Short Sale Constraints and the Likelihood of Crashes and Bubbles*

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Abstract

The literature on short selling restrictions focuses mainly on a ban's impact on market efficiency, liquidity and overpricing. Surprisingly, little is known about the effects on higher order moments of the return distribution. In addition, existing studies almost exclusively deal with the case of the skewness and focus on single stocks. We are the first to provide evidence on short sale constraints' effect on the kurtosis of market wide shocks. To this end, we rely on long lasting short selling regimes in 3 Asian markets that enable us to estimate sophisticated time series models for the market return. Our evidence suggests that, in some market phases, short sale restrictions lead to an increase in the kurtosis of the error distribution which, in turn, entails a higher likelihood of crashes and bubbles.

JEL Classification: G10, G12, G14, G15, G18

Keywords: Short Selling Ban, Financial Crisis, Crashes, Bubbles, Kurtosis.

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1 Introduction

Short sale constraints' impact on misspricing, market quality and liquidity have been extensively studied in the empirical literature. Recently, the research on this topic has once again flared up as a consequence of the unprecedented number of short selling bans imposed by regulators intended to stabilize stock markets during the recent global financial crisis and the ongoing European debt crisis. Work dealing with the effects on higher order moments of the distribution of stock returns is more scarce and in large part limited to the calculation of descriptive statistics. Most notably, the literature mainly focuses on the skewness, a measure of asymmetries in the tail behavior while it is more or less silent about the kurtosis, a measure for the frequency of both positive and negative extreme return realizations. Empirical research ought to be mindful of the latter as well since there are several grounds on which a strengthening effect on both positive and negative tails can be expected.

The present paper makes a start towards closing this gap. Perhaps our most salient contributions are that we, first, highlight a ban's impact on the kurtosis of the common market factor and, second, rather than reporting simple descriptive statistics, model the market return within a sophisticated time series framework. The latter enables us to shed light on the kurtosis of the unforeseen part of the return. This is crucial for market stability since rational expectations suggest that market participants adapt themselves in advance to the expected element of the return process. In order to consistently estimate time series models of the market return, we deal with long lasting short sale bans in Hong Kong, Malaysia and South Korea.

It is well known since Miller (1977) that short sales can mitigate price bubbles as pessimistic investors are able to express their negative beliefs on fundamental values without owning the stock. During rising markets, these investors are able to create additional supply, thereby, moderating strong price increases which may show up in less extreme positive returns. Additional supply and selling pressure can be generated either via selling "imaginary" shares in the case of naked short sales or by offering stocks that the lender otherwise would not have traded in the case of covered shorts. There is widespread evidence supporting Miller's (1977) overvaluation hypothesis (Seneca (1967), Figlewski (1981), Senchack and Starks (1993), Aitken et al. (1998), Danielsen and Sorescu (2001), Desai et al. (2002), Asquith et al. (2005), Boehme et al. (2006), Boulton and Braga-Alves (2010)) although there are dissenters (Hurtado-Sanchez (1978), Dickinson and Woolridge (1994), Huszár and Qian (2011)).

Diamond and Verrecchia (1987) develop predictions about negative skewness, a fat left tail, in the distribution of returns around earnings announcements. Their model shows that due to short sale constraints new information is impounded into prices with a delay where the effect is stronger for negative news. As a consequence, negative private information in the run-up to earnings announcement can be expected to have been priced to a lesser extent when the business report is released than positive one. This, in turn, entails a stronger reaction at the time negative news is released to the public which shows up in an increased likelihood of extreme negative returns.

The theoretical model put forward by Hong and Stein (2003) is mostly cited as an explanation for the unconditional average negative skewness in stock market returns. It is based on divergence of opinion among investors combined with a prohibition on short sales. The latter deters the pessimists from impounding their beliefs into prices during rising markets. However, when, thereafter, the market declines, these investors fail to act as "marginal support buyers" thereby suddenly revealing their estimates for the true asset value. Accordingly, this causes extreme negative returns that do not find an equivalent on the right side of the distribution. However, strictly speaking the model also has implications for the kurtosis. Hong and Stein (2003) actually show that, given short sale constraints, skewness becomes negative when the divergence of opinion gets large whereas it turns positive during times when investors' estimates for the stock value do not differ substantially. Assuming that the extent of investors' disagreement in the market is changing over time, in some market phases, a heavily left tailed return distribution prevails, as does a heavily right tailed one in other periods. Thereby, an overall increase in kurtosis arises since the frequency of extreme returns is increased for both sides of the distribution.

The work of Abreu and Brunnermeier (2003) deals with limits to arbitrage like short sale restrictions that prevent investors from coordinating their selling activities. As a result, persistent asset price bubbles may arise, finally ending up in a market crash. Scheinkman and Xiong's (2003) model is similar in spirit although it highlights the role of overconfidence rather than a lack of coordination. As suggested by Blanchard and Watson (1982), an increased incidence of bubbles and crashes, as predicted by these models, may show up in a leptokurtic return distribution.

