**Measuring systemic risk in emerging markets using CoVaR**

by

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## Abstract

The recent financial crisis has shown that the regulation framework that has been implemented over the last twenty years as formulated in the Basle I and II agreements relied excessively on the monitoring of individual financial institutions. It then failed to capture the contribution of systemic risk, which is considered to be the risk that results from the collective behaviour of financial institutions that have significant effects on the real economy. In this paper we investigate the extent to which distress within different sub-segments of the financial system, namely, the banking, insurance and other financial services industries contribute to systemic risk. We conduct our analysis using the measure of systemic risk recently developed by Adrian and Brunnermeier (2011). We employ weekly data for the period December 1995 to February 2013 for selected countries from three regions of emerging economies, namely, Latin America, Southeast Asia and Central and Eastern Europe. Our main results provide evidence that in most of the emerging markets under investigation the banking industry contributes relatively more to systemic risk in periods of distress than does the insurance industry or the other financial services industry. Furthermore, when we examine the estimated $\Delta CoVaR$ measures we observe that for all industries the contribution to systemic risks has increased since 2008.

**Keywords:** systemic risk, CoVaR, quantile regressions, risk management, emerging markets

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## 1. Introduction

The global financial crisis of 2007-2009 illustrated how distress can spread quickly through the financial system and threaten financial stability. Furthermore, Brunnermeier and Pedersen (2009) argue that the degree to which international financial institutions are linked depends on the level of market liquidity. Banks play a crucial role in the proper functioning of an economy since they provide the necessary liquidity to the markets and help to promote economic growth (Levine, 1997). Ill-functioning of the banking sector dramatically increases the costs in the real economy and historically has been a major source of financial crises, like the recent one, in both developed and emerging economies (Barth and Caprio, 2006; Demirguc-Kunt *et al.* 2009; Reinhart and Rogoff, 2009). Since October 1987, financial and banking regulation has focused on monitoring and regulating the banking industry.

The recent financial crisis revealed that the micro-prudential regulatory framework is not sufficient to prevent world-wide contagion as a result of bank failures initially in the U.S. and subsequently in Europe and elsewhere. The micro-prudential regulatory framework is based on the provisions of the Basle I and II agreements which imposed minimum capital requirements on the banks as a measure of prevention against unexpected losses (Pillar I). Within this framework the Basle II agreement led to the development of internal systems for measurement of market risk and such regulation looked at the soundness of individual financial institutions. However, such provisions based only on capital adequacy ignored factors such as size, degree of leverage, and interrelationships with the rest of the system. Stein (2010, p. 50) argued that “the overarching goal of financial reform must not be only to fortify a set of large institutions, but rather to reduce the fragility of our *entire system* of credit creation”.

Thus, there is now a shift in macro-prudential regulation which implies that we observe the operation of the banking system as a whole (see Borio and Lowe, 2002; Borio and Drehmann, 2009; Gauthier *et al*., 2012). The Bassle III agreement which is still under formation is expected to address most of the issues related to systemic risk and develop the appropriate framework for regulation and supervision of the financial markets based on recent experience. Therefore, for Central Banks and financial regulators, it is of great value to be able to quantify the risks that can threaten the financial system, not only on the national level but also globally. Early works on this front by Lehar (2005), Goodhart *et al*. (2005, 2006) and Goodhart (2006) proposed alternative measures of financial fragility which can be implemented at both the individual and the aggregate levels. Additionally, the Financial Sector Assessment Program (a joint IMF and World Bank initiative) was set up with the purpose of increasing the effectiveness of plans to promote the soundness of financial systems in their member countries.

Interdependence among financial institutions becomes particularly important during periods of distress, when losses tend to spread across institutions and the whole financial system becomes vulnerable. In this respect systemic risk is defined as multiple simultaneous defaults of large financial institutions. A systemic crisis that disrupts the stability of the financial system can have serious consequences and large costs for the whole economy and the society. During financial crises, episodes of contagion among financial institutions occur very often and therefore regulators need to take them into consideration when assessing the health of the financial system. Central banks are responsible for promoting financial stability in the domestic economy and hence it is a central component of the central banks' activities to follow and analyse systemic risk. The financial crisis of 2007-2009 has put increased emphasis on analysing systemic risk and developing systemic risk indicators that can be used by central banks and others as a monitoring tool. In order to evaluate the stability of the banking system, a crucial element is the measurement of the systemic risk of a financial system. According to the Group of Ten (2001, p.126):

"Systemic financial risk is the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainly [sic] about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy. Systemic risk events can be sudden and unexpected, or the likelihood of their occurrence can build up through time in the absence of appropriate policy responses. The adverse real economic effects from systemic problems are generally seen as arising from disruptions to the payment system, to credit flows, and from the destruction of asset values."

Arnold *et al*. (2012) also argue that key aspects of recent regulatory reforms which are under way through the Basle III agreement include measuring and regulating systemic risk and designing and implementing macro-prudential policies in an appropriate way. To this end the E.U. has established the European Systemic Risk Board and the U.S. the Financial Stability Oversight Council in order to focus on the issue of systemic risk not only in those two regions but also at the global level. The collapse of numerous financial institutions over the last five years has imposed significant negative spillovers on governments and the economy as a whole. Therefore, in measuring systemic risk we need to consider the degree of risk of financial institutions and to allocate risks and costs across them so that we take into account the negative spillovers associated with financial instability. Although the issue of stability of the banking sector is very important, there are only a few studies that examine the impact of bank regulation and supervision on banking risk, some of which find that it has little effect on minimizing banking risk. Thus, Demirguc-Kunt and Detragiache (2011), using a sample of 3000 banks from 86 countries, reject the hypothesis that better regulation and supervision results in a sounder banking system.

In contrast, Klomp and de Haan (2012) also examine the issue of the effectiveness of bank regulation and supervision and find evidence in favour of its effectiveness for high-risk banks. However, when they consider low-risk banks then they find no support in favour of the effectiveness of the regulatory framework.

The most commonly used measure of market risk is the Value-at-Risk ($VaR$) which calculates the monetary loss an institution may experience within a given confidence level. The problem with such a measure is that it does not consider the institution as part of a system which might itself experience instability and spread new sources of economic risk. Furthermore, it is noted that traditional measures have focused on banks' balance sheet information, including non-performing loans ratios, earnings and profitability, liquidity and capital adequacy measures which are not appropriate to evaluate the soundness of a financial system (see Huang *et al*., 2009; Sylvain *et al*., 2012).

Recently, Adrian and Brunnermeier (2011) developed CoVaR as a measure of systemic risk. CoVaR measures the contribution of a financial institution to systemic risk and its contribution to the risk of other financial institutions. CoVaR stands for Conditional Value-at-Risk, and indicates the Value-at-Risk (VaR) of financial institution $i$, conditional on financial institution $j$ being in distress. Adrian and Brunnermeier (2011) argue that this is a more complete measure of risk since it is able to capture alternative sources of risk which affect institution $i$ even though they are not generated by it. Furthermore, if we consider that institution $i$ is the whole financial system, then ΔCoVaR is defined as the difference between the CoVaR and the unconditional $VaR$ and it captures the marginal non-causal contribution of a particular institution to the overall systemic risk.

In this paper we build on the CoVaR methodology which allows us to generate time-varying estimates of the systemic risk contribution of three specific sectors of the financial industry subject to different regulation and supervisory framework: banks, insurances and financial services. We employ weekly data from December 1995 to February 2013 for selected countries from a group of emerging economies from Latin America, Central and Eastern Europe and Southeast Asia which have been seriously affected by the recent financial crisis. Furthermore, the purpose of the analysis is to examine whether the contribution of the different financial sectors has changed following the failure of Lehman Brothers in September 2008. Applying the CoVaR analysis we want to measure risk spillovers and model the conditional second moments of the financial sectors on the whole economy.

There are several important findings that stem from our analysis. First, the estimations of 1% and 50% quantile regressions show that equity returns is a key determinant in triggering systemic risk episodes. There is also evidence that volatility of the general index ex financials (system variable), liquidity spread, the three-month rate change and yield spread have an effect, although weaker. Second, we show that for Mexico, the Czech Republic, Hungary, Romania, Hong Kong, Indonesia, the Philippines and Thailand it is the banking sector that contributes mostly to the systemic risk. In Malaysia the insurance industry contributes most to the systemic risk whereas in Poland, Turkey, Korea, Malaysia, and Singapore the highest percentage contribution to systemic risk is due to the other financial services. Finally, based on the results of ΔCoVaR estimates before and after 2008, it is observed that for all emerging markets the contribution of each financial industry to systemic risk increased after the unfolding of the crisis.

The structure of the paper is as follows: Section 2 presents and discusses the recent literature on CoVaR modelling. In Section 3 the CoVaR modelling approach to estimate systemic risk is discussed. Section 4 presents the data and empirical results while a summary and the concluding remarks are given in section 5.

## 2. Review of the literature

Achieving macroeconomic stability requires the identification of systemic risk in the financial system and the factors driving it. Although there is no consensus on the definition and measurement of systemic risk we review the recent literature on the topic in this section (for a complete survey see Bisias *et al*., 2012).

The recent literature has followed two main channels to analyse systemic risk. First, several studies examine the channels through which risk is transmitted from one financial institution to another. Pritsker (2000) and Forbes and Rigobon (2001) were among the first studies to explain the transmission of disturbances from one market to another over time, identifying two transmission channels which take the form either of interdependence or contagion. Within this framework we also observed the development of research on early warning indicators for both developed and emerging economies in an attempt to forecast systemic events (see for example Borio and Lowe, 2002; Alessi and Detken, 2009; Alfaro and Drehmann, 2009, Borio and Drehmann, 2009; Giesecke and Kim, 2011; Huang *et al*., 2009; Khandani *et al*., 2010; Borio *et al*., forthcoming). A second approach of measuring systemic risk using either macroeconomic data or balance sheet data has also been employed but suffers from two shortcomings. Thus, Cerutti *et al*. (2011) emphasize the problem that researchers face with the lack of useful and consistent data and suggest the creation of a common reporting template for globally systematically important financial institutions. A second shortcoming of this approach lies in the static modelling of institutional behaviour and therefore models with low frequency data are not appropriate for studying the effects of the regulatory and supervisory framework.

