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Moroccan conventional banks' contribution to systemic risk

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Abstract: *Our paper aims to study the exposure of Moroccan conventional banks to systemic risk. We use three measures widely used in the empirical literature: the conditional value at risk (CoVaR) developed by (Tobias and Brunnermeier, 2016), the Marginal Expected Shortfall (MES), developed by (Acharya and al., 2012), and the Systemic Risk Index (SRISK) proposed by (Brownlees and Engle, 2012). For this purpose, we rely on a database of Moroccan conventional banks, including data on stock market returns and specific variables for the period 2005-2017. We measure the contribution to systemic risk of each bank, in order to compare its presence and the degree of exposure to systemic risk of Moroccan banks. Our empirical findings indicate that BMCE and AWB represent the two Moroccan banks that contributed the most to systemic risk during the three periods of our study: pre-crisis, crisis, and post-crisis, due to their high level of capital loss. Moreover, banks with a high level of capital inadequacy contribute more to systemic risk. Similarly, as the level of capitalisation increases, banks become less susceptible to systemic risk.*

***Key Words*: Moroccan conventional banks, CoVaR, MES, SRISK, Systemic risk, Capitalisation.**

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1.INTRODUCTION

The banking system, through its intermediation activity, plays a crucial role in the development of the economic environment, insofar as it covers and offers a wide range of services for all economic actors. Effective regulation of banks is essential to prevent the collapse of financial systems, especially as crises have been recurrent in the history of the economy and have been caused by the fragility of the financial system. The financial crisis of 2007 led banking regulators to learn from the weaknesses of the Basel II prudential rules and to introduce a new regulatory framework called Basel III (Schwerter, 2011). In December 2010, Basel III made adjustments to the prudential rules of Basel II, after analysing the weaknesses in the banking system following the 2007 crisis. Basel III proceeded to the suppression of Tier 3 capital and to the redefinition of the elements constituting Tier 1 and Tier 2 while increasing the thresholds of the ratios. However, this banking regulation did not make adjustments to the systemic risk associated with banks such as: size, leverage and connections with other parts of the financial system ((Brownlees and Engle, 2012), (Acharya and al., 2010)). The European Central Bank defines systemic risk as the risk of financial instability, which is so deep that it threatens the smooth functioning of the financial system to the point where growth is affected. Systemic risk is a global risk, a macroeconomic risk, consisting of the sudden deterioration of financial stability, caused by the dysfunction of financial institutions, which has repercussions on the real economy.

In this context, Jean Claude Trichet, President of the European Central Bank, proposed the creation of a new institution dedicated to the management and supervision of systemic risk: "the management of systemic risks will remain essential, particularly in the context of the increasing sophistication of global finance, which in turn is facilitated by rapid technological progress. In view of this, it is useful to create a new institution specifically responsible for macro-prudential supervision at European level in the form of a European Systemic Risk Board"[1].

While the 2007 financial crisis had a negative impact on the world's most developed economies, its effects on the Moroccan economy have not been verified, and even less so on the Moroccan financial system, especially banks, since credit demand has not been affected (HCP, 2010). The High Commission for Planning (HCP) used the macro-econometric model for forecasting and simulating economic policies to study the impact of the financial crisis on the Moroccan economy and concluded that the Moroccan financial system was not impacted by this crisis for two main reasons: compliance with the prudential rules dictated by the Basel 2 committee and the low level of integration of Morocco in global finance. According to Bank Al Maghrib (2007), the share of foreign assets in the total assets of Moroccan banks is 4%. Similarly, according to the *Conseil Déontologique des Valeurs Mobilières* (CDVM), the share of residents in the market capitalisation, excluding strategic holdings, was less than 1.8% at the end of 2007.

In this article, we attempt to explore the contribution of each Moroccan bank to systemic risk in three distinct periods: the pre-crisis period, the crisis period and the post-crisis period. Our motivation for this work is to provide empirical findings on the systemic risk of Moroccan banks based on the measures of this risk most adopted by the scientific community.