Previous empirical research on short sale constraints' effects on the kurtosis, the fourth standardized moment, is mostly restricted to raw returns. Investigating the ban on naked short sales in France during the recent financial crisis, the results of Lioui (2010) indicate no significant impact on the kurtosis of raw returns. In a recent paper, Saffi and Sigurdsson (2011) use lending supply data for 26 countries as a proxy for short selling restrictions on the individual firm level. They document that both a higher number of shares available for borrowing and lower lending fees result in significantly lower kurtosis of single stock raw returns as well as of market model residuals. The latter proxies for the idiosyncratic part of single stock returns while the number of stocks offered for borrowing and the associated fees constitute a fairly close approximation for short sale constraints on the individual firm level.

Unless in the case of raw returns or single stocks, where for the latter residuals of capital asset pricing type models can be used, investigating the effects of short sale constraints on market wide shocks requires a setting that allows for the estimation of sophisticated time-series models. This, in turn, requires markets where short sale regulations are changing over time and both banned and unbanned time spans last for a significant portion of the sample period. 3 Asian markets, namely Hong Kong, Malaysia and South Korea provide us with such a setting. In Hong Kong and Malaysia, short sale bans affected all listed stocks, whereas in South Korea financial stocks have been exempted from shorting since the peak of the global financial crisis. The periods where short selling constraints where in place do not coincide for the 3 markets under consideration and, in addition, in Malaysia, shorting was even banned twice during the sample period. These facts help us to rule out exogenous factors affecting all three markets at a time.

To model short sale constraints' effect on the unforeseen part of the returns, we make use of a Markov-Switching-GARCH model to price the equity indices under consideration allowing for separate evaluation of different market phases. We apply a t-distribution since it enables us to explicitly model the kurtosis of error terms via time-varying degrees of freedom. Thereby, dummy variables serve to capture shifts in the degrees of freedom during short sale constraints. We perform robustness checks to ensure a sufficient control for spillover effects from world stock markets as well as a correct specification of the asset pricing model.

Our empirical evidence for 3 Asian countries suggests, that at least in some market phases, short sale constraints entail a higher kurtosis of error terms. This effect is particularly strong in Hong Kong and South Korea. Our finding of an increased likelihood of crashes and bubbles contrasts with regulators' view and high-profile media coverage blaming short sellers for destabilizing stock markets.

The remainder of the paper proceeds as follows. Section 2 sets out the grounds on which the choice of the three markets under consideration is made, provides some related institutional details and sketches the data used. Section 3 outlines the econometric methodology. Section 4 discusses the empirical results while section 5 briefly concludes.

2 Institutional Settings

Unlike the case of single stocks which can be priced by simple capital asset pricing type regressions, modeling the market return requires a more sophisticated time series approach. This, in turn, requires a sufficiently long duration of the ban period to consistently define a dummy variable designed to capture the ban's impact on kurtosis. Unfortunately, the majority of short selling bans, in particular most of those imposed during the global financial crisis, were in place for relatively short time spans. The following 3 Asian markets constitute exceptions to this pattern.

In Hong Kong, there was an outright ban on short sales until 1994 when a pilot scheme started allowing covered short sales in 17 stocks. Since March 1996, a quarterly revised list defines the stocks that are eligible for short selling.[1] To be included in this list, a stock has to meet certain objective criteria. Among requirements in terms of capitalization, trading volume and free float that are subject to revisions from time to time, membership of the well known Hang Seng Index has been a sufficient condition for short selling throughout. Therefore, we use this index as market. Our sample period starts in 1990 and ends at March 31, 2011.

In Malaysia, so called regulated short selling was first introduced on September 30, 1996. Similar to Hong Kong, there is a time-varying list of stocks eligible for shorting. As in fact, the first draft of this list was published only on October 3, 1996, we regard the latter as the point of introduction. As a consequence of the Asian crisis, regulators again made short selling off limits on August 28, 1997. Almost 10 years later, with effect from January 1, 2007 this ban was removed and short selling now is again feasible for stocks being member of a list. Prerequisites that qualify a stock to be added to that list are minimum values of market capitalization and trading volume. For Malaysia, we proxy for the market using the Kuala Lumpur Composite Index (KLCI), a capitalization-weighted index calculated from the 100 largest companies listed at the Bursa Malaysia.[2] Compared to Hong Kong, on the one hand, the situation here is not that clear-cut as index membership does not automatically result in short sale eligibility. One the other hand, since the approval for short selling depends on the market capitalization, the KLCI, as a value-weighted index, is strongly dominated by stocks that are eligible for short sales.[3] Again we make use of a sample beginning in 1990 and ending at March 31, 2011.

On September 30, 2008 the South Korean Financial Supervisory Commission imposed an outright prohibition of all short sales affecting all listed stocks, which was justified with 'malignant rumors' in the market. On May 20, 2009 this ban was announced to be lifted for non-financial stocks effective June 2009, whereas the constraints

[1]In what follows then, we define the introduction date as March 1, 1996. As a robustness check, we also run our analysis using the former date which produced qualitatively similar results.