The second strand of literature on measuring systemic risk uses high frequency time series data. Several approaches have been proposed. Segoviano and Goodhart (2009) and Moreno and Pena (2013) argue that CDS spreads are good estimators of systemic risk. The problem with this approach is that it captures only credit risk and not market risk, which is the issue under examination in the present paper. Another approach focuses on individual measures of systemic risk, which seek to predict how much the stocks of financial institutions fall in a major market downturn. Essentially, this approach provides a framework to evaluate the co-dependence of financial institutions on a given system when a distress event occurs. The theoretical foundations of this approach were developed in Acharya and Richardson (2009), Acharya *et al*. (2010) and Acharya *et al*. (2012). Acharya *et al*. (2010) define the systemic expected shortfall as the propensity of a financial institution to be undercapitalized when the system as a whole is undercapitalized. In addition, Acharya *et al*. (2012) show that when this negative event occurs the government usually wants to minimize the resulting cost to the taxpayer. Furthermore, it is shown that this cost is a function of size, leverage and expected equity losses during a crisis. Brownlees and Engle (2012) propose a bivariate GARCH model for volatility as well as an asymmetric DCC model to capture correlation. Furthermore, they construct short- and long-run Marginal Expected Shortfall forecasts and propose the SRISK index, which is also a distress measure.

Adrian and Brunnermeier (2011) propose the *CoVaR* methodology in order to evaluate the impact of financial units which are in distress on the whole financial system. Therefore, this approach is useful in measuring risk transmission from a financial institution to the financial system. For their empirical application they use quantile regressions to estimate the conditional models using data for 1266 U.S. financial institutions which are distinguished into four groups: commercial banks, broker-dealers (including the investment banks), insurance companies and real estate. They conclude that systemic risk depends significantly on size, leverage and maturity mismatch. This methodology has been applied in several recent studies. Van Oordt and Zhou (2010) extended CoVaR to analyze situations at an extremely low probability level. Their analysis is based on 46 equally weighted industry portfolios including NYSE, AMEX and NASDAQ firms. Wong and Fang (2010) examine the interrelationships among eleven Asia-Pacific economies by estimating CoVaR for the CDS of their banks. Their main finding is that CoVaR measurements are higher than the respective unconditional VaR measure. Chan-Lau (2008) using a similar approach, studied the existence of spillover effects using the CDS spreads of a sample of 25 financial institutions in Europe, Japan and the United States.

Recently, Agrippino (2009) proposed the implementation of CoVaR analysis of five U.S. commercial banks using daily data in order to distinguish between interdependence and spillovers among financial institutions. The analysis concludes that CoVaR provides superior measurement of risk compared to the estimated with the traditional VaR model, particularly in case of financial instability when negative effects are spread across institutions. Roengpitya and Rungcharoenkitkul (2011) employ panel data from six major banks of Thailand in order to examine risk spillovers effects among these financial institutions. Girardi and Ergun (2013) modified the CoVaR model. They change the definition of financial distress from a financial institution $i$ to a financial institution $j$ as being higher, instead of being equal, than its VaR estimate. They estimate the systemic risk contributions of four financial industry groups consisting of a large number of institutions. Lopez-Espinoza *et al*. (2012a) analyze the banking system responses to positive and negative shocks to the market-value balance sheets of individual banks. Lopez-Espinoza *et al*. (2012b) employ an asymmetric CoVaR methodology to deal with the characteristic sample of 54 international banks and to address the asymmetric patterns that may underlie tail dependence. Bjarnadottir (2012) studies the contribution of four major Swedish banks to the systemic risk of the Swedish financial system. Finally, Bernal *et al*. (2012) depart from the above mentioned papers since they study systemic risk by analyzing how financial sectors of an economy that operate under different regulation systems contribute to systemic risk. Therefore, they examine the existence of inter-relationships between the financial sector and the whole, instead of focusing on individual institutions. They estimate the respective *CoVaR* model using daily data for the banking, insurance and other financial services industries of the U.S. and the Eurozone and they find that the insurance sector contributes relatively more to the systemic risk in periods of distress as compared to the banking and other financial services industries.

This paper adopts the approach suggested by Bernal *et al*. (2012) in evaluating the contribution to systemic risk by different aggregated components of the financial system including the banking, insurance and other financial services industries. The argument that Bernal *et al*. (2012) make is that the evaluation of the impact of shocks affecting one of these different financial industries on the whole system is important in designing an appropriate regulation. We employ CoVaR analysis to study the impact of these three financial sectors on the whole system for a selected group of emerging markets from three regions: Latin America, Central and Eastern Europe and Southeast Europe.

To the best of our knowledge this is the first study that provides an analysis of assessing systemic risk for the case of emerging markets, since all aforementioned studies focused exclusively on developed economies. This is due to the fact that the recent crisis is one of the few if not the first one whose source is the developed economies and not the emerging economies. Therefore, the propagation mechanism is from the U.S. and the Eurozone to the emerging markets. The recent banking crisis in Cyprus (a member country of the Eurozone) came with a possible 5 year delay from the initial shock. It was partly caused by the Eurozone debt crisis and more specifically as an outcome of the Greek debt crisis since the "haircut" on the Greek long-term sovereign bonds that took place in March 2012 imposed a loss of 4.5 billion euros on the banking system of Cyprus. The emerging economies suffered substantial losses since the credit crunch of 2007-2008 and the collapse of Lehman Brothers in September 2008. These negative effects have not been symmetric to the different groups of emerging markets. In particular the economies of the Central and Eastern European countries had to undergo major adjustment in their financial sectors and their real economies as a whole because of the recent financial and debt crisis. Countries like Hungary and Estonia almost went bankrupt and had to devalue their currency up to 30 percent. The Czech Republic, Poland and Romania also faced similar adjustments. Latin America countries were also hit by the credit crunch which was evident, for example, in Argentina where the long adjustment process to return to financial markets following the 2001 collapse has deteriorated once again. The Southeast Asian countries were also affected, although in a milder way, particularly with the experience of increased volatility in their stock markets.

## 3. Econometric methodology

During the last fifteen years there has been a voluminous literature on measuring approaches on market risk and propagation channels and causes of risk contagion effects. However, it has been shown that these traditional approaches have several modelling limitations, as well as strong assumptions with respect to the returns distribution and thus their application was proven problematic. Following the Basle II agreement, the Value-at-Risk measure became very popular to measure market risk because of its simplicity since the calculation of a single number was considered to be sufficient to quantify the minimum capital adequacy requirements for a financial institution. Intuitively, the VaR(α) is the worst loss over a target horizon that will not be exceeded with a given level of confidence 1-α (Jorion, 2007). Statistically, the VaR(α) defined for a confidence level 1-α corresponds to the α-quantile of the projected distribution of gains and losses over the target horizon.

This was the main approach used within the context of micro-prudential regulation as proposed by the Basle I and Basle II agreements. First, VaR models only estimate their own minimum loss if tail takes place under several alternative error distribution specifications. However, these models do not bring to the surface the potential loss of systemic risk transmitted from other sectors of either the domestic economy or the global economy. A stylized fact of these models is that the error terms of the dynamic correlation model or the autoregressive conditional heteroskedasticity model are assumed to have a specific distribution which leads to a bias toward the coefficients' estimation. Second, the extreme value theory and the derived models for estimating VaR do not take into consideration the full set of observations of the sample, leading to an underestimation of the respective risk measure, whereas there is also a small sample bias (see for example Wong and Fong, 2010). A final critical issue on modeling interrelationships between different sectors of the economy refers to time lag.

Given these criticisms regarding the ability of the traditional VaR model to capture systemic risk, we employ the CoVaR model (Adrian and Brunnermeier, 2011). The CoVaR model is particularly useful for measuring systemic risk by the VaR of an institution conditional on other institutions being in distress. During the 2007-2009 global financial crisis, the emerging economies faced severe credit risk and major financial problems. Therefore, the CoVaR model is appropriate to study risk spillovers and therefore is also a convenient measure of systemic risk.

Following Adrian and Brunnermeier (2011) we define $CoVaR_q^{j|i}$, which implies that the $VaR_q^j$ of an institution $j$ (or of the financial institution) conditional on institution $i$'s event $C(R^i)$ which is realized by the returns for this institution ($R^i$) being equal to its level of VaR for a $q^{th}$ quantile $R^i = VaR_q^i$. $CoVaR_q^{j|i}$ is then the $q^{th}$ quantile of the conditional probability distribution of returns of $j$

$$P(R^j \leq CoVaR_q^{j|C(R^i)} \mid C(R^i)) = q \tag{1}$$

Adrian and Brunnermeier (2011) defines $\Delta CoVaR$ as the difference between the $CoVaR$ of the financial institution $j$ conditional on the distress of another institution $i$ and $CoVaR$ of institution $j$ conditional on the normal state of institution $i$. Therefore, this $CoVaR$ measurement calculates how much an institution contributes to another institution's risk.

$$\Delta CoVaR_q^{j|i} = CoVaR_q^{j|X^i = VaR_q^i} - CoVaR_q^{j|X^i = Median^i} \tag{2}$$

where $\Delta CoVaR_q^{j|i}$ denotes the $VaR$ of institution $j's$ asset returns when institution $i's$ returns are at its normal state of their distribution (e.g. 50% percentile), and

$\Delta CoVaR_q^{j|i}$ is institution $j's\ VaR$ when institution $i's$ returns are in a distressed or extremely bad condition like the one experienced during the recent financial crisis. It can also be taken as the additional VaR caused by outside influences, which is above the ordinary interdependencies.

