by their respective national financial market regulators in a coordinated act with the European Securities and Market Authority (ESMA).

Belgium	*France*	*Italy*	*Spain*
Ageas	*April Group*	*Azimut Holding*	*Banca Cívica, S.A.*
Dexia	*Axa*	*Banca Carige*	*Banco Bilbao Vizcaya Argentaria, S.A.*
KBC Group	*BNP Paribas*	*Banca Finnat*	*Banco de Sabadell, S.A.*
KBC Ancora	*CIC*	*Banca Generali*	*Banco de Valencia*
	CNP Assurances	*Banca Ifis*	*Banco Español de Crédito, S.A.*
	Crédit Agricole	*Banca Intermobiliare*	*Banco Pastor, S.A.*
	Euler Hermés	*Banca Monte Paschi di Siena*	*Banco Popular Español, S.A.*
	Natixis	*Banca Popolare Emilia Romagna*	*Banco Santander, S.A.*
	Paris Ré	*Banca Popolare Etruria e Lazio*	*Bankia, S.A.,*
	Scor	*Banca Popolare Milano*	*Bankinter, S.A.*
	Société Générale	*Banca Popolare Sondrio*	*Bolsas y Mercados Españoles, S.A.*
		Banca Profilo	*Caixabank, S.A.*
		Banco di Desio e Brianza	*Caja de Ahorros del Mediterráneo*
		Banco di Sardegna Rsp	*Grupo Catalana de Occidente, S.A.*
		Banco Popolare	*Mapfre, S.A.*
		Cattolica Assicurazioni	*Renta 4 Servicios de Inversion, S.A.*
		Credito Artigiano	
		Credito Emiliano	
		Credito Valtellinese	
		Fondiaria – Sai	
		Generali	
		Intesa Sanpaolo	
		Mediobanca	
		Mediolanum	
		Milano Assicurazioni	
		Ubi Banca	
		Unicredit	
		Unipoland	
		Vittoria Assicurazioni.	

Table 2. Descriptive Statistics

Panel A of this table provides descriptive statistics for the implied volatility skews of unbanned and banned stocks calculated over the full sample period (February 15, 2008 to March 27, 2012) for the overall group of stocks as well as individually for Belgium, France, Italy, and Spain. Jarque-Bera normality tests are performed for all groups of stocks at the one percent significance level. Panel B presents the descriptive statistics for the level and daily differences in the excess volatility skew calculated over the entire sample for the overall group of stocks as well as individually for Belgium, France, Italy and Spain. The excess skew (B-U index) is calculated as the difference between the average implied volatility skew of all banned stocks and the average implied volatility skew of all unbanned ones. Jarque-Bera normality tests are performed for the level and difference of all groups of stocks at the one percent significance level.

Panel A: Implied volatility skew

	Overall		*Belgium*		*France*		*Italy*		*Spain*	
	Unbanned	*Banned*	*Unbanned*	*Banned*	*Unbanned*	*Banned*	*Unbanned*	*Banned*	*Unbanned*	*Banned*
Average	5.73	6.49	5.33	7.11	6.23	8.57	6.49	7.49	3.85	4.96
Median	5.31	5.98	5.14	6.94	6.09	8.16	6.23	7.24	3.19	3.98
Standard deviation	1.22	1.63	1.40	2.25	1.28	2.04	1.26	1.70	2.78	3.84
Skew	1.15	1.91	0.67	0.48	0.56	0.54	1.02	0.89	4.03	4.35
ExcessKurtosis	0.88	5.24	0.29	0.64	-0.11	-0.51	0.89	1.16	18.87	22.44
Jarque-Bera	266.0	1835.4	81.0	58.5	54.9	61.9	214.5	195.8	18395.7	25297.4