[2]Until April 18, 1995, the number of constituents was 83.

[3]For instance, on February 18, 2009, 81% of the stocks but 92% of the capitalization of the KLCI were eligible for short selling.

on financial stocks have not been removed yet. Accordingly, for South Korea our focus is on the financial sector. Therefore, we calculate the market as a value-weighted portfolio return of the 16 financials in the KOSPI 100 as it was on June 1, 2009 the date the ban on non-financial companies' stocks expired. All time series are obtained from Thomson Reuters Datastream. The historical constituents of the KOSPI 100 were provided by the Korea Exchange. Since for South Korea, we use a portfolio return as market and single stocks are listed and delisted, our sample begins in July 2002. We select this period to ensure that at least the returns of 13 out of 16 stocks are available at every point in time.[4]

3 Methodology

We aim at modeling the effects of short sale constraints on shocks affecting the stock markets as a whole. Unlike in the case of single stocks, which can be priced by simple capital asset pricing models, this requires a more sophisticated asset pricing approach. In the empirical literature, it is commonly accepted to model the market return in a GARCH framework where the conditional mean often is given by a first-order autoregressive process. In addition, to control for spillover effects from world stock markets, lagged values of foreign stock market returns can be included. For our baseline model, we use one period lagged US returns r_{t-1}^{US} to proxy for the global market.[5] Our mean equation, then, reads

$$r_t = \alpha_{S_t} + \varphi_{1,S_t} r_{t-1} + \varphi_{2,S_t} r_{t-1}^{US} + \epsilon_t. \tag{1}$$

To account for different asset pricing dynamics in different market phases, we allow the parameters to switch between two distinct regimes where $S_t \in \{1, 2\}$ indicates in which one of these states the process is in at time t. In particular, this enables us to detect potential differences in the effects of short sale constraints in phases of high or

[4]The Taiwanese stock market provides a setting similar in spirit to Malaysia with two ban periods since the 1990s. We do not include this case into our analysis since Bris et al. (2007) classify Taiwan as a market where short selling is actually not practiced although it is legally permissible.

[5]We use lagged values of US returns instead of returns based on opening notations since stock markets in the 3 Asian countries close before the opening of the US trading session.

low volatility. Additionally, Markov switching GARCH models often avoid estimating integrated or near-integrated variance processes.

The use of a normal distribution, which implies a constant kurtosis equal to 3, is not appropriate for our purpose since we explicitly want to model time-depending kurtosis in the error terms, ϵ_t. Instead, ϵ_t follows a mixture of 2 t-distributions with variances h_{S_t} and degrees of freedom parameters v_{S_t}, $\epsilon_t \sim t(0, h_{S_t}, v_{S_t})$. The kurtosis of a t-distribution with v degrees of freedom is given by

$$\frac{3v-6}{v-4} = \frac{6}{v-4} + 3. \tag{2}$$

From (2), it can be seen that lower degrees of freedom imply a higher kurtosis and, in turn, more extreme random draws. Conversely, as $v \to \infty$, the distribution converges to a normal distribution.

To identify changes in the kurtosis during periods with short sale constraints, we model the degrees of freedom according to the following regime depending process,

$$v_{S_t} = \kappa_{1,S_t} + \kappa_{2,S_t} I_t^{SSC}. \tag{3}$$

I_t^{SSC} takes on the value 1 when short sale constraints are in place and 0 otherwise. The parameters κ_{2,S_t} are of main interest as they capture the impact that displacing short sellers has on the frequency of extreme pricing errors. (2) shows that a significantly positive value of κ_{2,S_t} is associated with an error distribution that is less heavier tailed as long as the constraints are in place. Such a finding would support stabilizing effects of short sale restrictions as claimed by stock market regulators. In contrast, a significantly negative estimate would indicate an increased probability of extreme error realizations and could be interpreted as evidence against detaining investors from selling short.

To parsimoniously model ARCH effects and volatility clustering, we make use of a GARCH(1, 1) in our variance equation

$$h_t = \omega_{S_t} + \beta_{1,S_t}\epsilon_{t-1}^2 + \beta_{2,S_t}h_{t-1}^2, \tag{4}$$

where the parameter restrictions $\omega_{S_t}, \beta_{1,S_t}, \beta_{2,S_t} > 0$ and $\beta_{1,S_t} + \beta_{2,S_t} < 1$ apply. We solve the path dependence problem arising for h_t as proposed by Gray (1996b).

