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Martin T. Bohl, Badye Essid and Pierre L. Siklos

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Do Short Selling Restrictions Destabilize Stock Markets? Lessons from Taiwan*

Martin T. Bohl

Westfälische Wilhelms-University Münster

and

Badye Essid

Centre for International Governance Innovation

and

Pierre L. Siklos**

Wilfrid Laurier University

Hong Kong Institute for Monetary Research

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Abstract

Short sellers have been routinely blamed for triggering, or exacerbating, stock market declines. The experience of Taiwan provides an interesting case study of the impact of short selling bans on stock returns volatility in a time series framework due to the length of time the short selling ban was in place there. Estimating several variants of an asymmetric GARCH model and a Markov switching GARCH model we find robust evidence that short selling restrictions raise stock returns volatility. The only qualifier is that the impact of short sale bans is a feature of the expansionary phase of business cycles. During recessions this effect dissipates.

Keywords: Short-Selling Bans, Taiwanese Stock Market, Asymmetric GARCH Models, Markov Switching Models

JEL Classification: G12, G14, G18

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** Corresponding author: Department of Economics, Wilfrid Laurier University, 75 University Ave., Waterloo, ON, CANADA, N2L 3C5.

1. Introduction

During the global financial crisis 2007/2009, and the Greek and Irish crises of 2009/2010, governments in many countries imposed limitations on short selling activities to displace short sellers and prevent further declines in stock prices. While governments, regulators, and the media blame short sellers for reinforcing stock market downturns, the finance literature mostly concludes that short selling restrictions distort market efficiency and liquidity. Surprisingly little is known about the impact of short selling restrictions on stock returns volatility. We expect an increase in volatility when short selling restrictions are in place because they limit the ability of investors to find the fundamental price. Consequently, short selling bans contribute to a destabilization of stock prices during periods of market downturns and may even exacerbate stock price declines. Hence, short selling bans are counterproductive.

Often, the duration of restrictions on short selling practices is brief and this places limitations on the type of study that can be implemented to examine their consequences. Therefore, the bulk of the relevant literature relies on cross-sectional regressions or resorts to event type studies to investigate the effects of short selling bans. Given the brief periods short selling bans are in place the methodologies usually employed in these circumstances are understandable. The experience of Taiwan, however, provides an interesting case study that permits time series testing of some of the theoretical predictions of various models aimed at understanding the potential impact of short selling bans on stock returns and their volatility.

A ban on short selling was imposed in Taiwan from late 1998 until the middle of 2005, and then again in 2008 for a much shorter period until the beginning of 2009, in the wake of the financial crisis of 2007/2009. Importantly, unlike almost all other known experiences with a short selling ban, the length of time the restrictions were in place provides an opportunity for estimating time series models. In addition, the Taiwanese market is distinguished by the late emergence of derivatives trading and the dominance of individual investors relative to institutional traders. Institutional investors have become the main driving force behind trading in stock markets elsewhere in the advanced industrial economies.

To the best of our knowledge, we are the first to specify and estimate asymmetric GARCH models to test hypotheses surrounding the effects of restrictions on short sales for the data under investigation.[1] As a result, and unlike the available literature, we are also able to control for spill over effects from other stock markets. In particular, it is conceivable that the Chinese or the U.S. stock market, or both, will also have an influence on the performance of Taiwan's stock market. Some of these influences reflect a form of interdependence in stock markets facilitated by growing international financial market integration while

[1] Charoenrook and Daouk (2008) estimate a multivariate GARCH (M-GARCH) since they are interested in the cross-sectional effects of short selling bans around the world. In addition, to deal with the dimensionality problem common with the application of this technique, they effectively end up generating estimates based on a two step procedure which raises additional statistical issues. M-GARCH estimation can be problematic.

there may also be an element less likely linked to economic fundamentals and, hence, more akin to a form of contagion. Finally, to investigate the robustness of the empirical results we consider several subsamples. In addition, we resort to Markov switching GARCH models to provide additional tests of the hypotheses considered.

The remainder of the paper is structured as follows. Section 2 provides a brief overview of the literature on short selling with particular emphasis on the regulation and suspension of these activities. Section 3 provides institutional details of Taiwan's stock market and the data used. Section 4 outlines the econometric methodology. Section 5 discusses the results while section 6 concludes.

2. Related Literature

In all financial crises, including the most recent one, policy makers have often resorted to imposing short selling bans. The usual fear, amplified by the growth in size and importance of hedge funds, is that large scale shorting will drive down stock prices inducing a massive loss of confidence in financial markets. A notable feature of the financial crisis that began in 2007 is that restrictions on short selling proved 'contagious' with several countries imposing restrictions of various durations and severity (Reuters 2009a, Mackintosh *et al*. 2009).[2] While the jury is to some extent still out concerning the overall impact of the most recent spate of short selling bans, the balance of the evidence suggests that these have either been economically costly, interfering with the legitimate investment strategies of hedge funds and institutional investors, or have failed to stem the sharp downward movements in stock prices following the collapse of Lehman Bros. and AIG in the fall of 2008.

Not surprisingly then, there exists a rich and diverse literature assessing the impact of short selling restrictions. Although there is no recent survey as such, Bris *et al*. (2007) provide many of the most important references on the topic (also, see Bai *et al*. 2006). The onset of a crisis seems to increase the appetite of regulators in favour of the removal of short selling opportunities as they fear that any downward movement in stock prices will be hastened by short sellers, in spite of the fact that the evidence to support this contention is decidedly mixed. Moreover, theory suggests that, under certain circumstances, short selling restrictions can increase the likelihood of stock market crashes as these tend to follow stock market booms or bubbles (Abreu and Brunnermeier 2003, Scheinkmann and Xiong 2003). These models predict that short selling bans increase the prospect of stock market bubbles and lead to excessive stock market volatility. A difficulty is that a short selling ban may be introduced at a time when

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[2] Gruenewald *et al*. (2010, 2010a) provide a descriptive and legalistic overview of the most recent bout of short sale restrictions imposed around the world. Recent comprehensive economic and statistical analyses of the impact of short sale constraints on market performance include Bris *et al*. (2007) and Charoenrook and Daouk (2008).

other economic conditions might also be expected to influence stock market volatility.[3] Hence, while there is broad agreement that stocks are more volatile in the presence of constraints on short selling, the empirical evidence is not conclusive. Generally, studies in this area are based either on individual stock performance or must resort to an event type approach to assess the impact of such bans.