Panel B: Excess skew

	Overall		*Belgium*		*France*		*Italy*		*Spain*	
	Level	*Difference*	*Level*	*Difference*	*Level*	*Difference*	*Level*	*Difference*	*Level*	*Difference*
Average	0.76	0.002	1.78	0.001	2.34	0.004	1.00	0.000	1.11	-0.001
Median	0.71	-0.006	1.89	0.016	2.15	-0.003	1.06	0.005	0.89	-0.002
Standard deviation	0.77	0.567	2.08	1.576	1.41	0.679	1.11	0.898	1.78	1.396
Skew	1.47	0.749	-0.02	-0.219	0.65	0.199	-0.80	0.409	2.26	0.061
Kurtosis	7.65	11.32	0.93	6.59	-0.13	9.34	4.33	13.52	14.69	20.76
Jarque-Bera	2933.1	5697.5	38.2	1903.0	75.2	3814.5	932.7	8011.9	10314.1	18821.4

Table 3. Median Implied Volatility Skew and Excess Skew

Panel A of this table shows the median implied volatility skews for the overall group of stocks during the full sample period (February 15, 2008 to March 27, 2012), as well as for five different sub-periods. Two different groups of stocks are distinguished: All unbanned and all banned stocks. Mann-Whitney (MW) U-tests are applied to the implied volatility skew of paired sample splits to infer whether the medians are statistically different from each other. The null hypothesis (H_0) for the MW U-test is that there is no difference between the two unrelated samples. Rejection of H_0 and its implication that medians between sub-samples are different is denoted by ***, **, and *, for the 99, 95, and 90 percent significance levels, respectively. The superscripts are placed in the box of the second sub-sample that is compared. Therefore, the result for the statistical test that compares implied volatility skew between the first and the second sub-sample is shown in the box belonging to the 2009 stock market rally sub-sample. Panel B shows the median implied volatility excess skews between all unbanned and banned stocks for the overall sample (all) and for five different sub periods. The excess skew (B-U index) is calculated as the difference between the average implied volatility skew of all banned stocks and of all unbanned ones. Similarly to Panel A, MW) U-tests are applied to the implied volatility excess skews of paired sample splits to infer whether medians are statistically different from each other.

Panel A: Implied volatility skew

	Overall		*Belgium*		*France*		*Italy*		*Spain*	
	Unbanned	*Banned*	*Unbanned*	*Banned*	*Unbanned*	*Banned*	*Unbanned*	*Banned*	*Unbanned*	*Banned*
Full: 02/15/2008 – 03/27/2012	5.31	5.98	5.14	6.94	6.09	8.16	6.23	7.24	3.19	3.98
US recession: 02/15/2008 – 06/30/2009	5.02	5.99	4.70	6.97	5.46	7.83	6.31	8.02	3.47	4.87
2009 stock market rally: 07/01/2009 – 04/26/2010	5.05*	5.41***	4.46***	6.24***	5.69**	7.46***	5.99***	6.00***	2.42***	3.26***
Pre-ban European crisis: 04/27/2010 – 08/10/2011	5.78***	6.05***	5.63***	7.81***	6.42***	8.14***	5.82	7.11***	3.60***	3.98***
Ban period:08/11/2011 – 02/16/2012	6.05**	7.34***	5.90***	7.28	6.99***	11.97***	7.14***	7.98***	3.06***	3.98
Post-ban period: 02/17/2012 – 03/27/2012	5.17***	6.37***	5.32***	5.25***	5.59***	10.65***	6.73***	5.49***	2.73***	4.98***

Panel B: B-U Index

	Overall	*Belgium*	*France*	*Italy*	*Spain*
	Banned-Unbanned	*Banned-Unbanned*	*Banned-Unbanned*	*Banned-Unbanned*	*Banned-Unbanned*
Full: 02/15/2008 – 03/27/2012	0.71	1.89	2.15	1.06	0.89
US recession: 02/15/2008 – 06/30/2009	0.74	2.04	2.29	1.57	1.34
2009 stock market rally: 07/01/2009 – 04/26/2010	0.30***	1.79	1.75***	0.05***	0.83***
Pre-ban European crisis: 04/27/2010 – 08/10/2011	0.68***	2.10	1.50***	1.20***	0.60***
Ban period:08/11/2011 – 02/16/2012	1.18***	1.64**	4.87***	0.90***	0.88***
Post-ban period: 02/17/2012 – 03/27/2012	1.15	0.01***	5.09	-1.05***	2.28***

Table 4. Median Trading Volume for Options on Unbanned and Banned Stocks

This table shows the median daily trading volume, measured by the number of contracts traded for puts and for all options (calls and puts together) as well as the median daily put-call volume ratio for all unbanned and banned stocks for the overall sample period and for five different sub periods. We apply Mann-Whitney U-tests to the median daily volume for puts, for all options and for the put-call ratio of unbanned and banned stocks of paired sample splits to test whether the medians are statistically different from each other. The null hypothesis is that there is no difference between the populations of the two unrelated samples. Rejection of the null and its implication that the medians between our five sub-periods are different is denoted by the asterisks ***, **, and *, indicating significance at the one percent, five percent, and ten percent level, respectively.