We assume that the state variable S_t is governed by a first-order Markov process with constant transition probabilities, $p_{ij} = Pr\left(S_t = j | S_{t-1} = i\right)$, $i, j \in \{1, 2\}$. All models are estimated using a one-step numerical optimization procedure. To overcome starting value dependence, we perform the optimization for a large number of randomly drawn initial values. To draw inference about the state the process is in at time t, the ex-ante probabilities, $p_{i,t-1} = Pr\left(S_t | \Gamma_{t-1}\right)$, can be used. Γ_{t-1} indicates the information set available at $t-1$. These probabilities are of particular interest for agents on financial markets because they can be used in forecasting. In addition, we calculate smoothed probabilities $p_{i,T} = Pr\left(S_t | \Gamma_T\right)$ using the forward looking algorithm provided in Gray (1996a). These probabilities exploit all information available up to the end of the sample period T, Γ_T.

We perform robustness checks with respect to spillover effects from world stock markets as well as with respect to the general specification of the asset pricing model. For the first purpose, we replace the US return by the return of the MSCI world stock index. The US are the world's dominating stock market, however, in recent years, other markets have gained more and more influence and may provide important information for asset pricing. For the latter purpose, we, firstly, replace the autoregressive component in the mean equation by a moving average term. The mean equation, then, changes as follows

$$r_t = \alpha_{S_t} + \varphi_{3,S_t}\epsilon_{t-1} + \varphi_{2,S_t}r_{t-1}^{US} + \epsilon_t. \tag{5}$$

Secondly, we allow for time-varying transition probabilities.[6] In line with Gray (1996b) and Bohl et al. (2011), we use the natural logarithm of the lagged value of the stock index level, L_{t-1}, as explanatory variable.[7] To map the transition probabilities into the region $[0, 1]$, we apply the cumulative normal distribution, ϕ,

$$p_{ii,t} = \phi\left(\rho_{1,S_t} + \rho_{2,S_t} log\left(L_{t-1}\right)\right). \tag{6}$$

For the parameters matching with those from the baseline model, we use the estima-

[6] The theory of time-varying transition probabilities can be found in Diebold et al. (1994) and Filardo (1994).

[7] Gray (1996b) models the first difference of interest rates and applies the lagged interest rate level as explanatory variable for the transition probabilities. Analogously, we model the first difference of logarithmic indices and use the lagged log index level.

tion results from this basic specification as starting values. For the parameters of the moving average terms and those in equation (6), we again try different random numbers.

4 Empirical Results

We first discuss the results for the baseline model defined in (1), (3) and (4). The parameter estimates are reported in Table 1. In all cases, both separated regimes are highly persistent with average durations, $\frac{1}{1-p_{ii}}$, of at least 188 trading days. We identify high and low volatility regimes by calculating the long run variance for each state, $\sqrt{\frac{\omega_{S_t}}{1-\beta_{1,S_t}-\beta_{2,S_t}}}$ and by plotting the estimates for the regime probabilities together with the conditional variance as provided in Figure 1.

[Insert Table 1 about here]

[Insert Figure 1 about here]

The estimates for φ_{2,S_t}, the parameter of lagged US returns are always found highly significant with t-values ranging from 10.44 up to 22.95 which corroborates the control for spillover effects from world stock markets. To a lesser extent, this also holds for the parameters taking into account first-order autocorrelation as the estimates for φ_{1,S_t} show significant for 3 out of 6 cases, where the strongest evidence for autocorrelation is found for the Malaysian KLCI. This stock market is less developed than the other two markets under consideration and, thus, may be characterized by stronger informational efficiencies which may show up in disproportionately strong autocorrelation. When going through our results for the parameters governing the variance process, like in most daily financial time series, strong ARCH effects and volatility clustering, measured by $\hat{\beta}_{1,S_t}$ and $\hat{\beta}_{2,S_t}$, are present. For all markets, the stationarity condition for the variance is met in both states.

Turning to (3), the specification for the degree of freedom parameter of the t-distribution, in all cases, we find the constant, $\hat{\kappa}_{1,S_t}$ to be significant and to take on values where the kurtosis is defined.[8] Recall that we aim at revealing level shifts in the kurtosis of pricing errors by means of indicator variables for periods with short sale restrictions. Thus, the estimates for κ_{2,S_t}, the parameter designed for capturing changes in the degrees of freedom during short sale bans, are of main interest. For all countries, we find $\hat{\kappa}_{2,S_t}$ to be negative and significant in one state and indistinguishable from 0 in the other one. These findings suggests that short sale constraints have a strengthening effect on the frequency of extreme errors in some market phases whereas in others no influence is found. For Malaysia and South Korea the former is the case in the high volatility regime whereas, for Hong Kong, this holds in times of low volatility.

To sum up, for 3 Asian stock markets, namely Hong Kong, Malaysia and South Korea, we provide evidence that displacing short sellers can lead to an increased leptokurtosis of error terms in some market phases. These results suggests that, aiming to stabilize stock markets, short sale constraints can in fact have destabilizing effects by causing more extreme pricing errors. Please note that for South Korea the caveat applies that we provide evidence for the financial sector rather than for the equity market as a whole.