We further calculate $\Delta CoVaR$ for each institution as follows:

$$\Delta CoVar_t^{j|i}(q) = CoVaR_t^{j|i}(q) - CoVaR_t^{j|i}(50\%) = \hat{\beta}^{j|i}[VaR_t^i(q) - VaR_t^i(50\%)] \qquad (3)$$

Adrian and Brunnermeier (2011) estimate the related $VaR_q^{j|i}$ and their $\Delta CoVaR_q^{j|i}$ with the use of the growth rates of market-valued total assets for an individual institution and define them as a function of a constant, lagged state variables and error term. In order to assess the link between a set of independent variables and the quantiles of the dependent variable, they employ the quantile regressions methodology developed by Koenker and Basset (1978) and Koenker (2005).

In this paper we depart from Adrian and Brunnermeier (2011), who focus on the financial system, and we consider the real economy as the system variable. Recently, Bernal *et al.* (2012) defined systemic risk as the impact that a group of financial institutions may have on the whole economy. In this context systemic risk is measured with the estimation of $\Delta CoVaR$. Based on equations (1) and (2) we define $CoVaR_q^{system|i}$ as the $VaR_q^{system}$ of the whole system conditional on an event $C(R^i)$ affecting a financial sector $i$ being equal to its level of $VaR$ for a $q^{th}$-quantile. This is given by the following probability:

$$P(R^{system} \leq CoVaR_q^{systemC(R^i)} \mid C(R^i) = q \qquad (4)$$

Therefore,

$$\Delta CoVaR_q^{system|i} = CoVaR_q^{system|X^i = VaR_q^{i^i}} - CoVaR_q^{system|X^i = Median^i} \quad (5)$$

Following Bernal *et al*. (2012) we use this modelling approach to assess risk transmission from a given financial sector to the whole economy in selected emerging economies of Latin America, Central and Eastern European and South East Asia. The econometric approach is implemented in five stages.

The first stage deals with modelling the returns $R^i$ as a function of a set of state variables:

$$R_t^i = \alpha^i + \gamma^i M_t + \varepsilon_t^i \quad (6)$$

where $\alpha^i$ is the constant, $M_t$ represents a vector of contemporaneous control variables and $\varepsilon_t^i$ is a white noise error term. We then estimate the 1% quantile of market return based on the quantile regressions.

The second step involves the computation of the predicted 1% VaR for each segment of the financial system using only the statistically significant variables that were identified in the first stage. Given that the $VaR(\alpha)$ defined for a confidence level $1-\alpha$ is the quantile of the distribution of gains and losses over the target horizon, the forecast will be obtained as follows:

$$\hat{VaR} = \hat{\alpha}^i + \hat{\gamma}^i M_t \quad (7)$$

where $\hat{\alpha}^i$ and $\hat{\gamma}^i$ are the coefficient estimates from equation (6).

We then move to third stage of our analysis in which we estimate the system's returns using the following equation:

$$R_t^{system} = \alpha^{system|i} + \beta^{system|i} R_t^i + \gamma^{system|i} M_t + \varepsilon_t^{system|i} \quad (8)$$

where $\alpha^{system\backslash i}$ is the constant, $\beta$ gives the contribution of the return $R_t^i$ of each financial sector to the real economy, $M_t$ is a set of contemporaneous control variables and $\varepsilon_t^{system|i}$ is a white noise error term. Again the 1% quantile of returns are obtained from the quantile regression.

In the next stage we compute the CoVaR of the system which is the VaR of the system conditional to a situation of distress within either one of the individual financial sectors, represented by the 1% quantiles computed in the previous stages. Therefore, the estimation of CoVaR requires the use of the computed VaR (1%) from equation (7), given all the significant control variables obtained from equation (8).

$$\hat{CoVaR}_t^{i} = \hat{\alpha}^{sytem|i} + \hat{\beta}^{systemi} \hat{VaR}_t^{i} + \hat{\gamma}^{system|i} M_t \quad (9)$$

where $\hat{\alpha}^{system|i}$, $\hat{\beta}^{system|i}$ and $\hat{\gamma}^{system|i}$ are derived from equation (8).

The fifth and final stage of the estimation process involves the computation of ΔCoVaR which, as we explained above, is the difference between the CoVaR at the 1% quantile and the CoVaR at the 50% quantile. The calculation of CoVaR at the 50% quantile is made using the same approach, with the only difference being that we take 50% of the returns at each step. This CoVaR at the 50% quantile describes a conditional event at a median state given in formulation (5) which is required in order to compute the systemic risk measure. ΔCoVaR is the marginal contribution of each financial sector to systemic risk, i.e.

$$\Delta \hat{CoVaR}_t^i(q) = \hat{CoVaR}_t^i(1\%) - \hat{CoVaR}_t^i(50\%) \quad (10)$$

During a financial crisis, portfolio returns of all financial institutions are at their VaR level. Therefore, the CoVaR model is particularly appropriate for capturing risk contagion from a systemic crisis. Because the credit risk faced by financial institutions is more severe when there is a dramatic fall in prices and therefore returns, we focus on the downside risk of the changes in prices and thus, $\Delta \hat{CoVaR}$ takes negative values because it is computed from the 1% returns of each financial industry. Within this framework we consider that the financial sector with the larger absolute $\Delta \hat{CoVaR}$ is the sector that contributes the most to systemic risk in periods of distress.

## 4. Data and empirical results

We analyse the effect that three segments of the financial industry, namely banking, insurance and financial services sectors, have on the whole economy. It is interesting to note that these three sectors are subject to different regulatory frameworks. We employ our analysis for three groups of emerging markets: in Latin America, South East Asia and Central and Eastern Europe. We use weekly data from 29 December 1995 to 1 March 2013. We will thus be able to provide evidence as to whether there is a shift in the evidence before and after 2008, which will indicate whether or not systemic risk increased after the financial crisis.[1]

The first set of variables ($R_t^i$ s) consists of the returns of the three financial sectors and of the system. Specifically, for each country we employ the Banks index,

[1] Due to data availability the countries used in the present analysis are: Mexico, the Czech Republic, Hungary, Poland Romania, Turkey, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand. The same holds for the sample used in the estimations. The number of observations used also depends on data availability. We use high frequency weekly data in order to obtain a reactive measure of systemic risk. Alternatively, we could use daily data but the problem is that the bond markets in these emerging economies are not very liquid and we would unable to capture substantial reaction and volatility of the stock market indices.

the Insurances index and the Financial Services index whereas the system variable is proxied by the general stock returns index excluding the Financials index.[2]

In order to estimate the time-varying $CoVaR_t$ and $VaR_t$ we include a set of control variables $M_t$. These variables are taken to capture time variation in conditional moments of asset returns and at the same time are liquid and tradable. These control variables $M_t$ are given as follows: (1) *Liquidity spread*, which measures short-term liquidity risk, is defined as the difference between the 3-month repo rate and the 3-month treasury bill rate. (2) *3-month treasury bill spread variation* is defined as the difference between the 3-month bond rate in time $t$ and the 3-month bond rate in time $t-1$. Following Adrian and Brunnermier (2011) we use the change in the 3-month treasury bill, because the change and not the level is considered to be more significant in explaining the tails of financial sector market-valued asset returns. (3) *Yield spread change* is defined as the difference between the 10-year or 5-year government bond rate (depending on the availability of data) and the 3-month treasury bill rate. This measure captures the change in the slope of the yield curve. (4) *Equity return* is calculated using the general price index. Finally, we use a volatility measure to capture volatility of the system variable, since implied volatility measures are only available for the U.S. and the Eurozone but not for any of the emerging markets under consideration. To construct a proxy of volatility, we run a rolling regression for the returns of the general stock returns index excluding the Financials index with a window of 13 weeks. The estimated series of standard deviations are used to measure volatility. All data are in national currency. The spreads and the spread changes are

[2] The insurance index is not available for the Czech Republic, Hungary, Poland, Romania, Indonesia or the Philippines. For these economies we consider only the banking and other financial services industries.

expressed in basis points and the returns are expressed in percent. The series were taken from *Datastream* and *Bloomberg*.[3]

**4.1. Quantile regressions**

Table 1 reports quantile regressions results for the 1% and 50% quantile returns of the banking, insurance and other financial services industries of the thirteen emerging markets. Furthermore, Table 1 reports estimates for the system's returns in which the General stock market index excluding financial services is used to proxy each country's real economy. Table 1 also reports the pseudo-$R^2$ in order to assess the goodness-of-fit of quantile regressions. This measure has a similar interpretation as the standard $R^2$. The pseudo-$R^2$ is derived using the distances from data points to estimates in each quantile regression at each point along the $R_t^i$ - distribution. The estimated pseudo-$R^2$ obtained values imply that our estimated models have the appropriate specification.

Results for the Mexican banking industry show that equity returns have a positive impact on the 1% quantile returns of the banking index. With respect to the banking index at 50% (normal state), we observe that equity returns still influence its return but in addition volatility also has a positive effect. Turning now to the General Index ex Financials 1% quantile returns, we note that liquidity spread and equity returns are statistically significant with a positive sign whereas yield spread change and bank index total return are statistically significant and with a negative sign. With respect to the 50% quantile returns for the General Index ex Financials, volatility and

[3] Adrian and Brunnermeir (2011) and Bernal *et al*. (2012) employ an additional control variable to capture the time variation in the tails of asset returns, the change in *credit spread* which is defined as the difference between the 10-year Macrobond BBB corporate bonds rate and the 10-year bond rate. However, this data is not available for any emerging economies and therefore we did not include it in our estimations.

equity returns have a positive influence and bank index total return has a negative impact. The situation of the Mexican insurance industry is somehow weaker since the only statistically significant control variable is the equity return for the 1% and 50% quantile returns for the General Index ex Financials. Finally, our estimates for other financial services in Mexico show that both 1% and 50% quantile returns are positively impacted by equity returns for the General Index ex Financials, whereas the insurance index total return has no statistically significant impact on the system variable.