Trading volumes

	Put volume		*Options volume*		*Put-call volume ratio*	
	Unbanned	*Banned*	*Unbanned*	*Banned*	*Unbanned*	*Banned*
Full: 02/15/2008 – 03/27/2012	1,064	1,690	2,166	3,566	7.0	3.8
US recession: 02/15/2008 – 06/30/2009	877	1,377	1,849	3,046	7.1	4.1
2009 stock market rally: 07/01/2009 – 04/26/2010	1,200***	1,747***	2,488***	3,619***	7.0	3.4***
Pre-ban European crisis: 04/27/2010 – 08/10/2011	1,157	1,905**	2,325**	3,765	6.3	3.7**
Ban period:08/11/2011 – 02/16/2012	943***	1,727***	1,950***	3,526*	8.7***	3.8
Post-ban period: 02/17/2012 – 03/27/2012	1,245***	2,758***	2,554***	4,713***	7.9	5.7***

Table 5. Panel Regression Results

This table reports the panel regression results for Model 1. We distinguish three different periods: (a) Full, February 15, 2008 to March 27, 2012; (b) Euro Crisis, April 27, 2010 to March 27, 2012; and (c) Ban, August 11, 2011 to February 16, 2012. The single stock implied volatility skew is the dependent variable and information flow (*CountryCDS* and *V2X*), firm specific control variables (*StockRt, Turnover, Size, Beta*), trading volume on single put options (*PutVolume*) and on index options (*Euros50PutVolume*), and dummies are the explanatory variables. The intercept is estimated as common to all cross-sections and no weighting is used in the cross-sections for estimation. Residuals are not normal for most cross-sections. We applied White-Heteroskedaticity consistent standard error and covariance estimates. The asterisks ***, **, and *, indicate significance at the one percent, five percent, and ten percent level, respectively.

	(a) Full Vol skew	(b) Euro crisis Vol skew	(c) Ban Vol skew
Intercept	2.823***	2.198***	-0.283
	(0.155)	(0.329)	(0.344)
V2X	0.053***	0.094***	0.035***
	(0.004)	(0.011)	(0.009)
Country CDS	0.006***	0.003***	0.008***
	(0.001)	(0.001)	(0.001)
Stock returns	5.509***	9.663***	7.055***
	(0.921)	(1.710)	(1.385)
Stock turnover	-19.317***	-22.535***	-25.602***
	(1.834)	(2.468)	(3.313)
Stock size	0.048***	0.066***	0.109***
	(0.001)	(0.001)	(0.001)
Stock *Beta*	1.015***	1.710***	3.702***
	(0.036)	(0.060)	(0.097)
Dummy Ban Period	-0.180	-1.104***	
	(0.118)	(0.195)	
Dummy Stock Banned	0.719***	0.357***	0.037
	(0.035)	(0.064)	(0.049)
Dummy Ban Period*Stock	0.306***	0.451***	
	(0.098)	(0.119)	
Dummy Post Ban	-0.201	-0.695***	
	(0.200)	(0.224)	
Dummy Post Ban*Stock	0.280	0.389*	
	(0.207)	(0.230)	
Overall put volume	0.305***	0.185	-0.297**
	(0.074)	(0.147)	(0.144)
EuroStoxx50 put volume	-0.723***	-1.358***	0.397**
	(0.119)	(0.220)	(0.189)
R^2	0.105	0.129	0.276
Observations	146,201	73,327	21,298