5 Conclusion

As a consequence of the short selling bans imposed during the global financial crisis and the ongoing European debt crisis, the empirical literature on short sale constraints has gathered momentum. Nonetheless, existing studies mainly focus on the restrictions' impact on market quality, liquidity and informational efficiency but are relatively silent about changes in higher order moments of the return distribution. Work dealing with this topic is mostly limited to the analysis of raw returns, focuses mainly on the skewness and, in particular, is restricted to the individual firm level while neglecting the effects on the systematic part of returns. The present paper makes a start towards closing this gap by investigating short sale restrictions' effect on the kurtosis of market wide shocks.

[8] This is the case for degrees of freedom greater than 4.

Long lasting short selling bans in 3 Asian markets, namely Hong Kong, Malaysia and South Korea, provide us with a setting to estimate time series models for the market return, thereby modeling the impact of short sale constraints on the kurtosis of pricing errors. The time schedule of the short sale restrictions differ between the markets analyzed in this paper making it less likely that the results are caused by exogenous factors affecting all 3 markets. We design our asset pricing approach to discriminate between different market conditions by making it subject to Markov regime switching. In addition, we control for spill over effects from world markets where the results are not sensitive to the use of US returns versus world market returns. A second robustness check includes moving average effects and time varying transition probabilities as applied in Gray (1996b) and Bohl et al. (2011).

Our findings suggest an amplifying effect of short sale constraints on the kurtosis of market wide shocks. In addition, our results complement the work of Saffi and Sigurdsson (2011) reporting similar evidence for the idiosyncratic part of single stock returns. All things considered, we conclude that detering investors from expressing their negative beliefs on asset values can lead to an increased frequency of both positive and negative returns. This outcome sharply contrasts with regulators' hope of stabilizing equity markets by imposing short selling bans.

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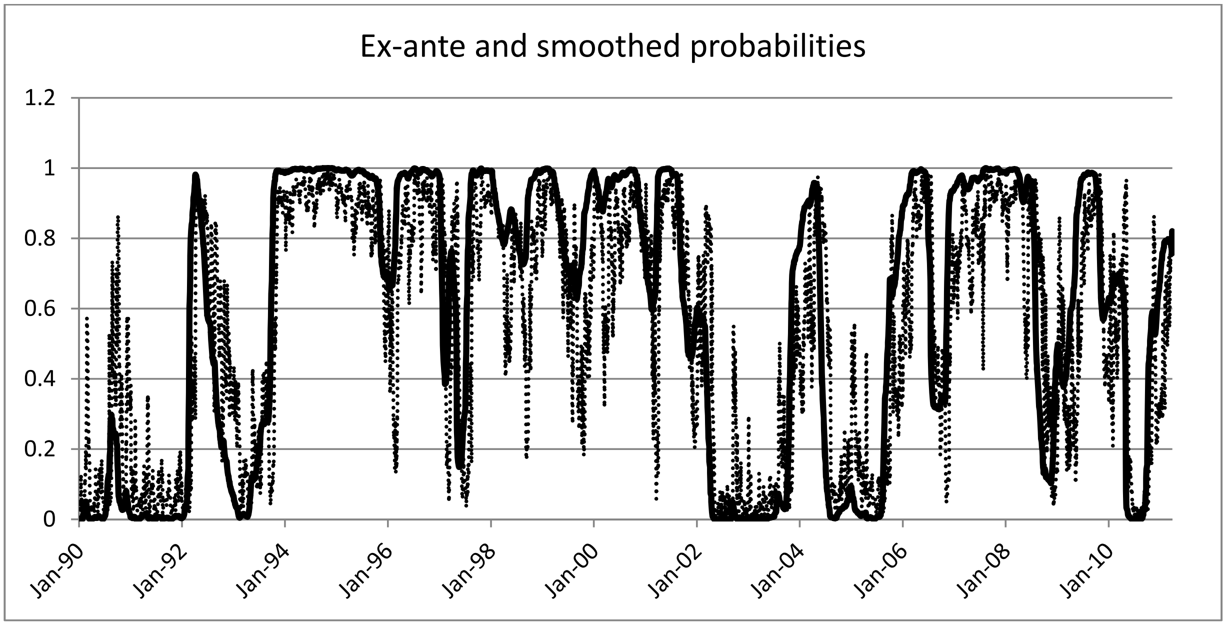
Table 1: Estimation Results for the Markov-switching GARCH model