Recent empirical evidence suggests that banning short selling is likely to create market distortions by hindering the ability of markets to engage in price discovery (Boehmer and Wu 2009). As a consequence, banning the shorting of stocks also has implications for market liquidity which is expected to fall in the presence of restrictions on this kind of activity. In the absence of such restrictions, stock prices will move more in line with underlying fundamentals (Miller 1977). Calvo and Mendoza (2000), although primarily interested in modelling the process of financial globalization and the conditions that lead to contagion type effects, also conclude that short selling bans are counterproductive because a segment of the investor population is prevented from taking full advantage of costly information. The weakening of the incentives to acquire information is also a by-product of the globalization phenomenon. To the extent that liquidity considerations may themselves be impeded by the absence of financial innovations the conclusions of Allen and Gale (1991) are germane since they show, theoretically, that short selling bans act to restrict financial innovations. Hence, the practice can potentially be detrimental to economic efficiency. This conclusion stands in sharp contrast with the prevailing empirical evidence.

Nevertheless, an important consideration is likely to be how well informed investors are (Diamond and Verrechia 1987) or investor sentiment. For example, if investors are labelled as being either of the optimistic or pessimistic variety then constraints on short selling are likely to reflect the influence of the former type over the latter type of investor resulting in pricing biases (Bai *et al*. 2006). The reason is that pessimists are likely to avoid trading when there are restrictions on short sales. Instead, the relatively more enthusiastic investors will, as a result, raise stock prices above the value consistent with fundamentals (Chang *et al*. 2007).

Among the many assumptions that prove critical in predicting the outcome for stock returns under short selling constraints, or otherwise, is whether expectations are rational, the degree of information asymmetry, and attitude towards risk. In the case of risk, many approaches presume that investors are risk neutral, hardly a realistic assumption especially in times of market stress as is true of the ongoing crisis-laden environment during the 2007-9 period. In the case of investor knowledge, the existence of heterogeneous beliefs can lead to differential reactions to good or bad news. Indeed, there is considerable evidence that stock prices move more when news is bad than when it is seen as being favourable.

3 Empirical evidence on the volatility of stocks suggests that it is higher in recessions (Hamilton and Lin 1996) or when returns are negative (Bekaert and Wu 2000). Changes in the volatility of stock returns have also been associated with increases in political tensions (Bittlingmayer 1998).

In addition, as found by Boehmer *et al*. (2008), short sellers are relatively better informed investors. Hence, restrictions on this type of activity leads to less efficient pricing and the distortions can show up in the behaviour of stock returns. The resulting asymmetry also has implications for the behaviour of higher moments in the distribution of stock returns. Therefore, adding to the impact of short selling behaviour on stock returns, models of investor behaviour have implications for higher moments of the distribution of returns, reflected in the volatility, and skewness of returns. Bris *et al*. (2007) report strong evidence, based on a large cross-section of countries including China, that the removal of short sale restrictions is associated with more negative skewness in returns but has no impact on the frequency of stock market crashes. In contrast, an equally large panel analysis by Charoenrook and Daouk (2009) finds no significant impact on skewness from the imposition of restrictions on short selling.

Whether short selling restrictions or their removal influence volatility and skewness clearly depend on these assumptions as well as any idiosyncratic legal and institutional characteristics that govern stock market behaviour (Bris *et al*. 2007).[4] An interesting example comes from Hong Kong where short selling is permitted for stocks that appear on a list that changes over time. There are stocks on the list that enter and exit permitting a clear test, for example, of the degree to which constraints on short sales hinder price discovery as well as the implications for the volatility of stock returns (Chang *et al*. 2007).

Another interesting case comes from the Chinese stock markets where, until recently, stocks where sold in segmented markets. A- and B-shares, respectively, used to be sold only to domestic and foreign residents.[5] There exist a number of calendar type effects in the behaviour of returns in A- versus B-shares (Bohl *et al*. 2010). These imply that the law of one price that ought to apply to otherwise identical shares (Lamont and Thaler 2003) is suspended, including the imposition of restrictions on short sales. Li and Fleisher (2004) investigate this possibility and conclude that short selling restrictions are binding for A-shares but not for the B-share market. They conjecture that one explanation for their results is analysts' forecasts for the B-share market does not exist, at least in their example.[6]

In the case of institutional characteristics one notable problem with the extant literature is that the data do not make it easy to identify the informed from the uninformed traders, nor whether the object of the trade is to hedge versus taking advantage of arbitrage opportunities. Yet, this consideration may potentially be important in evaluating the role of short selling constraints (Boehmer *et al*. 2008). Recent evidence

4 Among the important institutional elements is the 'uptick' rule which, like short selling restrictions, is periodically enacted or removed by regulators. For a discussion of the issues see, for example, Diether *et al*. (2009).

5 The restrictions were removed in 2001. In addition, the market was further segmented via the existence of H-shares, traded on the Hong Kong stock exchange (Walter and Howie 2006). As noted previously, short selling is now permitted in China for a limited number of stocks. To date, trading activity is not large. It is also not possible to hedge at the index level because only just under two-thirds of stocks are covered by the margin policy (Eoyang *et al*. 2010).

6 Chan *et al.* (2010) consider the implications stemming from the existence of A shares listed in Shanghai and Shenzhen and the identical ones listed as H-shares in Hong Kong. Since some H-shares are eligible for short selling while, in the period in question there existed a short selling ban on A shares in mainland China, the authors are able to explore their impact on the well-known premium that exists between these two types of shares. They conclude that a portion o f the premium that exists between these types of shares can be explained by presence of H-shares that can be shorted.

(Grundy *et al*. 2010), at least for the U.S., suggests that investors generally do not turn their attention to the options market to avoid the restrictions on the banning of short sales. Since options trading can complement as well as substitute for short selling, existing options market participants may well behave as if the safety valve available to short sellers is effectively limited. As will be seen below we find that our results are somewhat sensitive to the stage of the business cycle. For example, investors may become more attentive during a recession. Alternatively, there may be relatively more inattentive (who may, or may not, be uninformed) investors during a boom especially if a form of 'irrational exuberance' takes hold of markets.

Overall, studies of short selling bans have tended to focus on the performance of individual stocks relative to market index performance. Time series studies are in relatively short supply in large part because spells when the banning of short selling is in place are usually brief. Nevertheless, there are strong priors that the removal of short selling restrictions reduces stock price volatility while opinion is more divided about the impact of such regulations on the skewness of market returns. However, the fear expressed by some regulators, namely that the ability to engage in short selling increases the frequency of large negative returns (i.e., stock market crashes) is not borne out by the available empirical evidence (Bris *et al*. 2007, Saffi and Sigurdson 2008).

3. Institutional Details of Taiwan's Stock Market and Data

The Taiwan Stock Exchange (TWSE) was ranked as the 21th largest stock market in terms of market capitalization in 2009 totaling US-$ 657 billion (World Federation of Exchanges Annual Report 2009). For example, in 2009, the TWSE trailed the Moscow Interbank Currency Exchange, evaluated at US-$ 736 billion, the Johannesburg Stock Exchange, evaluated at US-$ 799 billion, and the Korea Exchange, evaluated at US-$ 834 billion. In terms of the number of listed companies, the TWSE grabbed 20th place with 755 listed companies in 2009.