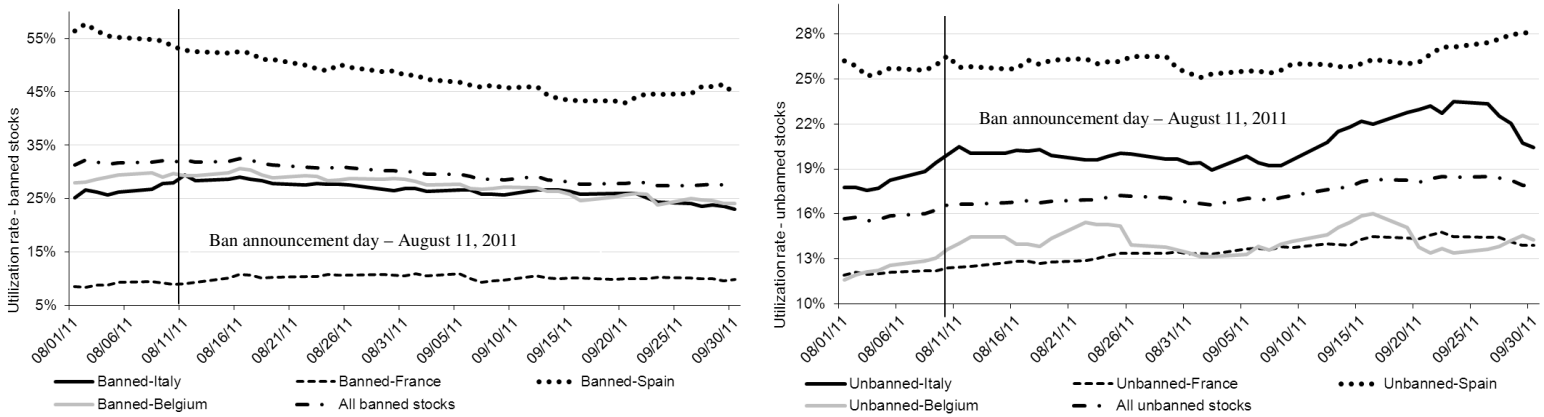
Table 6. Robustness Checks

Panel A reports the panel regression results for Model 2, in which we do not specify the dummies, using the pre-ban period, ranging from April 27, 2010 to March 27, 2012.We distinguish four different periods: (a) Full (pre-ban), February 15, 2008 to- August 10, 2011; (b) US recession, February 15, 2008 to June 30, 2009; (c) Market rally, July 1, 2009 to April 26, 2010, and (d) Euro Crisis, April 27, 2010 to August 10, 2011. Panel B reports the panel regression estimates excluding Belgium. Here we distinguish three different periods: (a) Full, 15 February 2008 to 27 March 2012; (b) Euro Crisis, 27 April 2010 to 27 March 2012; and (c) Ban, August 11, 2011 to February 16, 2012. The single stock implied volatility skew is the dependent variable and information flow (*CountryCDS* and *V2X*), firm specific control variables (*StockRt, Turnover, Size, Beta*), trading volume on single put options (*PutVolume*) and on index options (*Euros50PutVolume*), and dummies are the explanatory variables. The intercept is estimated as common to all cross-sections and no weighting is used in the cross-sections for estimation. Residuals are not normal for most cross-sections. We applied White-Heteroskedaticity consistent standard error and covariance estimates. The asterisks ***, **, and *, indicate significance at the one percent, five percent, and ten percent level, respectively.