2. REVIEW OF THE LITERATURE

Prior to the outbreak of the 2007 financial crisis, regulation focused primarily on the soundness of financial institutions without taking into account other components of the economic system. However, over the last decade, there has been a shift from micro-prudential to macro-prudential banking regulation. The objective of this regulation is to limit risk-taking. In this regard, research and empirical work has focused on the study of systemic risk over the last decade. (Bisias and al., 2012) propose different measures of systemic risk, with 31 measures, each having its own purpose, use and specific utility. (Benoit and., al 2017) conducted a study on systemic risk measures. They distinguished between two main measures namely: specific and global approach to measuring systemic risk. The specific sources represent contagion risk, liquidity crises, etc... While the global measure corresponds to the MES, SRISK and CoVaR. Marginal Expected Shortfall (MES), represents the expected capital loss when the market drops below a certain threshold over a given period (Acharya and al., 2012), Systemic Risk Index (SRISK) considers both the liabilities and the size of the institution (Brownlees and Engle, 2012), and the conditional value at risk (CoVaR) which is the Value-at-Risk (VaR) of the financial system conditional on a particular event impacting a given firm. The contribution of a given firm to systemic risk (CoVaR) is the difference between its CoVaR when the firm is, or is not, in financial trouble (Tobias and Brunnermeier, 2016).

The methods and techniques used in the financial literature have been diverse, we can mention : CoVaR by panel data regression ((Wong and Fong, 2011) ; (Roengpitya and Rungcharoenkitkul, 2011)), ΔCoVaR by quantile regression and stochastic dominance test (Castro and Ferrari, 2014), (Girardi and et Ergun, 2013), Estimation by the generalized autoregressive conditional heteroskedasticity generalized autoregressive (GARCH) estimation of the CoVaR (Girardi and Ergun, 2013), Distress Insurance Premium (Huang and al., 2012), heteroskedasticity models (Zakaria, 2015), and

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quantile regression of the state-dependent sensitivity value-at-risk (Adams and al., 2014).

A study on Moroccan banks was conducted by (Zakaria, 2015) to assess the systemic risk of Moroccan banks. The results of this research show that there are three main Moroccan banks with significant systemic risk namely: BMCE, BMCI and ATW. Large banks contribute more to systemic risk ((Roengpitya and Rungcharoenkitkul, 2011) ; (Huang and al., 2012)). The contribution of banks to systemic risk depends on their probability of default (linearly) and their size and asset correlation in a non-linear way (Huang and al., 2012). However, (Lopez-Espinoza and al., 2015) point out that the size of the bank does not affect the increase in systemic risk; it is the instability of short-term wholesale funding that determines the CoVaR. Few banks contribute to systemic risk because of the linear relationship between the interest variables that affect macro-rudential measures for financial institutions (Castro and Ferrari, 2014). Based on a study of four financial groups in the US: banking institutions, insurance companies, brokers, non-banking institutions, (Girardi and Ergun, 2013) find that Banking institutions contribute the most to systemic risk after conducting a multivariate GARCH estimation of the CoVaR. Commercial banks induce shocks to other financial institutions (Adams and al., 2014). (Zakaria, 2015) finds similar results for Moroccan banks by stating that the spillover dimension of systemic risk is procyclical. Among the components of the financial system, banks produce the greatest tail risk, the second largest source of risk is securities and insurance (Bühler and Prokopczuk , 2010).

3. RESEARCH METHODOLOGY

In order to analyze systemic risk in the Moroccan banking sector, we estimated three systemic risk measures commonly used in the literature; the conditional value at risk (CoVaR) developed by (Tobias and Brunnermeier, 2016), the Marginal Expected Shortfall (MES) developed by (Acharya and al., 2012), the Systemic Risk Index (SRISK) proposed by (Brownlees and Engle, 2012).

The CoVaR measure is based on the VaR approach, which is estimated by the maximum potential loss of a bank within a confidence interval q :

$$\mathbf{P}_r(\mathbf{R}it \leq \mathbf{VaR}qit) = q \qquad (1)$$

Hence :

VaR_{qit} is q^{th} quantile of the return distribution, and R_{it} is the return of bank i.