	Hong Kong		Malaysia		S. Korea	
	Coeff.	p-Value	Coeff.	p-Value	Coeff.	p-Value
$S_t = 1$						
α_1	0.028	(0.215)	0.031**	(0.026)	0.054	(0.218)
$\varphi_{1,1}$	-0.015	(0.352)	0.194***	(0.000)	0.041	(0.134)
$\varphi_{2,1}$	0.757***	(0.000)	0.328***	(0.000)	0.755***	(0.000)
ω_1	0.012	(0.143)	0.045***	(0.000)	0.060**	(0.038)
$\beta_{1,1}$	0.083***	(0.000)	0.139***	(0.000)	0.060***	(0.000)
$\beta_{2,1}$	0.894***	(0.000)	0.738***	(0.000)	0.908***	(0.000)
$\kappa_{1,1}$	11.206***	(0.000)	5.971***	(0.000)	18.979**	(0.028)
$\kappa_{2,1}$	1.871	(0.835)	-1.687**	(0.024)	-16.936*	(0.051)
p_{11}	0.995***	(0.000)	0.998***	(0.000)	0.999***	(0.000)
$S_t = 2$						
α_2	0.084***	(0.000)	0.036***	(0.000)	0.026***	(0.701)
$\varphi_{1,2}$	-0.011	(0.557)	0.090***	(0.000)	-0.061*	(0.079)
$\varphi_{2,2}$	0.354***	(0.000)	0.173***	(0.000)	0.449***	(0.000)
ω_2	0.034***	(0.002)	0.001*	(0.056)	0.046	(0.106)
$\beta_{1,2}$	0.037***	(0.001)	0.023***	(0.000)	0.053***	(0.002)
$\beta_{2,2}$	0.880***	(0.000)	0.955***	(0.000)	0.915***	(0.000)
$\kappa_{1,2}$	9.129***	(0.000)	4.337***	(0.000)	6.377**	(0.011)
$\kappa_{2,2}$	-3.974*	(0.098)	-0.047	(0.912)	1.397	(0.667)
p_{22}	0.995***	(0.000)	1.000***	(0.000)	0.997***	(0.000)

Notes: ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. p-Values are provided in brakets.

Figure 1: Ex-ante and smoothed probabilities and conditional variance: Hong Kong



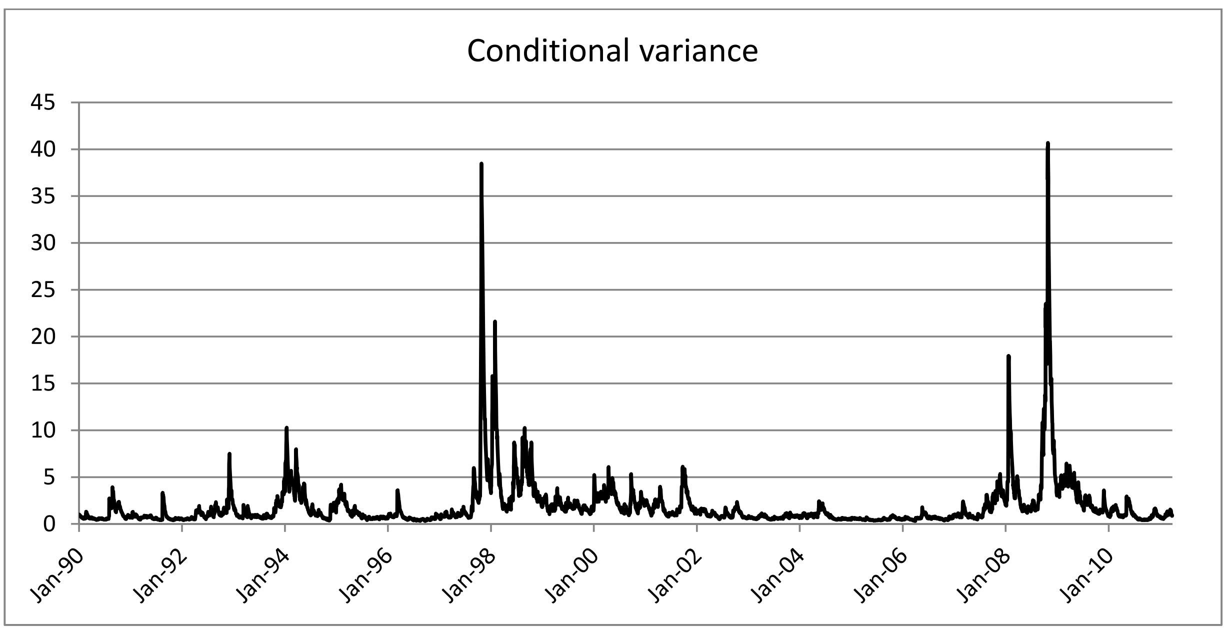
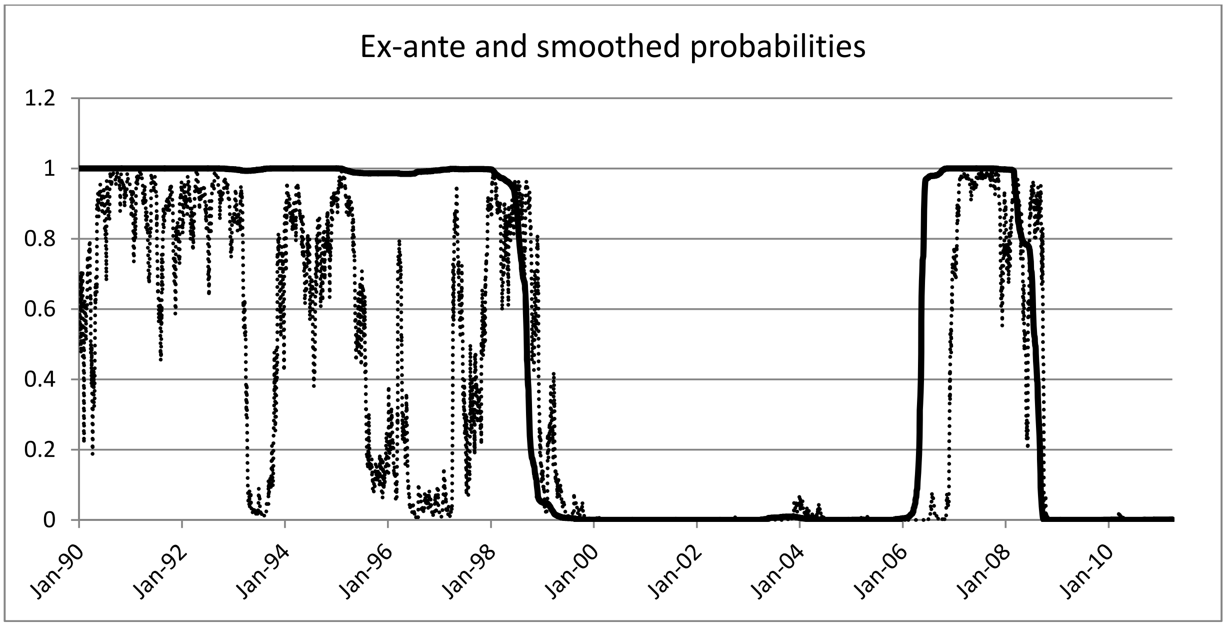