The evidence for the four Central and Eastern European countries relies only on the banking industry and the other financial services industry since no insurance index is available. Looking into the banking industry of the Czech Republic, we see that the 1% quantile returns of the banking index are influenced positively by the three-month rate change and the equity returns and negatively by volatility. In the case of the banking index at the 50% quantile returns, only the equity return has a statistically significant impact. For the case of the 1% and 50% quantile returns of the General Index ex Financials, the yield spread change and equity returns enter positively and the bank index total returns negatively and equity returns positively and bank index returns negatively, respectively. The banking index of Hungary, Poland and Romania exhibit very similar patterns with respect to the variables that influence the banking index and the General Index ex Financials at the 1% and 50% quantile returns, although in the case of Poland and Romania the three-month rate change is not statistically significant.

Looking at the financial services industry for the Czech Republic, our results indicate that the financial services 1% quantile returns are negatively related to volatility and the three-month rate change and positively to equity returns. The 50%

quantile returns are only positively related to equity returns. The General Index ex Financials 1% and 50% are positively influenced by equity returns and negatively by the financial index total return whereas in addition the 50% quantile returns are influenced by the yield spread change. Hungary's 1% and 50% quantile returns for the financial services index are similar to the those of the Czech Republic, but in addition volatility is also statistical significant with a negative sign. The same holds for the 1% and 50% for the General Index ex Financials. Poland and Romania exhibit minor differences from the results obtained for the Czech Republic and Hungary since the volatility variable has no influence on the 1% and 50% for the financial services index. The results for the 1% and 50% quantile returns of the General Index ex Financials show no significant statistically significant results.

Results for the Turkish banking industry indicate that only equity returns positively influence the bank index at the 1% and 50% quantile returns and the same evidence holds for both estimated quantiles for the General Index ex Financials. Turning our attention to the insurance industry, we observe that at the 1% quantile returns of the insurance index, volatility enters significantly with a negative sign and the equity returns affects this index positively. In the 50% quantile returns only the equity returns has a positive impact. In the case of the General Index ex Financials the equity returns is the only variable that influences in a positive way at both the 1% and 50% quantile returns. Finally, our estimates for the other financial services in Turkey indicate that both the 1% and 50% quantile returns for the financial services index are negatively influenced by the equity returns. Concerning the General Index ex Financials, the volatility and the financial services total returns negatively influence and yield spread change and equity returns positively influence at the 1% quantile returns whereas at the 50% quantile returns, equity returns have a positive impact and the financial services total returns influences in a negative manner.

Finally, we discuss the evidence from Southeast Asia. For the case of Indonesia and the Philippines we only consider the effects of the banking and other financial services industries. For the case of the banking sector in Hong Kong, we observe that for both the 1% and 50% quantile returns the equity returns positively influence the banking index. For both the 1% and the 50% of the General Index ex Financials, the equity returns has a positive impact and the liquidity spread and the banking sector total return have a negative impact. In addition for the 1% quantile returns there is a negative effect by liquidity spread. Similar results were obtained for Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand. Furthermore, in these markets the liquidity spread change and volatility also play an important role.

The results for the insurance industry are summarized as follows. In Hong Kong, for both the 1% and 50% quantile returns, equity returns positively affect the insurance index and for the latter case, the index is also influenced negatively by the three-month rate change. For the 1% and 50% quantile returns for the General Index ex Financials index, only the equity returns positively affect the insurance index. The results for the insurance industry in Korea, Malaysia, Singapore and Thailand are similar. In Korea, Malaysia and Singapore, the insurance index total return enters significantly in the 1% and 50% quantile returns of the General Index ex Financials.

Finally, our estimates for other financial services in Hong Kong at the 1% and 50% quantile returns of the insurance index are influenced positively by the equity returns. For the General Index ex Financials both at the 1% and 50% quantile returns, the equity returns have a positive impact and the financial services total return has a negative effect. Similar results hold for Malaysia and Thailand. In addition, for the case of Indonesia, Korea, the Philippines and Singapore the liquidity spread has a positive impact at the 1% quantile returns whereas the coefficient of volatility is negative and statistically significant.

### 4.2. $\Delta \hat{CoVaR}$ estimates

In this section we present and discuss the $\Delta \hat{CoVaR}$ estimates based on our presentation in Section 3. We define that a $\Delta \hat{CoVaR}$ with a value of zero implies that none of the three financial industries contributes to the systemic risk. Therefore, if the value is different from zero, we then consider the case that the financial industry which has the larger absolute estimate of $\Delta \hat{CoVaR}$ is taken to be the sector that contributes relatively the most to systemic risk in periods of distress.

In Table 2 we report descriptive statistics of the estimated $\Delta \hat{CoVaR}$. We observe that for Mexico, the Czech Republic, Hungary, Romania, Hong Kong, Indonesia, the Philippines and Thailand, the absolute value of the estimated $\Delta \hat{CoVaR}$ conditional to the banking sector is larger that the corresponding values for the insurance and other financial services industries. This finding suggests that when a distress situation occurred in the banking industry, it will increase the value of the VaR in those emerging markets as a whole as compared to the normal state. Looking at the cases of Poland, Turkey, Korea and Singapore, it is documented that the estimated $\Delta \hat{CoVaR}$ conditional to the financial services industry has the larger absolute value and therefore it is the segment of the financial sector that contributes most to the systemic risk in these emerging markets. Finally, in Malaysia, the absolute value of the estimated $\Delta \hat{CoVaR}$ conditional to the insurances industry has the larger absolute value which means that when this industry is in distress will contribute most to the systemic risk.

An additional interesting result we can derive from the results in Table 2 is that when we split the full sample into two periods, before and after the financial crisis with the year 2008 as the break point, then we note that the absolute values of the estimated $\Delta \hat{CoVaR}$ for all cases in the period prior to the financial crisis are smaller as compared to those obtained for the post-crisis period. This finding provides further evidence that the banking, insurance and other financial services, when in distress, contribute more to the systemic risk as the financial crisis moves into full swing.

**5. Summary and concluding remarks**

The recent financial crisis led to the understanding that financial intermediary distress documented in extreme (tail) events tend to spillover to financial institutions, financial industries and through them to the whole economy. It was also made clear that such spillovers are the results of an increase in the risk-appetite of banks, insurances and other financial services, either individually or at the industry level. Another important aspect of these negative effects is the need for a new regulatory framework that is currently under development within the context of Basle III in order to embody the main factors of systemic risk. Following the failure of the micro-prudential regulatory framework, there is now a shift to the development of macro-prudential regulations.

In this paper we adopt ΔCoVaR, a recent econometric methodology developed by Adrian and Brunnermeier (2011). This is a parsimonious measure of systemic risk that complements measures designed for individual financial institutions and also extends risk measurement to allow for a macro-prudential approach. We implement this new measure of systemic risk on selected countries from three regions of emerging markets, namely, Latin America, Central and Eastern Europe and Southeast Asia. Although recent studies investigate many aspects of the financial crisis in relation to developed economies, less research has been done with respect to emerging economies. Following Bernal *et al*. (2012), we do not study systemic risk in the context of individual financial institutions. We consider the contribution of the banking, insurance and other financial services industries that maybe in distress to the systemic risk. The ΔCoVaR analysis allows us to investigate the additional level of risk that the economy as a whole faces when at least one of the financial sectors is in distress.

We use weekly data for the period December 1995 to February 2013 for Mexico, the Czech Republic, Hungary, Poland, Romania, Turkey, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand. The main findings, based on estimation of 1% and 50% quantile regressions, show that equity returns is a key determinant in triggering systemic risk episodes. There is also evidence that volatility of the general index ex financials (system variable), liquidity spread, the three-month rate change and yield spread have an effect although weaker. Furthermore, we show that for Mexico, the Czech Republic, Hungary, Romania, Hong Kong, Indonesia, the Philippines and Thailand, it is the banking sector that contributes mostly to the systemic risk. In Malaysia the insurance industry contributes most to the systemic risk whereas in Poland, Turkey, Korea and Singapore the highest percentage contribution to systemic risk is due to the other financial services. Finally, based on the results of ΔCoVaR estimates before and after 2008, it is observed for all emerging markets that the contribution of each financial industry to systemic risk increased after the unfolding of the crisis.

Our results are of interest to regulators since it is shown that the different financial industries have an important and negative impact on the economy as a whole. It is emphasized that regulatory authorities should be able to identify the different segments of the financial sector of the economy which represent different risks for the system. Therefore, there is a need for regulatory provisions to reduce the risk on the whole economy emanating from these financial industries being in distress.