	Panel A				Panel B		
	(a) Full (pre-ban) Vol skew	(b) US recession	(c) Market rally	(d) Euro Crisi	(a) Full Vol skew	(b) Euro Crisis Vol skew	(c) Ban Vol skew
Intercept	3.213***	2.196***	6.035***	2.429***	2.893***	1.981***	-0.728**
	(0.170)	(0.102)	(0.281)	(0.473)	(0.164)	(0.353)	(0.335)
V2X	0.052***	0.052***	-0.022**	0.125***	0.050***	0.103***	0.037***
	(0.005)	(0.002)	(0.010)	(0.017)	(0.004)	(0.012)	(0.009)
Country CDS	0.005***	0.025***	0.024***	0.000	0.006***	0.003***	0.009***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Stock returns	4.861***	4.085***	3.569***	11.958***	5.383***	9.735***	7.090***
	(1.060)	(0.667)	(1.234)	(2.927)	(0.995)	(1.832)	(1.374)
Stock turnover	-22.602***	-18.110***	-5.120	-30.131***	-19.694***	-23.984***	-27.241***
	(2.200)	(3.245)	(4.332)	(3.727)	(1.890)	(2.572)	(3.330)
Stock size	0.042***	0.034***	0.038***	0.054***	0.049***	0.069***	0.114***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Stock *Beta*	0.939***	0.944***	0.383***	1.262***	1.002***	1.739***	3.893***
	(0.031)	(0.046)	(0.037)	(0.052)	(0.040)	(0.068)	(0.099)
Dummy Ban Period					-0.184	-1.217***	
					(0.124)	(0.207)	
Dummy Stock Banned					0.712***	0.339***	0.087
					(0.036)	(0.068)	(0.056)
Dummy Ban Period*Stock					0.318***	0.497***	
					(0.106)	(0.128)	
Dummy Post Ban					-0.277	-0.743***	
					(0.210)	(0.237)	
Dummy Post Ban*Stock					0.438**	0.578**	
					(0.223)	(0.244)	
Overall put volume	0.364***	0.052	-0.016	0.370*	0.341***	0.236	-0.274*
	(0.081)	(0.054)	(0.056)	(0.201)	(0.077)	(0.156)	(0.140)
EuroStoxx50 put volume	-0.901***	-0.252***	-0.165	-2.188***	-0.724***	-1.452***	0.423**
	(0.132)	(0.082)	(0.164)	(0.308)	(0.124)	(0.233)	(0.184)
R^2	0.083	0.141	0.276	0.099	0.099	0.127	0.285
Observations	119759	44644	28230	46735	128757	64470	18702

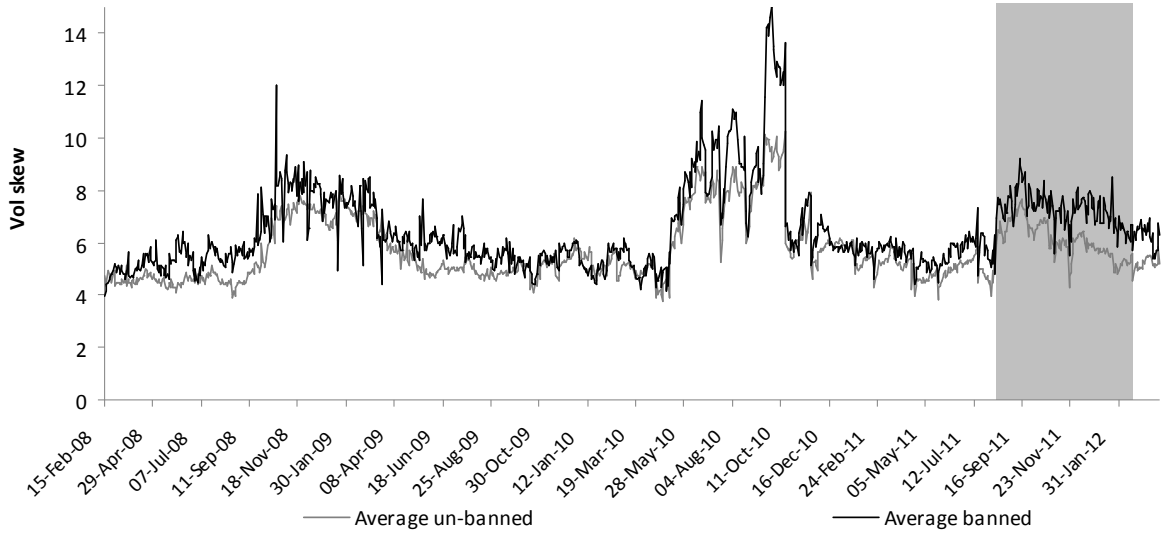
Figure 1. Short Positions Around Ban Date