The TWSE is characterized by the dominance of individual investors in the spot market and, at least until 2004, in the futures market, too. Trading volume in the spot market accounted for 90% in 1995 and decreased to 80% in 2000 and 70% in 2009. While trading volume of domestic institutional investors fluctuates around 10% during the period from 1995 to 2009, foreign individual trader activities are negligible and foreign institutional investors account for about 15% of trading volume only since 2005.

Futures were first introduced to the Taiwan Futures Exchange in 1998. Individual investors account for about 90% of trading volume the first years. From 2002 onwards the participation of private investors in the Taiwanese futures market declines to 40%. Options are available in late 2001. Derivatives' trading volume developed slowly the first four years. From 2003 onwards it increased and was relatively stable since then. The fact that the Taiwanese derivatives market was created gradually, until at least late 2003, limited the possibilities of circumventing the short selling bans for the TWSE.

The Taiwanese Securities and Futures Bureau imposed restrictions on the short sale of all stocks on September 4, 1998 (e.g, see Charoenrook and Daouk 2008) . The tick rule prohibits investors from short selling a stock at a price below its close price of the previous day. The reference price is determined and fixed the day before the stock market opens and investors are aware of the condition short selling is banned or not during the trading hours of the following day.[7] It is a stability measure for the aftermath of the Asian crisis and is intended to prevent short sellers from driving stock prices further downward. Chang *et al*. (2007) find evidence that the impact of a tick rule on stock returns is similar to short sale constraints. Consequently, a tick rule can be viewed as another form of short sale constraints. Domestic and foreign investors were not allowed to sell short before July 2003 so that only individual investors can undertake short selling. Nevertheless, the short selling ratio was 4% in 1998 and declined to 2% in 2009. Moreover, over the period from October 19, 2000 to July 12, 2001 stocks with close price below its par value (10 NT$) were not allowed to sell short. It is a temporary measure to stabilize the market after the dotcom bubble. The tick rule was suspended for stocks of the Taiwan 50 Index on May 16, 2005.[8]

As a reaction to the global financial crisis the Taiwanese authority short selling restrictions on all stocks were once again re-introduced for a much shorter period from. On September 21, 2008 the authority was re-imposing a ban on short-selling shares in 150 companies below their closing prices in the previous session. Investors could not short stocks in 150 companies in the Taiwan 50 Index, the Taiwan Mid-Cap 100 Index and the Taiwan Information Index from September 22 to October 3, 2008. Short selling was banned for all stocks from October 1 to 14 and the restriction was extended until the end of the year.

Our empirical analysis relies on the Taiwan Stock Exchange Weighted Index (TAIEX) and the Taiwan 100 stock market indices. The latter is modeled on London's Financial Times index (i.e., the FTSE 100) and consists of mid-cap stocks, while the TAIEX is a broader index consisting of 656 companies weighted by their capitalization.[9] We measure the regional and international influences on the Taiwanese stock market with the Shanghai A-share index and the U.S. S&P 500 index, respectively.[10] The data source for the indices is Datastream and Bloomberg. The three stock market indices are available at the daily frequency

[7] In addition, the TWSE imposes a quota limit for each stock. A stock is not allowed to sell short if the short interest reaches 25% of its outstanding stocks. The quota limit is intended to prevent short sellers from concentrating on shorting one stock.

[8] Some of the documentation we have looked at suggests that an alternative date for the lifting of the short selling ban is June 27, 2005. In the empirical section we report on robustness tests to changes in the ending of the ban. Also relevant, though this is ignored in the empirical analysis below since the amounts in question are likely very small, are various restrictions on foreigners' ability to hedge or own Taiwanese securities.

[9] Additional details are available from the Taiwan Stock Exchange (http://www.twse.com.tw/en/).

[10] We could also have chosen returns from A-shares in Shenzhen. However, the correlation in the returns for the two indices is around 0.90. Hence, we opt for the larger and more liquid Shanghai market as the proxy for spill over effects from the Chinese markets.

at the close of every trading day. The sample begins January 5, 1995 and ends May 20, 2009, while data for the Taiwan 100 market index are available beginning July 3, 1995.

In order to ascertain the robustness of our results several samples are considered. One sample excludes all weekends and public holidays another excludes crises periods.[11] We consider the possibility that some events (e.g., the terrorist attacks in 2001 and the accounting scandals in the U.S. in 2002) are not crises as such but exogenous events that can be conditioned in our estimated model via a separate set of dummy variables. In this scheme the remaining crises periods are then excluded. The dates for the crisis periods before 2007 are provided in Table 1 and were chosen based on the sources given in Serwa and Bohl (2005) for crises until 2002.[12] Thereafter, the dating of the global financial crisis of 2007/2009 is based on the St. Louis Fed's financial crisis timeline (http://timeline.stlouisfed.org/). We chose to date the beginning of the global financial crisis on June 7, 2007 when Bear Sterns suspended redemptions from some of its instruments previously labeled of the 'high grade' variety. Admittedly, there can be disagreement about the precise date when the crisis originating in the U.S. began but most observers tend to focus on the events of the summer of 2007. As there is some disagreement about the precise dating of some crises we also estimate our model for alternative crises dates (also see Table 1) as well as samples that distinguish between recessionary versus expansionary periods. To the extent that liquidity considerations influence stock prices and portfolio holdings over the business cycle there is the possibility that the addition of short-selling restrictions will further influence volatility in equity returns (e.g., see Naes et.al. 2010). For the U.S. the NBER business cycle dating chronology (http://www.nber.org/cycles.html) while for Taiwan the chronology of the Economic Cycle Research Institute (http://www.businesscycle.com/home/) is used. There was no recorded recession for China over the estimation sample considered. Recessions in both Taiwan and the U.S. are combined. Therefore, no distinctions were made between a recession in Taiwan and the U.S.

Figure 1 plots the levels of the indices for the TAIEX, the S&P500 and the Shanghai A-share index. The index for the Taiwan 100 is not shown. Also relevant for our empirical analysis are crisis periods which are highlighted in Figure 1 as shaded areas. One sees that all three indices fall shortly after the global financial crisis. Not shown here but considered in the empirical investigation below are periods when any one of the three economies considered were in recession. Since this can be an important determinant of stock market performance a role for the state of the business cycle is also contemplated in the empirical investigation reported in the following sections.

[11] Chae and Wang (2003) point out that, until the end of December 2000, stock trading also took place on most Saturdays, except for the January to March 1998 period when trading took place only on the second and fourth Saturday of the month. All estimates reported in the following section were repeated with a dummy added for Saturday trading. None of the results are affected. Therefore, this variable is dropped from the subsequent analysis.

[12] The dates are based on widely used sources in the literature that deals with the dating of various financial crises.