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**Table 1. Quantile regressions**

Mexico: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| **Variable** | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -0.2966<br>(1.6262) | -0.0126<br>(0.0964) | -0.2051<br>(0.2558) | 0.0143*<br>(0.0068) |
| Liquidity spread | 0.3532<br>(0.5677) | 0.1594*<br>(0.0543) | 0.4127<br>(0.2473) | 0.0062<br>(0.0089) |
| Three-month rate change | -0.5391<br>(1.0722) | -0.0456<br>(0.1339) | -0.1891<br>(0.8211) | 0.0086<br>(0.0419) |
| Yield spread change | -0.4450<br>(0.9396 | -0.0970*<br>(0.0416) | -0.1960*<br>(0.0858) | -0.0001<br>(0.0027) |
| Equity return | 0.7625***<br>(0.1745) | 1.0729***<br>(0.0164) | 0.8168***<br>(0.0765) | 1.0941***<br>(0.0033) |
| $R_t^i$ | | -0.0777***<br>(0.0089) | | -0.0818***<br>(0.0026) |
| Pseudo-$R^2$ | 0.3882 | 0.9577 | 0.2669 | 0.9625 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Mexico: Insurance companies

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| **Variable** | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | 1.9518<br>(2.1089) | -0.0005<br>(0.2284) | -0.0115<br>().0432) | 0.0261<br>(0.0334) |
| Liquidity spread | 3.6105<br>(3.3281) | -0.0699<br>(0.1010) | 0.0005<br>(0.0203) | -0.0063<br>(0.0213) |
| Three-month rate change | -1.9659<br>(2.6027) | -0.0309<br>(0.1198) | 0.5076<br>(0.3921) | -0.0838<br>(0.0529) |
| Yield spread change | -1.3405<br>(1.2115) | 0.0585<br>(0.0636) | -0.0016<br>(0.0169) | 0.0004<br>(0.0093) |
| Equity return | 0.4465<br>(0.3026) | 1.0133***<br>(0.0137) | 0.0165<br>(0.0147) | 1.0234***<br>(0.0055) |
| $R_t^i$ | | 0.0138<br>(0.0193) | | 0.0059<br>(0.0045) |
| Pseudo-$R^2$ | 0.0935 | 0.9355 | 0.2500 | 0.922 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the insurances index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Mexico: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -0.1950<br>(1.2309) | 0.0782<br>(0.0726) | -0.2650<br>(0.2729) | 0.0032 |
| Liquidity spread | 0.2866<br>(0.5577) | -0.0567<br>(0.0323) | 0.0005<br>(0.1712) | 0.0004 |
| Three-month rate change | -0.3866<br>(1.4056) | 0.0483<br>(0.0636) | 0.5282<br>(0.3741) | -0.0097 |
| Yield spread change | 0.0124<br>(0.4426) | 0.0275<br>(0.0310) | -0.0717<br>(0.0894) | 0.0006 |
| Equity return | 0.7742***<br>(0.1917) | 1.1230***<br>(0.0110) | 0.7800***<br>(0.0588) | 1.1108***<br>(0.0012) |
| $R_t^i$ | | -0.1168***<br>(0.0062) | | -0.1110***<br>((0.0012) |
| Pseudo-$R^2$ | 0.4663 | 0.9785 | 0.3405 | 0.9807 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Czech Republic: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -5.8501***<br>(1.9607) | -0.0223<br>(0.3235) | 0.0036<br>(0.6347) | 0.0475<br>(0.0255) |
| Liquidity spread | 1.9368<br>(3.4615) | 1.4582<br>(0.7674) | 0.1806<br>(1.6295) | 0.0365<br>(0.1107) |
| Three-month rate change | -14.6919***<br>(3.8920) | 2.1009<br>(1.2612) | -0.2650<br>(1.5385) | 0.0386<br>(0.0780) |
| Yield spread change | -1.1872<br>((0.8069) | 0.3350***<br>(0.1281) | 0.0464<br>(0.2226) | 0.0222<br>(0.0114) |
| Equity return | 1.5970***<br>(0.2162) | 1.2104***<br>(0.0262) | 0.9701***<br>(0.0780) | 1.2029***<br>().0516) |
| $R_t^i$ | | -0.1909***<br>(0.0195) | | -0.1923***<br>(0.0041) |
| Pseudo-$R^2$ | 0.5186 | 0.9251 | 0.2179 | 0.9256 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Czech Republic: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -5.5203***<br>(1.5439) | -0.2075<br>(0.2862) | -0.1094<br>(0.5936) | 0.0444<br>((0.0233) |
| Liquidity spread | -1.0939<br>(4.6569) | 0.6498<br>((0.4293) | 0.8666<br>(1.6452) | 0.0306<br>(0.1343) |
| Three-month rate change | -13.9268**<br>(4.8530) | 1.0989<br>(1.1885) | -1.2100<br>(1.4743) | 0.1195<br>(0.0882) |
| Yield spread change | -0.4681<br>(0.6755) | 0.1839<br>(0.1271) | -0.0169<br>(0.2532) | 0.0244*<br>(0.0101) |
| Equity return | 1.5445***<br>((0.2535) | 1.2310***<br>(0.0257) | 0.9655***<br>(0.0641) | 1.1979***<br>(0.0064) |
| $R_t^i$ | | -0.2204***<br>(0.0226) | | -0.1966***<br>(0.0049) |
| Pseudo-$R^2$ | 0.5254 | 0.9261 | 0.2150 | 0.9246 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Hungary: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -3.1705*<br>(1.3976) | -1.0626**<br>(0.3612) | 0.0456<br>(0.4189) | 0.0501<br>(0.0436) |
| Liquidity spread | -0.5483<br>(1.1452) | 0.2519<br>(0.1653) | -0.0735<br>(0.6613) | -0.0179<br>(0.0510) |
| Three-month rate change | -5.0844***<br>(1.3626) | -0.4281<br>(0.2986) | -1.1520<br>(0.7928) | -0.0119<br>(0.0359) |
| Yield spread change | -0.8306**<br>(0.2837) | 0.1934***<br>(0.0413) | -0.0718<br>(0.0680) | 0.0003<br>(0.0058) |
| Equity return | 1.3542***<br>(0.1272) | 1.3826***<br>(0.0326) | 1.2896***<br>(0.0658) | 1.3078***<br>(0.0079) |
| $R_t^i$ | | -0.3380***<br>(0.0192) | | -0.3016***<br>(0.0064) |
| Pseudo-$R^2$ | 0.6646 | 0.9074 | 0.4206 | 0.9040 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Hungary: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -2.3062*<br>(0.9273) | -1.0564**<br>(0.3504) | 0.0655<br>(0.4236) | 0.0312<br>(0.0362) |
| Liquidity spread | -0.0564<br>(1.1198) | 0.2182<br>(0.1831) | -0.1577<br>(0.5518) | -0.0027<br>(0.0235) |
| Three-month rate change | -4.8104***<br>(1.2297) | -0.4428<br>(0.3441) | -0.9210<br>(0.6408) | -0.0277<br>(0.0236) |
| Yield spread change | -0.6927**<br>(0.2264) | 0.2075***<br>(0.0468) | -0.0685<br>(0.0732) | -0.0051<br>(0.0047) |
| Equity return | 1.2871***<br>0.1043) | 1.3787***<br>(0.0382) | 1.2561***<br>(0.0613) | 1.3249***<br>(0.0063) |
| $R_t^i$ | | -0.3548***<br>(0.0207) | | -0.3281***<br>(0.0064) |
| Pseudo-$R^2$ | 0.6714 | 0.9066 | 0.4206 | 0.9040 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Poland: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -1.2853<br>(1.2868) | -0.2600<br>(0.4101) | 0.2062<br>(0.2884) | -0.1166<br>(0.0859) |
| Liquidity spread | -0.5227<br>(0.3872) | -0.0073<br>(0.1033) | 0.0075<br>(0.0977) | 0.0265<br>(0.0234) |
| Three-month rate change | 0.6493<br>(0.9271) | 0.0868<br>(0.3243) | -0.0874<br>(0.2030) | -0.1389<br>(0.0747) |
| Yield spread change | 0.4940***<br>(0.1468) | -0.0048<br>(0.0567) | -0.0638<br>(0.0376) | -0.0190*<br>(0.0092) |
| Equity return | 1.2544***<br>(0.1220) | 1.6175***<br>(0.0598) | 1.0712***<br>(0.0286) | 1.6004*<br>(0.0239) |
| $R_t^i$ | | -0.5941***<br>(0.0400) | | -0.6181***<br>(0.0233) |
| Pseudo-$R^2$ | 0.6570 | 0.8759 | 0.5645 | 0.8572 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Poland: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -1.6784<br>(1.1358) | -0.5244*<br>(0.2440) | 0.0468<br>(0.2013) | 0.0008<br>(0.0260) |
| Liquidity spread | -0.3985<br>(0.2802) | -0.1169<br>(0.0707) | 0.0441<br>(0.1044) | 0.0312<br>(0.0201) |
| Three-month rate change | 0.7467<br>(0.8109) | -0.0656<br>(0.1889) | 0.0864<br>(0.1945) | -0.0330<br>(0.0271) |
| Yield spread change | 0.5197***<br>(0.1418) | 0.0960*<br>(0.0373) | -0.0607<br>(0.0419) | -0.0173<br>(0.0090) |
| Equity return | 1.1911***<br>(0.1360) | 1.7164***<br>(0.0470) | 1.0153***<br>(0.0270) | 1.7947***<br>(0.0173) |
| $R_t^i$ | | -0.7526***<br>(0.0411) | | -0.8123***<br>(0.0161) |
| Pseudo-$R^2$ | 0.6948 | 0.9157 | 0.5876 | 0.9178 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Romania: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -1.4403<br>(1.2755) | 0.3458<br>(0.8352) | -0.6337<br>(0.3294) | 0.0361<br>((0.1310) |
| Liquidity spread | -1.8808<br>(1.0993) | 0.1307<br>().3029) | 0.0493<br>(0.3197) | -0.0341<br>(0.0517) |
| Three-month rate change | -1.5584<br>(1.8411) | 0.0477<br>(0.3561) | -0.0567<br>(0.4360) | -0.0368<br>(0.0769) |
| Yield spread change | 1.1922**<br>(0.3895) | -0.0019<br>(0.1768) | -0.1094<br>(0.1112) | 0.0217<br>(0.231) |
| Equity return | 1.0925*** | 1.5570***<br>(0.1103) | 0.9175***<br>(0.0786) | 1.3678***<br>(0.0211) |
| $R_t^i$ | | -0.5201***<br>(0.0815) | | -0.3889***<br>(0.0172) |
| Pseudo-$R^2$ | 0.6615 | 0.9271 | 0.4423 | 0.8572 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Romania: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -1.9274<br>(1.1703) | -0.3478<br>(0.2174) | -0.2637<br>(0.3707) | 0.0055<br>(0.0125) |
| Liquidity spread | -0.5855<br>(0.9897) | -0.0976<br>(0.0614) | -0.1592<br>(0.2865) | 0.0158<br>(0.0093) |
| Three-month rate change | -2.3288<br>(1.9277) | -0.1111<br>(0.1164) | -0.2578<br>(0.2589) | 0.0043<br>(0.0155) |
| Yield spread change | 0.8933*<br>(0.3653) | -0.0207<br>(0.0319) | -0.0131<br>(0.0988) | 0.0010<br>(0.0034) |
| Equity return | 1,2687***<br>(0.1963) | 1.5055***<br>(0.0329) | 0.9516***<br>(0.0434) | 1.5834***<br>(0.0124) |
| $R_t^i$ | | -0.4939***<br>(0.0300) | | -0.5792***<br>(0.0129) |
| Pseudo-$R^2$ | 0.7551 | 0.9784 | 0.5511 | 0.9578 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Turkey: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -3.8876<br>(2.5255) | -0.5620<br>(0.8940) | 0.7080<br>((0.7637) | -0.1331<br>(0.3242) |
| Liquidity spread | 0.0985<br>(0.5678) | 0.3736<br>(0.3204) | 0.4507<br>(0.3704) | 0.0461<br>(0.0933) |
| Three-month rate change | -0.1054<br>(0.8660) | 0.2031<br>0.3790) | 0.5937<br>(0.4975) | 0.0374<br>(0.1180) |
| Yield spread change | -0.0525<br>(0.3369) | -0.1306<br>(0.0940) | -0.0927<br>(0.1737) | 0.0052<br>(0.0394) |
| Equity return | 1.3065***<br>(0.1299) | 1.8485***<br>(0.1595) | 1.2452***<br>(0.0647) | 1.7585***<br>(0.0478) |
| $R_t^i$ | | -0.9109***<br>(0.1172) | | -0.8017***<br>(0.0385) |
| Pseudo-$R^2$ | 0.7881 | 0.8982 | 0.6994 | 0.8538 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Turkey: Insurance companies