CoVaR is then defined as the q^{th} quantile of the market return conditional on a bank-specific distress event. This event is defined when bank i's return is less than or equal to its VaR ($R_{it} = VaR_{qit}$.).

$$\mathbf{P}_r(\mathbf{R}_{mt} \leq \mathbf{CoVaR}_{qm|i,t}|\mathbf{R}_{it} = \mathbf{VaR}_{qit}) = q \qquad (2)$$

We define the market return (R_{mt}) as the weighted average of all returns of the banks that make up the financial system, where w_{it} is the market capitalisation of each bank.

$$\mathbf{R}_{mt}=\sum^{n}_{i=1}\mathbf{w}_{it}\,\mathbf{R}_{it}.$$

A bank's daily return (R_{it}) is calculated according to the following formula:

$$\mathbf{R}_{it}= \mathbf{Ln}(\mathbf{P}_t)-\mathbf{Ln}(\mathbf{P}_{t-1})$$

With : P_t and P_{t-1} are the daily share prices of each bank.

The contribution of a bank i to systemic risk is calculated as the difference between the CoVaR of the financial system conditional on the bank's distress and the CoVaR of the financial system conditional on the bank's normal situation. Mathematically, the formula is written as follows:

$$\Delta\,\mathbf{CoVaR}_{qm|i,t}=\mathbf{CoVaR}_{m|Rit=VaRit,t} - \mathbf{CoVaR}_{m|Rit=VaR^{0,5}it,t} \qquad (3)$$

The Marginal Expected Shortfall (MES) measures a bank's contribution to overall systemic risk on condition that the performance of the financial system is undercapitalised below the threshold C. The threshold C is defined as a systemic event if the market performance falls below this threshold [R_{mt}<C]. The MES is defined according to (Acharya and al., 2012) by :

$$\mathbf{MES}_{it}(\mathbf{C}) = \mathbf{E}_{t-1}[\mathbf{R}_{it}|\mathbf{R}_{mt} < \mathbf{C}] \qquad (4)$$

With C is the threshold value of the crisis event, R_{it} and R_{mt} represent the return of bank i and the return of the market.

The SRISK measures the expected capital shortfall of a bank in the event of a systemic event. This approach combines both the bank's capital, its MES and its size. The bank with the largest capital gap is considered to be the most systemically risky. This approach is written as follows:

$$\mathbf{SRISK}_{it}= \mathbf{k}\,\mathbf{D}_{it} - (\mathbf{1}-\mathbf{k})(\mathbf{1}-\mathbf{LRMES}_{it})\,\mathbf{W}_{it} \qquad (5)$$

Where D_{it} and W_{it} are the book value of the total liabilities and equity of institution i. K is the prudential capital ratio between equity and assets. The LRMES represents the expected loss of institution i over a long period of time.

To empirically analyze the determinants of systemic risk of Moroccan banks, we estimate an ordinary least squares (OLS) regression. We use the quarterly averages of ΔCoVaR, MES and SRISK as dependent variables and the bank-specific variables as explanatory variables.

Our three models are written as follows:

$$\textbf{\textit{Model (1)}}\ \Delta\mathbf{CoVaR}_{it} = \alpha_0 + \beta Bank_{i,t} + \mu Country_{i,t} + Dummy\ crisis + \eta_{i,t} + \varepsilon_{i,t}$$

$$\textbf{\textit{Model (2)}}\ \mathbf{MES}_{it} = \alpha_0 + \beta Bank_{i,t} + \mu Country_{i,t} + Dummy\ crisis + \eta_{i,t} + \varepsilon_{i,t}$$

$$\textit{Model (3)}\ \mathbf{SRISK}_{it} = \alpha_0 + \beta Bank_{i,t} + \mu Country_{i,t} + Dummy\ crisis + \eta_{i,t} + \varepsilon_{i,t}$$

$Bank_{i,t}$ is the vector of bank-specific explanatory variables. $Country_{i,t}$ represents the macroeconomic variables. The variable Dummy crisis=1 for the period 2007-2008, otherwise it is equal to 0.

3.1 Presentation of variables

Based on the empirical literature, the factors influencing systemic risk are size and leverage ((Brownlees and Engle, 2012), (Acharya and al., 2010)), market beta and VaR (Adrian and Brunnermeier, 2011). We incorporate the ratio of total loans of each to total credit risk assets as an indicator of credit risk (Bostandzic and Weil, 2018).