Figure 2 plots the returns on the TAIEX and the S&P500. The returns of the remaining time series are not shown to conserve space. In addition to the crisis periods discussed above the lightly shaded areas consists of the period September 5, 1998 to June 27, 2005, as well as a much shorter period from October 1, 2008 to January 5, 2009, the latter indicated by the dashed vertical lines. These are periods when a short selling ban was in place in Taiwan. In the case of the S&P 500 the ban on the short sale of certain financial stocks from September 15, 2008 to October 8, 2008 is also shown by dashed vertical lines. The contrast in the duration of the short selling ban in the two countries is unmistakable.

The summary statistics shown in Table 2 reveal a few interesting stylized features about the data. If one examines the summary statistics for Taiwan stock market returns, the period when the short-selling ban was in place is characterized by lower returns and higher volatility as measured by the standard deviation of returns.[13] Next, excluding crisis periods raises mean returns in all three markets. This is especially true for recessions which have a considerably larger impact on mean returns in all stock markets than during crises periods only. Volatility of stock returns is, perhaps unsurprisingly, considerably greater during recessions and in the midst of crises than at any other time.

Moreover, it is abundantly clear that stock returns volatility is considerably larger in Taiwanese markets and in the Shanghai A-shares market, than for the S&P500. Nevertheless, it is instructive that the more volatile stock indices in the Asian markets considered is not a feature of crises or recession periods. Finally, the distribution of returns in the Shanghai market is seen to have excessively fat tails. Note, however, that kurtosis in the Shanghai returns begins to resemble that of the remaining two stock markets shown when crises and recession periods only are considered. Indeed, the excess kurtosis for the Shanghai market is primarily a feature of the expansion phase of the business cycle.

4. Methodology

Our aim is to model returns of Taiwan's stock market using conditional volatility and Markov switching models. Two of the most widely used asymmetric conditional volatility models are the exponential GARCH or EGARCH, and threshold GARCH, or TGARCH models. In what follows both models produced virtually identical results and additional diagnostic testing did not permit us to choose one over the other. All results shown below are based on the TGARCH model. Since both GARCH models are univariate, we also consider estimates based on a multivariate GARCH (MGARCH) model and Engle's (2002) dynamic conditional correlation (DCC) model.[14]

[13] The differences are all statistically significant (results not shown).

[14] Empirical findings on EGRACH, MGARCH and DCC models are available on request largely because none of the conclusions reported below are affected. Moreover, it is well known that MGARCH models easily become over-parameterized and this is especially the case when the investigator wishes to allow for asymmetric effects. Also, there are a number of other outstanding statistical issues around the estimation of such models that remain unanswered (Silvennoinen and Teräsvirta 2008).

Our empirical investigation on the effect of short selling restrictions on stock market volatility relies on the following TGARCH model:

$$r_t = \alpha_0 + \sum_{i=1}^{4} \alpha_i DoW_{it} + \alpha_5 r_{t-1} + \beta_1 r_{t-1}^{US} + \beta_2 r_t^{SH} + \beta_3 911_t + \beta_4 ENRON_t + \varepsilon_t \tag{1}$$

$$h_t = \omega + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 h_{t-1} + \gamma_3 I_t \varepsilon_{t-1}^2 + \gamma_4 D_t \varepsilon_{t-1}^2 I_t + \lambda_1 r_{t-1}^{US} + \lambda_2 r_{t-1}^{SH} \tag{2}$$

$$I_t = \begin{cases} 1 \text{ if } \varepsilon_{t-1} < 0 \\ 0 \text{ if } \varepsilon_{t-1} \geq 0 \end{cases} \tag{3}$$

$$D_t = \begin{cases} 1 \text{ if } SSR_B \leq t \leq SSR_E \\ \quad 0 \text{ otherwise} \end{cases} \tag{4}$$

The index return is defined as 100 times the logarithmic difference $r_t = \ln P_t - \ln P_{t-1}$ and $\varepsilon_t = N(0, h_t)$ denotes the unpredictable component of stock index returns. $\sum_{i=1}^{4} DoW_{it}$ are day of the week dummy variables for Tuesday, Wednesday, Thursday and Friday $i = 1,...,4$. Lagged stock index returns r_{t-1} enable us to detect autocorrelation in returns of order one. Stock returns on U.S. S&P500 r_{t-1}^{US} and Shanghai A-share index r_t^{SH} are used to determine whether there are spill over effects from these markets into the Taiwanese stock market. Notice that the return for the Shanghai market is contemporaneously related to the dependent variable since stock markets in Taiwan and Shanghai trade in the same time zone, while the U.S. market has a lagged effect since New York is 12 hours behind. In the conditional variance equation spillover effects from the Shanghai and the U.S. are lagged one day since realized daily volatility is known only at the end of the day.[15] I_t takes on the value of 0 if the return innovation is negative, $\varepsilon_{t-1} < 0$, and 1 in case the return shocks are 0 or positive, $\varepsilon_{t-1} \geq 0$.

With the dummy variable D_t we model the regulatory change connected with the introduction of short selling constraints in both periods. First, the dummy D_t takes on a value of 1 for the beginning SSR_B to the end SSR_E of both periods of short selling restrictions, i.e., from September 5, 1998 to June 27, 2005 and from October 1, 2008 to January 5, 2009. Hence, both periods of short selling bans are not treated differently. Second, the equations are estimated with separate dummies for both short selling ban periods to test whether the dummy coefficients of both periods are different from each other.

15 Nevertheless, various permutations of the relationship between Shanghai A-shares returns and the dependent variable were considered. Details of the comparisons are available on request. In general, there was little to choose between lagging the Shanghai A-shares market versus a contemporaneous relationship in both the mean and variance equations. However, since there was slightly more evidence of a spill over effect from the Shanghai market to the Taiwanese market in the mean equation this was chosen as the preferred specification.

The volatility equation is a version of the asymmetric GARCH model put forward by Glosten, Jagannathan and Runkle (1993) in which positive and negative shocks can have different effects on subsequent volatility via the dummy variable I_t. In case the asymmetry coefficient γ_3 is positive and significant, volatility is higher in downward markets relative to upward markets. More important for our research question is the parameter γ_4. If the short-selling ban raises the volatility structure of index returns, the coefficient γ_4 should be positive and statistically significant. If $\gamma_4 = 0$, short selling bans do not have an impact on volatility in falling markets. If γ_4 is statistically significant but negative, then short selling bans exhibit a dampening influence on volatility.

The short sales restrictions in our data set encompass an extended period. Therefore, we are able to further examine the impact of imposing short selling bans on the conditional volatility by exploring the sensitivity of our results to changes in overall economic conditions. Our empirical procedure is motivated by the results presented in Table 2. The Taiwan stock market returns summary statistics show a difference in mean and volatility as between recession versus expansion phases of the business cycle. To estimate the effect of short selling bans, given the business, we also estimate TGARCH models for recession and expansion periods. As such, we split the data into two sub-samples based on the dates defined in Table 1.