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -8.3180*<br>(3.8619) | -1.3265<br>(1.5795) | -3.2190<br>(1.9185) | 0.0715<br>(0.8088) |
| Liquidity spread | -1.4839<br>(1,6196) | 0.6495<br>(0.9220) | 0.4576<br>(0.6287) | -0.3037<br>(0.3212) |
| Three-month rate change | 0.4649<br>(1.5596) | -1.2836<br>(0.7829) | 0.8807<br>(1.2879) | -0.6442<br>(0.4081) |
| Yield spread change | 0.9536<br>(0.5683) | -0.0904<br>(0.2223) | 0.0713<br>(0.3438) | -0.0053<br>(0.1550) |
| Equity return | 0.7338***<br>(0.2062) | 0.7746***<br>(0.1452) | 0.8917***<br>(0.0824) | 0.7011***<br>(0.0613) |
| $R_t^i$ | | 0.0230<br>(0.0764) | | 0.0396<br>(0.0462 |
| Pseudo-$R^2$ | 0.6376 | 0.7468 | 0.2420 | 0.5963 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the insurances index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Turkey: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -3.3219<br>(2.0211) | -0.8118*<br>(0.3303) | -0.1035<br>(0.8051) | -0.0120<br>(0.0596) |
| Liquidity spread | 0.6936<br>(0.4364) | 0.0230<br>(0.1002) | 0.4031<br>(0.2901) | 0.0185<br>(0.0286) |
| Three-month rate change | 0.5409<br>(0.6783) | 0.2051<br>(0.1280) | 0.5931<br>(0.3497) | 0.0060<br>(0.0227) |
| Yield spread change | 0.2828<br>(0.1912) | 0.0835**<br>(0.0298) | 0.0833<br>(0.1266) | 0.0066<br>(0.0135) |
| Equity return | 1.2325***<br>(0.0885) | 2.2176***<br>(0.0610) | 1.2195***<br>(0.0486) | 2.0792***<br>(0.0135) |
| $R_t^i$ | | -1.2002***<br>(0.0491) | | -1.0770***<br>(0.0124) |
| Pseudo-$R^2$ | 0.8425 | 0.9652 | 0.7528 | 0.9544 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Honk Kong: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -6.4697<br>(5.3042) | 0.0063<br>(1.0772) | -1.2105<br>(1.7889) | -0.2354<br>(1.0053) |
| Liquidity spread | -0.3221<br>(1.6357) | -0.6134*<br>(0.2419) | -0.9321<br>(0.5022) | -0.0825<br>(0.04266) |
| Three-month rate change | -10.2197<br>(22.1665) | 3.2529<br>(6.4970) | 9.3180<br>(8.5954) | 3.4356<br>(4.9693) |
| Yield spread change | 2.3856<br>(3.0190) | -0.8598<br>(0.4815) | -0.7804<br>(1.2976) | 0.0684<br>(0.6377) |
| Equity return | 0.7047**<br>(0.2373) | 1.0348***<br>(0.0774) | 0.9624**<br>(0.1222) | 1.1181***<br>(0.0836) |
| $R_t^i$ | | -0.1527*<br>(0.0650) | | -0.1915*<br>(0.781) |
| Pseudo-$R^2$ | 0.6885 | 0.9131 | 0.5527 | 0.8125 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Honk Kong: Insurance companies

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | 7.1390<br>(7.7416) | 0.6249<br>(1.0574) | 6.9271<br>(4.0332) | 0.5473<br>(1.0892) |
| Liquidity spread | 4.4245<br>(3.5962) | -0.4020<br>(0.4112) | 0.3860<br>(1.4467) | 0.0562<br>(0.3890) |
| Three-month rate change | -14.7512<br>(36.0537) | -8.2801<br>(7.8816) | -38.1728*<br>(16.5155) | 3.0200<br>(5.1442) |
| Yield spread change | 0.7080<br>(4.7174) | -1.2734<br>(0.7259) | -0.5889<br>(2.8018) | 0.1453<br>(0.6054) |
| Equity return | 1.3910***<br>(0.3490) | 0.9199***<br>(0.0699) | 0.8995***<br>(0.2452) | 0.9984**<br>(0.0692) |
| $R_t^i$ | | -0.0207<br>(0.0440) | | -0.0557<br>(0.0660) |
| Pseudo-$R^2$ | 0.4611 | 0.8983 | 0.3685 | 0.7890 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the insurances index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Honk Kong: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -5.5107<br>(3.3442) | -0.1013<br>(0.0672) | -0.4319<br>(1.9190) | -0.0073<br>(0.0519) |
| Liquidity spread | 1.0699<br>(1.2435) | -0.0083<br>(0.0321) | 0.0454<br>(0.6133) | -0.0010<br>(0.0222) |
| Three-month rate change | -0.0742<br>(8.8936) | -0.1692<br>(0.3755) | -7.6256<br>(7.7663) | -0.0580<br>(0.2857) |
| Yield spread change | 0.6623<br>(1.7609) | 0.0767<br>(0.0440) | 0.2261<br>(1.1742) | 0.0340<br>(0.0397) |
| Equity return | 1.0069***<br>(0.1402) | 1.5387***<br>(0.0180) | 1.0832***<br>(0.0867) | 1.5465***<br>(0.0146) |
| $R_t^i$ | | -0.5413***<br>(0.0156) | | -0.5456***<br>(0.0148) |
| Pseudo-$R^2$ | 0.7615 | 0.9936 | 0.6996 | 0.9859 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Indonesia: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -3.2923**<br>(1.2000) | -0.2489<br>(0.1444) | 0.4656<br>(0.2754) | 0.0062<br>(0.105) |
| Liquidity spread | 0.4887<br>(0.3760) | 0.0336<br>(0.0437) | -0.0232<br>(0.0994) | 0.0047<br>(0.0066) |
| Three-month rate change | 0.3704<br>(1.6461) | -0.1826<br>(0.1548) | -0.8251<br>(0.9483) | -0.0154<br>(0.0300) |
| Yield spread change | -0.2493<br>(0.2059) | -0.0126<br>(0.0290) | -0.0146<br>(0.0511) | 0.0060*<br>(0.0028) |
| Equity return | 0.9975***<br>(0.011) | 1.3322***<br>(0.0279) | 1.0564***<br>(0.0286) | 1.3838***<br>(0.0066) |
| $R_t^i$ | | -0.3565***<br>(0.0168) | | -0.3760***<br>(0.0058) |
| Pseudo-$R^2$ | 0.6578 | 0.9728 | 0.5336 | 0.9637 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Indonesia: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -3.2244**<br>(1.0480) | -0.1314<br>(0.1109) | 0.3926<br>(0.2370) | 0.0056<br>(0.0039) |
| Liquidity spread | 0.1384<br>(0.3664) | 0.0665**<br>(0.0254) | -0.0099<br>(0.0967) | 0.0005<br>(0.0038) |
| Three-month rate change | 0.2979<br>(1.6392) | -0.1401<br>(0.0863) | -0.8276<br>(0.0509) | -0.0057<br>(0.0219) |
| Yield spread change | -0.0576<br>(0.1835) | -0.0257<br>(0.0183) | -0.0149<br>(0.0486) | 0.0008<br>(0.0008) |
| Equity return | 0.9703***<br>(0.0881) | 1.3796***<br>(0.0160) | 1.0304***<br>(0.0266) | 1.4050***<br>(0.0019) |
| $R_t^i$ | | -0.3826***<br>(0.0110) | | -0.4051***<br>(0.0019) |
| Pseudo-$R^2$ | 0.6724 | 0.9811 | 0.5436 | 0.9792 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Korea: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -4.2649***<br>(1.2408) | -0.0725<br>(0.1636) | -0.3687<br>(0.4145) | -0.0689<br>(0.0410) |
| Liquidity spread | -10.1465***<br>(1.9950) | 0.0598<br>(0.2721) | -0.9035<br>(1.1486) | 0.1287<br>(0.0067) |
| Three-month rate change | 2.7933<br>(5.6895) | 0.3784<br>(0.7271) | 3.3108<br>(0.4319) | 0.1232<br>(0.2402) |
| Yield spread change | 0.8920*<br>(0.4357) | 0.0444<br>(0.0825) | 0.3624<br>(0.2454) | -0.0023<br>(0.0140) |
| Equity return | 0.8214***<br>(1.1298) | 1.1502***<br>(0.0160) | 1.0683***<br>(0.1017) | 1.1384***<br>(0.0065) |
| $R_t^i$ | | -0.1536***<br>(0.0110) | | -0.1413***<br>(0.0062) |
| Pseudo-$R^2$ | 0.5797 | 0.9610 | 0.3132 | 0.9349 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Korea: Insurance companies