Figure 1: Ex-ante and smoothed probabilities and conditional variance (continued): Malaysia



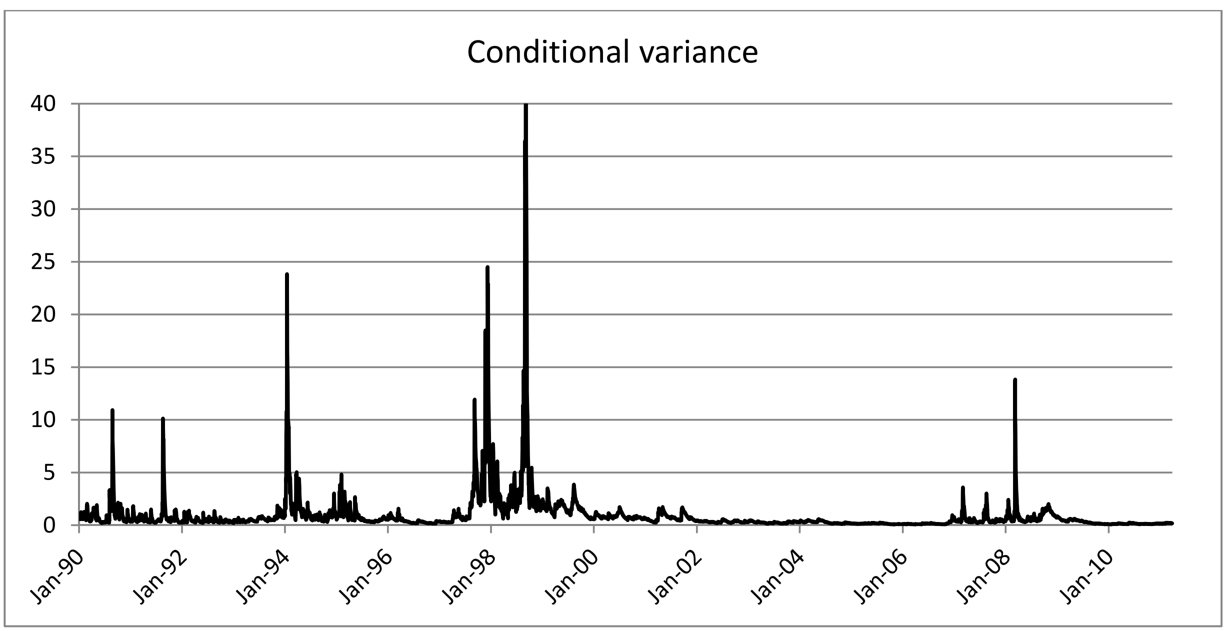
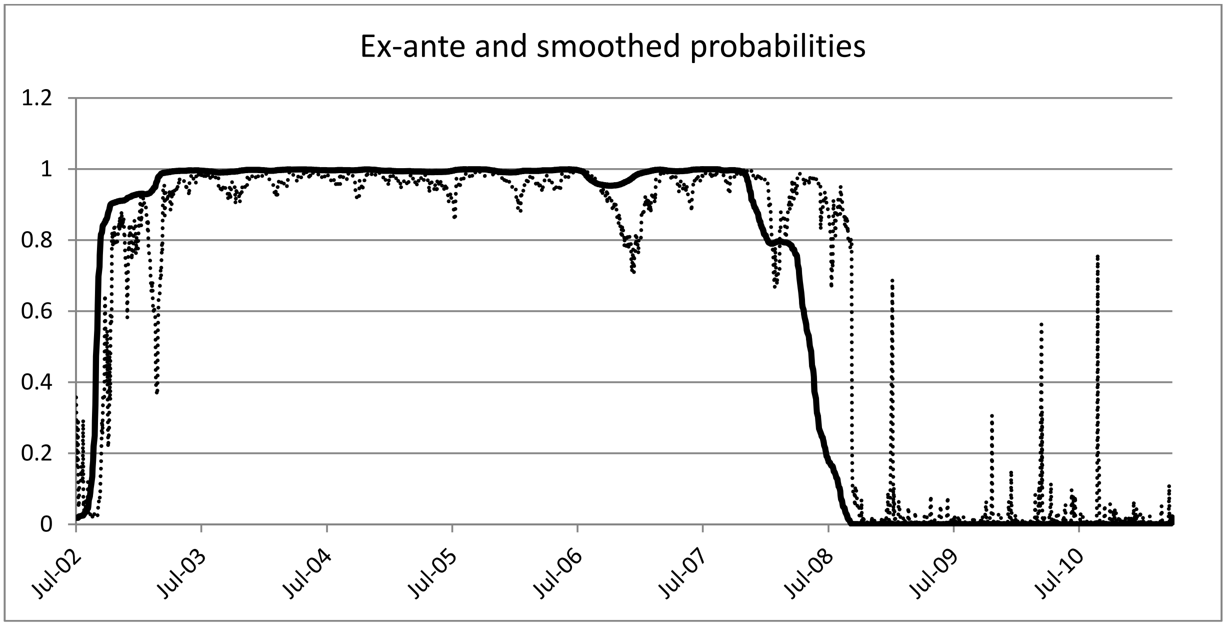
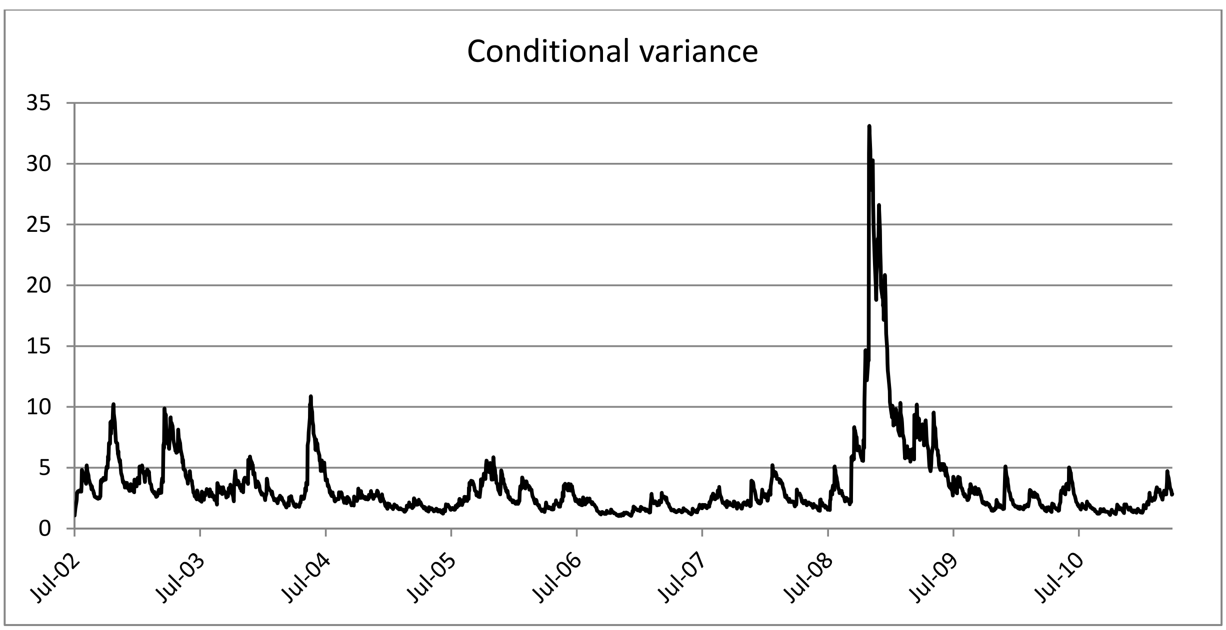


Figure 1: Ex-ante and smoothed probabilities and conditional variance (continued): Korea





Notes: In the upper part, ex-ante (dotted line) and smoothed probabilities calculated as proposed by Gray (1996b). In the lower part, conditional variance.