Next, we explore the effect of short sales restrictions on conditional volatility based on a two state Markov switching TGARCH (MS-TGARCH) model. In this framework we do not exogenously distinguish between different cycles in the economy but rather allow the states to be determined by Taiwan stock return conditions. Relying on the MS-TGARCH model we let the data speak for themselves. In effect not only are we able to establish whether business cycle influences play a separate role in explaining the impact of a short selling ban but, just as important, this approach provides an additional robustness test for the parameter of interest, namely γ_4.Therefore, short selling bans might have different effects on volatility in two different states of the business cycle. The MS-TGARCH specification is written:

$$r_t = \alpha_{0,s_t} + \alpha_{1,s_t} r_{t-1} + \beta_{1,s_t} r_{t-1}^{US} + \beta_{2,s_t} r_t^{SH} + \varepsilon_t \tag{5}$$

$$h_t = \omega_{s_t} + \gamma_{1,s_t} \varepsilon_{t-1}^2 + \gamma_{2,s_t} h_{t-1} + \gamma_{3,s_t} I_t \varepsilon_{t-1}^2 + \gamma_{4,s_t} D_t \varepsilon_{t-1}^2 I_t \tag{6}$$

where s_t is the state variable which is assumed to follow a two state Markov chain. For our model to be tractable and given the results obtained by estimating TGARCH (1) to (4) we remove the day of the week dummy variables from the mean equation and the spill over effects from the volatility equation. Our empirical specification, therefore, is a simplified version of the model presented in equation (1) and (2). To approximate an MS-TGARCH model, we use a Markov Chain Monte Carlo method using Gibbs sampling.

When the likelihood function is difficult to characterize the Bayesian approach is widely used in the literature to simulate model parameters (Tsay 2001, Bauwens *et al*. 2010).[16]

5. Empirical Results

Tables 3, 4 and 5 provide the main empirical findings. Table 3 contains estimates of the TGARCH model for the full sample excluding weekends and public holidays and, alternatively, crisis periods.[17] When alternative dates are assumed for the timing of the various banking and currency crises are considered (see Table 1) none of the results were significantly affected. Hence, these are not shown. We present in Table 4 estimates when the TGARCH model is separately fitted to a sample that considers only recessionary versus expansionary periods. Finally, in Table 5 we present MS-TGARCH estimates for two regimes.

When looking at the estimated coefficients of the mean equation in Tables 3 and 4, we find only very weak day of the week effects. In a few cases mean returns are lower on Tuesdays compared with the rest of the work week. Moreover, the broader Taiwan index displays no statistically significant autocorrelation throughout the various cases considered, while the narrower Taiwan100 index displays negative autocorrelations. The result is robust to changing the sample but disappears when the TGARCH model is estimated for the recession only sample. These findings seem to indicate the existence of feedback traders (Sentana and Whadwani 1991, Shiller 1981) in mid-cap type stocks.

Another characteristic of all estimated models is that spill over effects influence stock returns. Spill over effects in mean returns are large and positive coming from the S&P500 but the impact of Shanghai A-shares, though also consistently statistically significant, is considerably smaller. Finally, we note that the events of 9/11 and the period when the U.S. was dealing with the consequences of accounting scandals are never statistically significant. This suggests that it is likely preferable to separate periods of financial crises from other major events. In any case, none of the other coefficients are affected by the way we treated these two sets of events relative to the banking and currency crises considered.

Turning to the empirical findings of the estimated parameters describing the conditional volatility process of the TGARCH models we find the well-established result of volatility persistence in stock returns

16 The Gibbs sampling approach combines prior belief and data to elucidate posterior distributions on which statistical inference will be based. In the present study, transition probabilities will be drawn from a Beta prior distribution. The parameters entering the mean equation will be drawn from a normal prior distribution. Since the parameters entering the variance equation are nonlinear, we rely on the Griddy Gibbs sampling approach to draw random distribution from a uniform prior distribution. We proceed by drawing a random number of each of the conditional specified distributions. A large number of random draws is approximately equivalent to a random draw from the joint distribution. For further details about the estimation procedure see Tsay (2001).

17 The estimates rely on the assumption that the residuals follow the generalized error distribution (GED) since, as is well-known, the errors have fat tails. The results shown at the bottom of the relevant Tables support the choice.

measured by γ_1 and γ_2. In addition, all asymmetry coefficients γ_3 are statistically significant suggesting that volatility is higher in periods of market decline than during market upturns, which can be theoretically justified by the leverage effect. It is also worthwhile highlighting the fact that bad news actually has roughly twice as large an effect on volatility during recessions, or crises, than during expansions or when the full sample is considered. In the variance equation the S&P500 has a dampening effect on the conditional volatility of returns in Taiwanese markets, while there is almost no statistically significant impact from the Shanghai A-share index on the conditional volatility of the Taiwanese market. Hence, spill over effects from the U.S and the Chinese stock markets mainly operate through mean returns whereas there appears to be almost no evidence of volatility spill over from the Shanghai stock market.

Turning the coefficient that is our main interest here, imposing a short selling ban raises the conditional volatility of returns in the Taiwanese stock market as indicated by positive and highly statistically significant estimated parameter γ_4. The only exception is when recessions alone are considered. Note that short sale restrictions overlap with recessions in Taiwan from August 2000 to September 2001 and again from October 2008 to January 2009. However, it is also the case that for Taiwan the short sale restrictions also encompass a period when the Taiwanese economy was expanding. Given the rather strong evidence of robustness across the various specifications the overall conclusion is that short selling restrictions raise stock return volatility. The only qualifier is that during recessions these effects dissipate. Therefore, volatility is not reduced by an imposition of restrictions on short selling.[18]

Table 5 shows estimates of a two regimes MS-TGARCH model. The two regimes identified by the MS-TGARCH simulation are: the first (second) regime is characterized by a positive (negative) return and a low (high) conditional volatility. Regime one expected duration is about 23 days compared to an expected duration of 6 days for the second regime. Therefore, the first regime will be associated with favourable financial conditions. Clearly then, regime 2 will be associated to adverse financial conditions.

The results of the MS-TGARCH simulation corroborate the importance of the spill-over effects in the mean equation from US market: S&P 500 effect is significant for both regimes and both Taiwanese stock return indexes used in this study. The spill-over effect from the Shanghai A-share market, in accordance with the results obtained from the TGARCH models, seems to be non significant. More importantly, the conditional volatility is positively and significantly affected by short selling ban, particularly during period of favourable financial conditions. In other words, the previously reported findings based on an alternative GARCH model appear robust.