A. Banned stocks **B. Unbanned stocks**



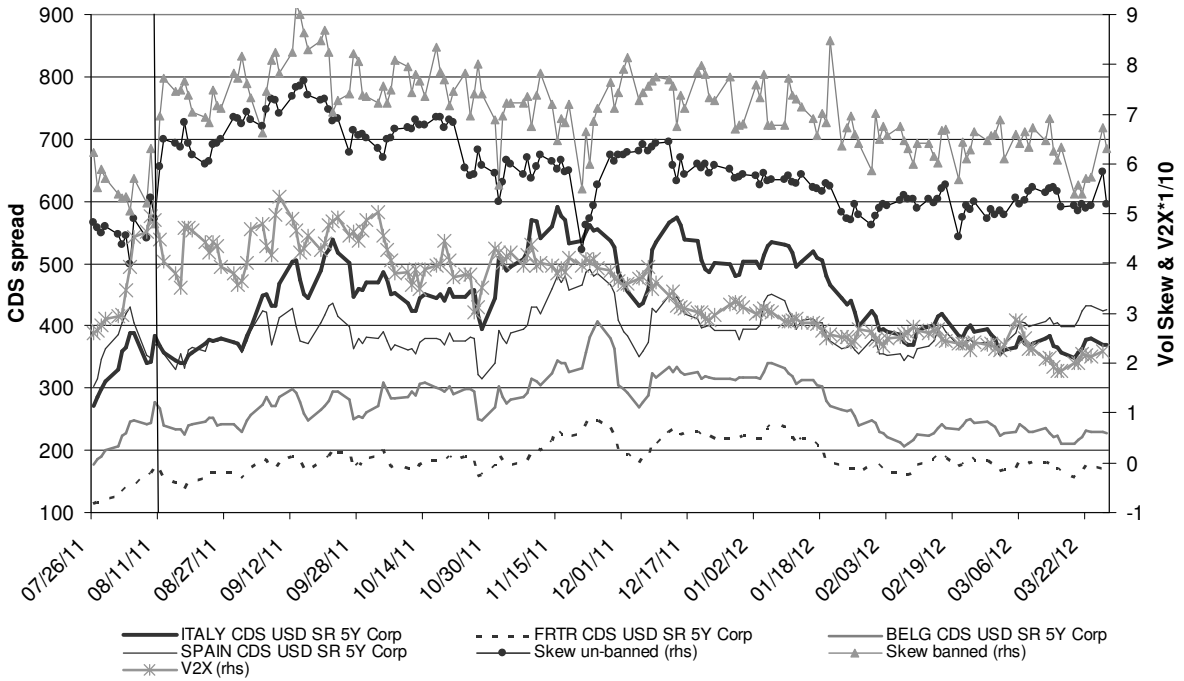
These figures present average short utilization rates calculated for banned (Section A) and unbanned stocks (Section B) in our sample. Utilization rates have been calculated for all banned and all unbanned stocks as well as for stocks in Belgium, France, Italy and Spain only. The utilization rate is calculated by $Utilization = 100 * \left(\frac{ValueOnLoan}{InventoryValue} \right)$, where *ValueOnLoan* is the beneficial owner value on the loan and *InventoryValue* is the beneficial owner inventory value. The utilization rate indicates the value of a stock utilized for securities lending against the total value of inventory available for lending. It is the demand to short as measured by the portion of shares in lending programs currently out on loan and ranges from zero to 100 percent.

Figure 2. Averaged Implied Volatility Skews



This figure depicts the average implied volatility skew for banned and for unbanned stocks over the entire sample period. Averages are calculated over all stocks in Belgium, France, Italy, and Spain that have listed options. The implied volatility skew per stock is calculated as the difference between the implied volatility of the 80 percent moneyness OTM put option and the ATM put option. The European short-selling ban period (August 12, 2011 to February 16, 2012) is shadowed in the figure.

Figure 3. Sovereign CDS Spreads, V2X and Implied Volatility



Skews

This figure depicts the five-year sovereign CDS spreads for Belgium, France, Italy, and Spain, the V2X, and the implied volatility skews for unbanned and banned stocks. Sovereign CDS spreads are used as proxy for country-specific information flow in our study. V2X is the implied volatility index from the EuroStoxx 50 index and proxies for market-wide information flow. The V2X plot is multiplied by a factor of 1/10 to fit the same scale of the implied volatility skew. The implied volatility skew per stock is calculated as the difference between the implied volatility of the 80 percent moneyness OTM put option and the ATM put option. The ban announcement day of August 11, 2011 is made distinct by a vertical line in the figure.

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