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | 1.7094<br>(2.4170) | -0.6666<br>(0.3524) | 0.3917<br>(0.7364) | 0.0381<br>(0.0563) |
| Liquidity spread | -1.8349<br>(4.5279) | -0.0824<br>(0.3308) | -2.4150<br>(1.6430) | 0.0722<br>(0.1544) |
| Three-month rate change | 7.3084<br>(7.0853) | -1.0449<br>(1.1396) | 1.3844<br>(3.9024) | -0.2523<br>(0.3798) |
| Yield spread change | 1.0504<br>(1.4071) | 0.0381<br>(0.0972) | 0.2667<br>(0.2748) | -0.0264<br>(0.0317) |
| Equity return | 1.1320***<br>((1.4071) | 1.0156***<br>(0.0272) | 0.7525***<br>(0.0662) | 1.0244***<br>(0.0131) |
| $R_t^i$ | | -0.0573***<br>(0.0231) | | -0.0500***<br>(0.0073) |
| Pseudo-$R^2$ | 0.4840 | 0.9152 | | 0.2324 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the insurances index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Korea: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -4.4326*<br>(2.0750) | 0.1269<br>(0.0650) | 0.1283<br>(0.3841) | -0.0012<br>(0.0071) |
| Liquidity spread | 0.9476<br>(2.7630) | -0.3003<br>(0.2117) | -0.2612<br>(0.8166) | 0.0155<br>(0.0140) |
| Three-month rate change | 12.8915<br>(11.1145) | -0.1132<br>(0.3144) | 3.1132<br>(2.1022) | 0.0816**<br>(0.0303) |
| Yield spread change | -1.0793*<br>(0.5259) | 0.0168<br>(0.0392) | 0.0736<br>(0.1461) | -0.0013<br>(0.0034) |
| Equity return | 0.8221***<br>(0.1560) | 1.2099***<br>(0.0089) | 1.0387***<br>(0.529) | 1.2033***<br>(0.0035) |
| $R_t^i$ | | -0.2165***<br>(0.0106) | | -0.2033***<br>(0.0034) |
| Pseudo-$R^2$ | 0.6058 | 0.9823 | 0.4305 | 0.9798 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Malaysia: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -2.2497* (0.9671) | -0.2664*** (0.0773) | 0.0831 (0.2538) | 0.0085 (0.0234) |
| Liquidity spread | -0.9803 (0.5182) | 0.0217 (0.0452) | 0.0543 (0.1297) | -0.0081 (0.0123) |
| Three-month rate change | 2.5564 (1.6235) | 0.3685 (0.2200) | 0.3916 (0.6910) | 0.1021 (0.0878) |
| Yield spread change | 0.1223 (0.5612) | -0.0524 (0.0317) | 0.1034 (0.0968) | 0.0112 (0.0104) |
| Equity return | 1.0876*** (0.1172) | 1.2730*** (0.0117) | 1.0047*** (0.0362) | 1.2638*** (0.0075) |
| $R_t^i$ | | -0.3016*** (0.0100) | | -0.2867*** (0.0061) |
| Pseudo-$R^2$ | 0.6848 | 0.9702 | 0.5161 | 0.9482 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Malaysia: Insurance companies

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -11.3252*** (3.9085) | -0.9666*** (0.2894) | 0.0472 (0.4699) | -0.0461 (0.1323) |
| Liquidity spread | 1.2972 (1.7761) | -0.1772* (0.0853) | 0.2092 (0.2984) | -0.0100 (0.0418) |
| Three-month rate change | 6.9709 (9.5411) | -0.9004 (0.6551) | -0.5689 (1.7372) | 0.0334 (0.2633) |
| Yield spread change | -1.0521 (1.0338) | -0.2167* (0.1031) | -0.0502 (0.2231) | -0.0313 (0.0377) |
| Equity return | 0.8019* (0.4018) | 0.9673*** (0.0249) | 0.6289*** (0.0972) | 0.9585*** (0.0142) |
| $R_t^i$ | | -0.0582*** (0.0172) | | 0.0068 (0.0104) |
| Pseudo-$R^2$ | 0.2640 | 0.9098 | 0.1263 | 0.8239 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the insurances index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Malaysia: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -1.2280<br>(0.9452) | -0.0249<br>(0.0301) | 0.0009<br>(0.2953) | 0.0020<br>(0.0031) |
| Liquidity spread | -0.6430<br>(0.4447) | -0.0147<br>(0.0116) | 0.0602<br>(0.1147) | -0.0007<br>(0.0012) |
| Three-month rate change | 1.9435<br>(2.0258) | -0.0912<br>(0.0565) | 0.0413<br>(0.5670) | -0.0038<br>(0.0094) |
| Yield spread change | 0.3457<br>(0.4210) | -0.0093<br>(0.0087) | 0.0821<br>(0.1072) | 0.0000<br>(0.0010) |
| Equity return | 1.2681***<br>(0.1248) | 1.3351***<br>(0.0072) | 1.0936***<br>(0.0240) | 1.3547***<br>(0.034) |
| $R_t^i$ | | -0.3365***<br>(0.0062) | | -0.3548***<br>(0.0034) |
| Pseudo-$R^2$ | 0.7323 | 0.9930 | 0.5879 | 0.9911 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Philippines: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -2.8536*<br>(1.2027) | 0.0330<br>(0.3819) | -0.3156<br>(0/2731) | -0.0716<br>().0563) |
| Liquidity spread | 0.1106<br>(0.2020) | -0.0381<br>(0.0621) | -0.0161<br>(0.0715) | -0.0250<br>(0.0186) |
| Three-month rate change | -0.9939<br>(0.5172) | 0.1973<br>(0.2682) | -0.1596<br>(0.3305) | -0.0173<br>(0.0440) |
| Yield spread change | -0.0411<br>(0.1129) | -0.0964*<br>(0.0435) | -0.0843<br>(0.0479) | -0.0142<br>(0.0124) |
| Equity return | 0.8156***<br>(0.1129) | 1.2403***<br>(0.0544) | 0.9278***<br>(0.0317) | 1.2280***<br>(0.0151) |
| $R_t^i$ | | -0.3201***<br>(0.0499) | | -0.2814***<br>(0.0141) |
| Pseudo-$R^2$ | 0.6245 | 0.8835 | 0.4605 | 0.8321 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Philippines: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -1.7896<br>(1.1239) | -0.1513<br>(0.1286) | -0.0743<br>(0.2459) | 0.0011<br>(0.0176) |
| Liquidity spread | 0.5203***<br>(0.1414) | 0.0311<br>(0.0446) | -0.0072<br>(0.0467) | 0.0063<br>(0.0053) |
| Three-month rate change | -0.9265<br>(0.8356) | -0.0778<br>(0.0720) | 0.0446<br>(0.2432) | -0.0079<br>(0.0261) |
| Yield spread change | 0.1463<br>(0.0904) | -0.0896**<br>(0.0289) | -0.0016<br>(0.0428) | 0.0040<br>(0.0043) |
| Equity return | 0.9154***<br>(0.0745) | 1.4566***<br>(0.0225) | 1.0753***<br>(0.0307) | 1.4828***<br>(0.0225) |
| $R_t^i$ | | -0.4879***<br>(0.0263) | | -0.4840***<br>(0.0221) |
| Pseudo-$R^2$ | 0.7094 | 0.9491 | 0.5920 | 0.9419 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Singapore: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -5.6314***<br>(1.3706) | -1.1196**<br>(0.2838) | 0.5068<br>(0.3116) | 0.2346***<br>(0.0707) |
| Liquidity spread | -3.4250<br>(1.9306) | 0.0489<br>(0.2368) | 0.0791<br>(0.2528) | -0.0041<br>(0.0594) |
| Three-month rate change | -0.6569<br>(2.5854) | -0.2836<br>(0.6978) | -1.6337<br>(0.9175) | 0.2474<br>(0.2248) |
| Yield spread change | 0.8717*<br>(0.3481) | 0.0202<br>(0.0983) | 0.0656<br>(0.0676) | 0.0210<br>(0.0186) |
| Equity return | 1.4728*<br>(0.1460) | 1.2406***<br>(0.0335) | 1.1272***<br>(0.0469) | 1.2935***<br>(0.0192) |
| $R_t^i$ | | -0.3135***<br>(0.0231) | | -0.3203***<br>(0.0175) |
| Pseudo-$R^2$ | 0.6262 | 0.8732 | 0.4706 | 0.8339 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Singapore: Insurance companies

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -9.6197** (3.6951) | -2.5613** (0.7753) | -0.0483 (0.4554) | 0.0680 (0.0799) |
| Liquidity spread | 1.6195 (1.2065) | -0.1287 (0.5499) | -0.4837 (0.3491) | 0.0530 (0.0721) |
| Three-month rate change | 6.7470 (4.0473) | -1.1680 (0.8008) | 0.7206 (1.1381) | 0.7253** (0.2621) |
| Yield spread change | -0.5644 (0.5392) | -0.0406 (0.1594) | 0.0874 (0.1016) | -0.0325 (0.0282) |
| Equity return | 0.2743 (0.3033) | 0.9620*** (0.0576) | 0.3989*** (0.0578) | 0.9472*** (0.0161) |
| $R_t^i$ | | -0.0793* (0.0332) | | -0.0336** (0.0116) |
| Pseudo-$R^2$ | 0.3160 | 0.7606 | 0.0757 | 0.7224 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the insurances index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Singapore: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -5.0329* (2.1215) | -0.8242*** (0.2304) | -0.1750 (0.1800) | -0.0002 (0.0090) |
| Liquidity spread | -3.6533* (1.8492) | -0.7685 (0.4114) | -0.0495 (0.1110) | -0.0079 (0.0113) |
| Three-month rate change | -1.6315 (2.4357) | -0.5365 (0.4904) | -1.4013* (0.6557) | -0.0600 (0.0321) |
| Yield spread change | 0.5336 (0.3390) | -0.0016 (0.0406) | 0.0446 (0.5465) | 0.0033 (0.0021) |
| Equity return | 1.2696*** (0.1125) | 1.5332*** (0.0618) | 1.1139*** (0.0287) | 1.5856*** (0.0082) |
| $R_t^i$ | | -0.5348*** (0.0581) | | -0.5850*** (0.0085) |
| Pseudo-$R^2$ | 0.6654 | 0.9225 | 0.6163 | 0.9563 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Thailand: Banks