[18] We also investigated the possibility that the second short selling ban had different volatility effects. Note that the samples which exclude crises or include expansion only periods effectively exclude the second short sale ban. If we consider instead a sample that begins in 2007 then the second short sale ban is still found to raise volatility for the TAIEX but not the Taiwan100 (results not shown).

We assume that there is an important connection between the first regime (second regime) and the expansion (recession) period. We also conclude, therefore, that the short selling ban seems to have no influence on the conditional volatility during period of recession (adverse financial conditions). This result corroborates the idea that short selling could exacerbate a downward movement in stock prices. Restrictions on short sales imposed by governments, during bad economic and financial conditions, seem to have no impact on the stock return conditional volatility. However, short selling restrictions seem to have significant and positive effect on the conditional volatility during period of expansion (favourable financial conditions), which underscores the idea that short-selling restrictions induce stock prices to move far from the underlying fundamentals (Miller 1977) and may increase the likelihood of stock market booms or bubbles (Abreu and Brunnermeier 2003, Scheinkmann and Xiong 2003).

6. Conclusions

Short selling bans have a storied history and are frequently invoked when stock prices begin to fall, especially in crisis type conditions. However, such restrictions are also typically only put in place for relatively brief periods. This places limitations on the kind of statistical analysis that can be brought to bear on the data. Taiwan represents an interesting case study since a complete ban on short selling was in place between 1998 and 2005 and then again in 2008/2009 for a little over three months in the aftermath of the financial crisis that began in the U.S. Consequently, time series analysis can be used to explore what happens to the conditional volatility of stock returns when a ban on the short selling of stocks is imposed.

Relying on a variety of asymmetric GARCH-type models we find robust evidence that supports the view that a ban on this kind of stock trading activity raises the conditional volatility of stock returns. Perhaps just as importantly, we also conclude that the impact of the ban on short sales is also dependent on whether the economy is in recession or not. While short selling restrictions are often imposed in crisis environments these need not be coincident with recessionary periods. The latter are frequently a casualty of such crises. We find strong evidence that the impact of these bans is asymmetric in nature with no statistically significant impact during recessions but a higher conditional is found when the restrictions are imposed in the expansionary phase of a business cycle. Ongoing research will aim to explore whether, the asymmetry identified for Taiwan can be replicated in a cross-country setting.

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Table 1. Crisis Periods, Other Key Events and Recession Dates

Crisis Periods	
Crisis Name	Crisis Period (Alternative Dates)
Asian "Flu"	October 23, 1997 – November 22, 1997 (July 2, 1997)
Russian "Virus"	August 6, 1998 – October 5, 1998 (July 7, 1998, August 17, 1998 or September 2, 1998)
Brazilian Crisis	January 1, 1999 – March 1, 1999
Turkish Collapse	February 2, 2001 – March 13, 2001 (November 2, 2000)
Argentinean Crisis	December 27, 2001 – February 26, 2002
Global Financial Crisis	June 7, 2007 – End of Sample
Other Key Events	
Name	Dates
Terrorist Acts and Economic Slowdown	September 14, 2001 – October 13, 2001
Accounting Scandals in the U.S. (Enron, Sarbanes-Oxley disclosure legislation)	June 25, 2002 – July 24, 2002
Recession Dates for Taiwan	August 2000 – September 2001 February 2008 – January 2009

Sources: Serwa and Bohl (2005), Financial Superivsory Commission of Taiwan (http://www.fscey.gov.tw/Layout/main_en/index.aspx?frame=16), financial crisis timeline (http://timeline.stlouisfed.org/), Bris *et al*. (2007), Gruenewald *et al*. (2010a), and Laeven and Valencia (2010). The recession dates are expressed in monthly terms and refer to the peak to through in business cycles.

Table 2. Summary Statistics

Statistic	TAIEX	Taiwan100	S&P500	Shanghai A-Shares
Full Sample				
Observations	3529	3399	3529	3529
Mean	- 0.0001	0.015	0.028	0.043
Std Dev.	1.527	1.609	1.066	1.850
Skewness	- 0.148	0.017	- 0.123	0.582
Kurtosis	5.756	7.091	6.482	24.484
When short-selling ban is not in place				
Observations	1905	1778	1905	1905
Mean	0.854	0.024	0.037	0.087
Std Dev.	1.419	1.475	1.087	2.242
Skewness	-0.325	-0.219	-0.680	0.451
Kurtosis	5.608	5.575	11.643	20.286
When short-selling ban is in place				
Observations	1930	1930	1930	1930
Mean	-2.389	-0.015	-0.008	-0.020
Std Dev.	1.724	1.811	1.426	1.444
Skewness	-0.0002	0.168	-0.009	0.464
Kurtosis	5.201	6.684	10.173	9.016
Excluding Crises, 9/11 and Enron Scandal				
Observations	3032	2905	3032	3032
Mean	0.015	0.030	0.050	0.068
Std. Dev.	1.485	1.572	0.981	1.797
Skewness	- 0.202	- 0.001	0.032	0.837
Kurtosis	5.897	7.704	5.749	30.166

Table 2. Summary Statistics (Continued)

Statistic	TAIEX	Taiwan100	S&P500	Shanghai A-Shares
Excluding Crises Only				
Observations	3299	3172	3299	3299
Mean	0.013	0.281	0.044	0.056
Std. Dev.	1.493	1.576	1.005	1.852
Skewness	-0.239	-0.051	0.012	0.643
Kurtosis	5.769	7.384	5.493	25.569
Recessions Only				
Observations	732	732	732	732
Mean	- 0.116	- 0.110	- 0.099	- 0.106
Std. Dev.	2.078	2.114	1.977	2.009
Skewness	- 0.115	- 0.262	- 0.035	0.074
Kurtosis	4.134	4.154	8.010	6.610
Expansions Only				
Observations	2841	2723	2841	2841
Mean	0.028	0.044	0.039	0.066
Std. Dev.	1.478	1.568	1.029	1.887
Skewness	- 0.067	0.110	- 0.180	0.725
Kurtosis	5.419	7.423	7.158	26.609

Note: Returns are 100 times the log difference in the value of the stock index. The full sample is daily from January 5, 1995 to May 20, 2009 but excludes public holidays in Taiwan and weekends. For the Taiwan 100 the sample begins July 3, 1995. The short selling bans in Taiwan are September 5, 1998 to June 27, 2005 and October 1, 2008 to January 5, 2009. Dates for crises and other events are given in Table 1.

Table 3. Empirical Results for Full Sample Period, TGARCH Model

Coefficient	Weekends and Public Holiday Excluded TAIEX	Weekends and Public Holiday Excluded Taiwan100	Crises Periods Excluded TAIEX	Crises Periods Excluded Taiwan100
α_0	0.035	0.041	0.045	0.018
	(0.040)	(0.042)	(0.039)	(0.042)
α_1	- 0.023	- 0.037	- 0.120	- 0.098
	(0.056)	(0.060)	(0.058)**	(0.062)
α_2	- 0.046	- 0.046	- 0.070	- 0.044
	(0.057)	(0.060)	(0.056)	(0.059)
α_3	- 0.014	- 0.005	0.013	- 0.054
	(0.055)	(0.059)	(0.056)	(0.060)
α_4	- 0.039	- 0.060	0.041	- 0.067
	(0.056)	(0.061)	(0.056)	(0.060)
α_5	- 0.017	- 0.041	- 0.018	- 0.040
	(0.016)	(0.016)***	(0.016)	(0.017)**
β_1	0.304	0.343	0.313	0.354
	(0.020)***	(0.021)***	(0.021)***	(0.021)***
β_2	0.039	0.045	0.039	0.045
	(0.009)***	(0.010)***	(0.009)***	(0.011)***
β_3			- 1.245	- 0.783
			(0.820)	(0.844)
β_4			0.096	0.104
			(0.065)	(0.066)
ω	0.041	0.035	0.037	0.036
	(0.009)***	(0.009)***	(0.010)***	(0.010)***
γ_1	0.027	0.030	0.036	0.040
	(0.009)***	(0.009)***	(0.011)***	(0.010)***
γ_2	0.912	0.920	0.911	0.913
	(0.012)***	(0.011)***	(0.012)***	(0.012)***
γ_3	0.067	0.056	0.058	0.052
	(0.000)***	(0.014)***	(0.015)***	(0.015)***
γ_4	0.046	0.040	0.030	0.029
	(0.014)***	(0.013)***	(0.011)***	(0.011)***
λ_1	- 0.061	- 0.060	- 0.062	- 0.063
	(0.022)***	(0.020)***	(0.022)***	(0.023)***
λ_2	- 0.001	0.007	- 0.001	0.007
	(0.009)	(0.010)	(0.009)	(0.010)
LL	- 5938	- 5858	- 5475	- 5392
GED	1.238	1.251	1.247	1.249
	(0.040)***	(0.040)***	(0.041)***	(0.042)***
$\overline{R}^2$	0.065	0.072	0.065	0.073

Note: Estimation technique and sample details are given in the text and in Tables 1 and 2. GED is the generalized error distribution that is assumed to drive the error process, and LL is the log likelihood ratio.

Table 4. Empirical Results for Recessions and Expansions

Coefficient	Recession Periods Only TAIEX	Recession Periods Only Taiwan100	Expansion Periods Only TAIEX	Expansion Periods Only Taiwan100
α_0	- 0.170	- 0.112	0.080	- 0.052
	(0.138)	(0.144)	(0.040)*	(0.045)
α_1	- 0.078	- 0.176	- 0.198	- 0.163
	(0.208)	(0.216)	(0.065)***	(0.069)**
α_2	0.314	0.233	- 0.092	- 0.068
	(0.199)	(0.206)	(0.063)	(0.066)
α_3	0.079	- 0.002	- 0.004	0.031
	(0.192)	(0.199)	(0.063)	(0.067)
α_4	- 0.139	0.065	0.062	0.096
	(0.028)	(0.220)	(0.062)	(0.067)
α_5	- 0.030	- 0.051	- 0.012	- 0.038
	(0.038)	(0.038)	(0.019)	(0.019)**
β_1	0.324	0.344	0.362	0.397
	(0.037)***	(0.039)***	(0.023)***	(0.024)***
β_2	0.138	0.129	0.040	0.045
	(0.028)***	(0.030)***	(0.010)***	(0.012)***
ω	0.067	0.068	0.036	0.030
	(0.025)**	(0.029)**	(0.009)***	(0.009)***
γ_1	- 0.012	- 0.018	0.032	0.037
	(0.018)	(0.014)	(0.010)***	(0.010)***
γ_2	0.964	0.959	0.914	0.922
	(0.012)***	(0.014)***	(0.012)***	(0.011)***
γ_3	0.102	0.104	0.060	0.047
	(0.021)***	(0.023)***	(0.010)***	(0.015)***
γ_4	- 0.024	- 0.023	0.026	0.022
	(0.017)	(0.020)	(0.011)***	(0.011)***
λ_1	- 0.005	- 0.005	- 0.067	- 0.067
	(0.047)	(0.050)	(0.022)***	(0.023)***
λ_2	0.042	0.040	0.005	0.011
	(0.021)**	(0.025)	(0.009)	(0.010)
LL	- 1478	- 1491	- 4727	- 4645
GED	1.705	1.725	1.328	1.319
	(0.140)***	(0.136)***	(0.048)***	(0.049)***
$\overline{R}^2$	0.124	0.120	0.070	0.077

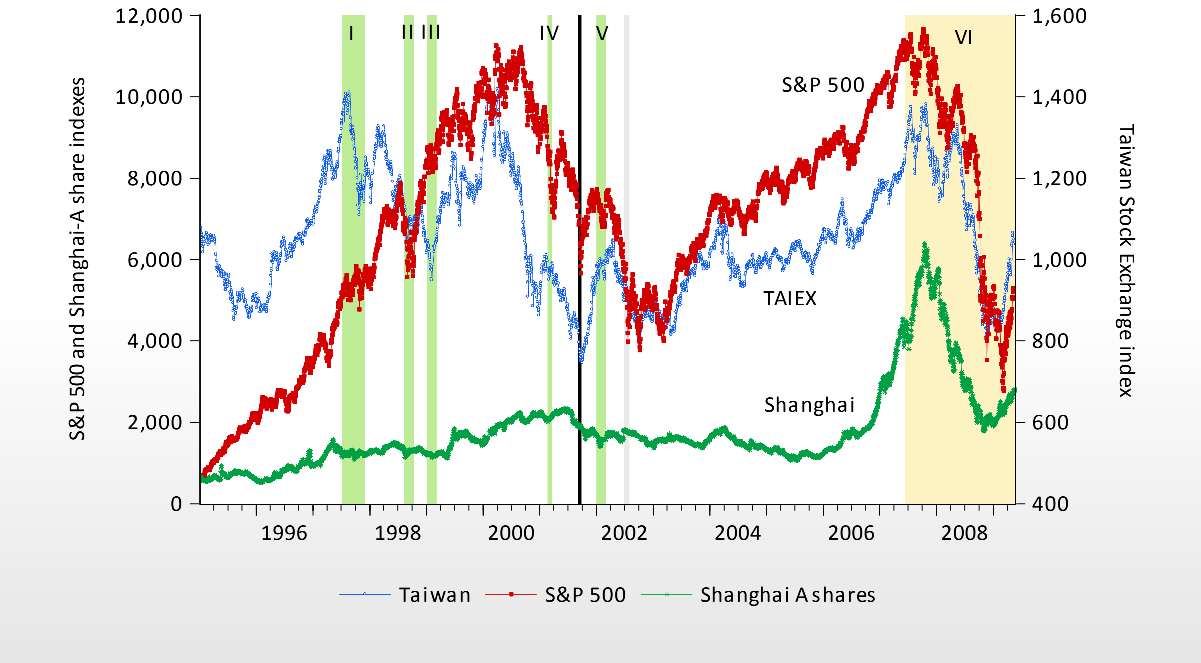
Note: Estimation technique and sample details are given in the text and in Tables 1 and 2. GED is the generalized error distribution that is assumed to drive the error process, and LL is the log likelihood ratio.