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -0.4978<br>(1.1203) | 0.0789*<br>(0.0401) | 0.2956<br>(0.3679) | 0.0181<br>(0.0173) |
| Liquidity spread | 2.6328*<br>(1.1124) | 0.1177<br>(0.0780) | -0.5904<br>(0.5078) | -0.0009<br>(0.0356) |
| Three-month rate change | 0.6211<br>(4.2454) | 0.2862<br>(0.1505) | 1.1425<br>(2.0214) | 0.0270<br>(0.0605) |
| Yield spread change | 0.3933<br>(0.2505) | -0.0008<br>(0.0147) | -0.0329<br>(0.1025) | 0.0122<br>(0.0067) |
| Equity return | 1.0958***<br>(0.1402) | 1.3149***<br>(0.0103) | 1.0352***<br>(0.0305) | 1.3082***<br>(0.0058) |
| $R_t^i$ | | -0.3149***<br>(0.0099) | | -0.3067***<br>(0.0046) |
| Pseudo-$R^2$ | 0.7052 | 0.9819 | 0.5491 | 0.9646 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the banks index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Thailand: Insurance companies

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -3.2089<br>(2.6942) | -0.6079<br>(0.3370) | -0.0301<br>(0.5916) | 0.0768<br>(0.1163) |
| Liquidity spread | -10.1392**<br>(3.8848) | 0.6455<br>(0.4466) | -0.3401<br>(0.5176) | 0.2406<br>(0.1736) |
| Three-month rate change | -21.1113*<br>(9.2554) | -1.2609<br>(-1.5294) | 0.8836<br>(1.8312) | -0.7231<br>(0.5840) |
| Yield spread change | 1.8403*<br>(0.8385) | 0.0261<br>(0.1041) | 0.1847<br>(0.1147) | -0.0071<br>(0.0335) |
| Equity return | 0.6952***<br>(0.2022) | 0.8895***<br>(0.0470) | 0.2132<br>(0.1134) | 0.9803***<br>(0.0131) |
| $R_t^i$ | | 0.0138<br>(0.0144) | | 0.0018<br>(0.0069) |
| Pseudo-$R^2$ | 0.4416 | 0.8977 | 0.0127 | 0.8215 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the insurances index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

Thailand: Financial services

| | Quantile Regression 1% | | Quantile Regression 50% | |
|---|---|---|---|---|
| | $R_t^i$ | $R_t^{system}$ | $R_t^i$ | $R_t^{system}$ |
| Volatility | -0.7821<br>(0.8500) | -0.0604<br>(0.0561) | -0.0618<br>(0.3406) | 0.0027<br>(0.0032) |
| Liquidity spread | 0.9903<br>(1.0879) | 0.0372<br>(0.0804) | -0.7055<br>(0.4923) | 0.0153<br>(0.0083) |
| Three-month rate change | -0.5807<br>(4.0308) | -0.0700<br>(0.1839) | 2.5191<br>(1.7136) | 0.0045<br>(0.0217) |
| Yield spread change | 0.2186<br>(0.2491) | -0.0161<br>(0.0218) | 0.0214<br>(0.1423) | 0.0004<br>(0.0015) |
| Equity return | 1.1214***<br>(0.1282) | 1.3569***<br>(0.0140) | 1.0626***<br>(0.0347) | 1.3297***<br>(0.7921) |
| $R_t^i$ | | -0.3470***<br>(0.0101) | | -0.3299***<br>(0.0034) |
| Pseudo-$R^2$ | 0.7495 | 0.9856 | 0.5662 | 0.9801 |

**Notes:** The $R_t^i$ and the $R_t^{system}$ are respectively the weekly market returns of the financial services index and the weekly market returns of the general index excluding the financial index. (***), (**) and (*) denotes significance at the 1%, 5% and 10% critical level, respectively.

**Table 2.** $\Delta \widehat{CoVaR}$ estimates

Mexico

| | 1996-2013 | | 1996-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | -0.227 | 0.137 | 0.005 | 0.093 | -0.165 | 0.192 |
| $\Delta CoVaR$ insurances | -0.003 | 0.030 | 0.006 | 0.080 | -0.014 | 0.120 |
| $\Delta CoVaR$ financial services | 0.002 | 0.025 | -0.033 | 0.107 | 0.065 | 0.218 |

Notes: All the figures above are in percentages.

Czech Republic

| | 1999-2013 | | 1999-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | 1.390 | 0.602 | -0.024 | 0.223 | 1.155 | 0.882 |
| | | | | | | |
| $\Delta CoVaR$ financial services | 0.838 | 0.691 | 0.619 | 0.296 | 1.208 | 0.854 |

Notes: All the figures above are in percentages.

Hungary

| | 1999-2013 | | 1999-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | -0.814 | 1.028 | -0.498 | 0.372 | -2.038 | 0.773 |
| | | | | | | |
| $\Delta CoVaR$ financial services | -0.610 | 0.988 | -0.231 | 0.354 | -1.583 | 0.563 |

Notes: All the figures above are in percentages.

Poland

| | 1999-2013 | | 1999-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | 0.084 | 0.857 | 0.201 | 0.471 | 0.020 | 0.525 |
| | | | | | | |
| $\Delta CoVaR$ financial services | -0.343 | 0.949 | 0.371 | 0.939 | 0.984 | 1.512 |

Notes: All the figures above are in percentages.

Romania

| | 1996-2013 | | 1996-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| Δ*CoVaR* banks | 2.429 | 1.543 | 0.044 | 0.444 | 2.523 | 1.593 |
| | | | | | | |
| Δ*CoVaR* financial services | 1.767 | 1.332 | 0.084 | 0.849 | 1.605 | 1.143 |

Notes: All the figures above are in percentages.

Turkey

| | 1996-2013 | | 1996-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| Δ*CoVaR* banks | -0.060 | 0.575 | -0.091 | 0.631 | -0.012 | 0.403 |
| Δ*CoVaR* insurances | 0.043 | 0.415 | 0.020 | 0.432 | 0.008 | 0.291 |
| Δ*CoVaR* financial services | -0.431 | 0.147 | -0.139 | 0.061 | -0.415 | 0.147 |

Notes: All the figures above are in percentages.

Hong Kong

| | 1996-2013 | | 1996-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| Δ*CoVaR* banks | -1.695 | 0.247 | -1.203 | 0.401 | -1.895 | 0.247 |
| Δ*CoVaR* insurances | -0.008 | 0.268 | -0.032 | 0.135 | 0.005 | 0.273 |
| Δ*CoVaR* financial services | 0.004 | 0.130 | 0.015 | 0.090 | 1.543 | 1.145 |

Notes: All the figures above are in percentages.

Indonesia

| | 1998-2013 | | 1998-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| Δ*CoVaR* banks | 2.065 | 0.533 | -0.405 | 0.368 | 1.499 | 0.942 |
| | | | | | | |
| Δ*CoVaR* financial services | 1.197 | 0.537 | -0.191 | 0.364 | 1.334 | 0.807 |

Notes: All the figures above are in percentages.

Korea

| | 1996-2013 | | 1996-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | 0.774 | 0.574 | -0.638 | 0.360 | 0.376 | 0.365 |
| $\Delta CoVaR$ insurances | -0.005 | 0.159 | 0.006 | 0.151 | -0.905 | 0.441 |
| $\Delta CoVaR$ financial services | 1.163 | 0.472 | 0.800 | 0.527 | 1.294 | 0.538 |

Notes: All the figures above are in percentages.

Malaysia

| | 1996-2013 | | 1996-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | 0.259 | 0.215 | 0.003 | 0.164 | 0.677 | 0.369 |
| $\Delta CoVaR$ insurances | -0.766 | 0.213 | -0.308 | 0.381 | -2.019 | 0.332 |
| $\Delta CoVaR$ financial services | -0.004 | 0.172 | 0.004 | 0.192 | -0.0004 | 0.017 |

Notes: All the figures above are in percentages.

Philippines

| | 1998-2013 | | 1998-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | 0.633 | 0.334 | -0.509 | 0.165 | 1.184 | 0.278 |
| | | | | | | |
| $\Delta CoVaR$ financial services | -0.482 | 0.352 | 1.050 | 0.454 | -0.123 | 0.185 |

Notes: All the figures above are in percentages.

Singapore

| | 1998-2013 | | 1998-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | -0.256 | 0.517 | 1.240 | 0.704 | 1.517 | 0.600 |
| $\Delta CoVaR$ insurances | -1.184 | 0.590 | -2.222 | 0.964 | 1.449 | 0.683 |
| $\Delta CoVaR$ financial services | 2.159 | 1.995 | 1.444 | 1.189 | 2.271 | 0.730 |

Notes: All the figures above are in percentages.

Thailand

| | 1996-2013 | | 1996-2007 | | 2008-2013 | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| $\Delta CoVaR$ banks | -0.221 | 0.189 | -0.207 | 0.201 | 0.181 | 0.281 |
| $\Delta CoVaR$ insurances | -0.003 | 0.388 | 0.002 | 0.202 | 0.0057 | 0.098 |
| $\Delta CoVaR$ financial services | -0.000 | 0.0491 | -0.105 | 0.090 | 0.008 | 0.154 |

Notes: All the figures above are in percentages.

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Professor of International Finance

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