Table 5. Empirical Results for MS-TGARCH

	Regime 1		Regime 2	
Coefficient	TAIEX	Taiwan100	TAIEX	Taiwan100
α_{0,S_t}	0.073	0.081	-0.343	- 0.279
	(0.030)***	(0.026)***	(0.112)***	(0.090)**
α_{1,S_t}	- 0.020	- 0.085	0.040	0.118
	(0.021)	(0.027)***	(0.050)	(0.084)
β_{1,S_t}	0.323	0.352	0.447	0.472
	(0.028)***	(0.034)***	(0.075)***	(0.088)***
β_{2,S_t}	0.018	0.021	0.202	0.186
	(0.014)	(0.013)	(0.051)***	(0.052)***
ω_{S_t}	0.068	0.007	1.068	1.150
	(0.015)**	(0.002)***	(0.172)***	(0.123)***
γ_{1,S_t}	0.004	0.012	0.036	0.037
	(0.004)	(0.007)*	(0.025)	(0.027)
γ_{2,S_t}	0.857	0.870	0.724	0.738
	(0.025)***	(0.012)***	(0.060)***	(0.067)***
γ_{3,S_t}	0.006	0.006	0.033	0.031
	(0.006)	(0.005)	(0.026)	(0.026)
γ_{4,S_t}	0.176	0.142	0.085	0.128
	(0.043)***	(0.030)***	(0.063)	(0.086)
Transition	0.043	0.087	0.159	0.327
Probability	(0.007)***	(0.010)***	(0.026)***	(0.036)***

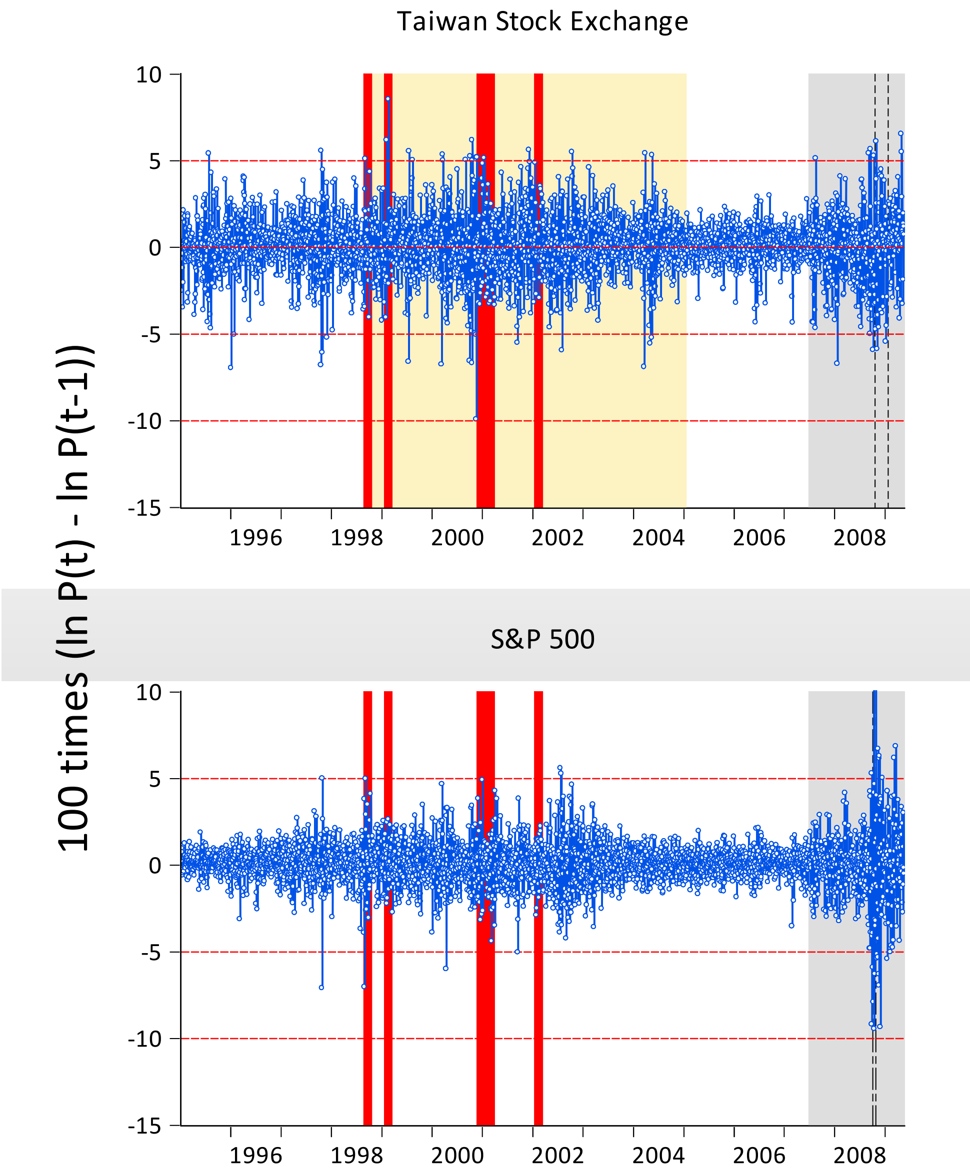
Note: The numbers shown are based on a Gibbs sampling procedure. We use 7000 iterations and we discard the first 5000. Then, 2000 iterations will be used to calculate the posterior means and standard deviations. Gibbs samples of the volatility equation are drawn using the Griddy Gibbs with 400 grid points, equally spaced for each parameter. Sample and estimation details are provided in the text and in Tables 1 and 2. Note that spillover effects in the conditional variance equation and day of the week effects in the mean equation are omitted for reasons given in the text.

Figure 1. Stock Indices for Taiwan, the U.S., and China



Note: Vertical shaded areas identify major financial (i.e., currency and banking crises) during the sample investigated. Table 1 provides the dates. The solid vertical line identifies the period around the terrorist attacks on September 11, 2001. Data are from Datastream and are sampled at the daily frequency.

Figure 2. Stock Returns for Taiwan and the U.S.



Note: See Figure 1 for the data source. The shaded areas identify crisis periods (also see Figure 1 and Table 1) while, in the top figure, the lightly shaded area in the case of Taiwan as well as the dashed vertical lines identify when short selling was banned in either country's stock markets.