Size is represented by the logarithm of total assets in millions of Dirham. The financial literature gives great importance to size as a determinant of a bank's contribution to systemic risk (Zhang and al.,, 2015). There is a positive relationship between size and its contribution to systemic risk, the larger a bank is affected, the more likely it is to influence systemic risk (Vallascas and Keasey, 2012). Leverage is presented by the ratio of equity to total assets, this ratio is widely used in the literature as an indicator of default risk (Brownlees and Engle, 2012), (Acharya and al., 2010). The higher the solvency risk, the more the bank is affected by systemic risk. Credit risk is defined as the ratio of total loans to total assets. Banks that extend more credit may be the most exposed to systemic risk (Bartram and al., 2007). VaR and beta are included in our model since the estimates of ΔCoVaR and the MES are related to the market VaR and beta (Adrian and Brunnermeier, 2011). For the macroeconomic variables, we use GDP growth and inflation.

3.2 Sample and data collection

Our analysis focuses on a sample of six Moroccan banks (Attijariwafa Bank (AWB), La banque marocaine du commerce extérieur (BMCE), Crédit du Maroc (CM), la banque populaire (BP), crédit immobilier et hôtelier (CIH), banque marocaine pour le commerce et l'industrie (BMCI)), during the period 2005-2017. The data are collected from the Datastream database. We estimated the three measures on a daily basis for the 6 banks of the Moroccan banking sector for a period from 2005 to 2017. We then calculated quarterly averages of these measures to assess the individual contribution of each bank to systemic risk before, during and after the 2008 financial crisis.

The descriptive statistics and correlation analysis between the variables in our study are presented in Tables 1 and 2. Table 1 shows a negative average of 2.43%, 1.06% and 17.9% million of ΔCoVaR, MES and SRISK respectively. Regarding the relationships between systemic risk and bank-specific variables, we find a strong positive relationship between size and the capital shortfall measured by the SRISK. Leverage and credit risk are negatively correlated with ΔCoVaR and MES. Market risk and value-at-risk VaR and macroeconomic variables are positively related to systemic risk.

Table 1: Descriptive statistics

	ΔCoVaR	MES	SRISK	Size	Leverage	Credit	VaR	Beta	GDP	Inflation
Mean	2,43	1,06	17,9	146290	8,34	72,34	2,72	0,22	4,12	1,57
Median	1,19	0,86	9,5	72598	8,24	73,68	2,75	0,15	4,08	1,28
Maximum	38,78	4,55	75,9	475024	13,81	88,45	7,81	0,87	7,57	3,7
Minimum	0,01	0,09	0,7	19362	-6,03	14,69	0,99	0,003	1,12	0,44

Table 2: Correlation matrix

	ΔCoVaR	MES	SRISK	Size	Leverage	Credit	VaR	Beta	GDP	Inflation
ΔCoVaR	1,0000									
MES	0,5507	1,0000								
SRISK	-0,0066	0,1565	1,0000							
Size	-0,0285	0,1836	0,9291	1,0000						
Leverage	-0,2533	-0,3752	-0,0899	-0,1279	1,0000					
Credit	-0,2357	-0,2013	-0,2267	-0,3346	0,3090	1,0000				
VaR	0,0153	0,1308	-0,5614	-0,6148	0,0588	0,4593	1,0000			
Beta	-0,0762	0,5096	0,4693	0,6006	-0,1240	-0,2074	-0,2661	1,0000		
GDP	0,3788	0,2063	-0,1016	-0,1818	-0,1412	-0,0195	0,1729	-0,1863	1,0000	
Inflation	0,3469	0,1911	-0,0833	-0,1855	-0,1481	-0,0964	0,1612	-0,1860	0,6092	1,0000

Figures 1, 2 and 3 (Appendix 1) present the evolution of the ΔCoVaR, MES and SRISK of Moroccan banks for the period from 2005 to 2017. Our estimates clearly show that systemic risk was significantly increased during the financial crisis for Moroccan banks (Figure 1,2 and 3). We note that there is a strong fluctuation in all three measures of systemic risk during the 2007-2008 crisis, which shows the impact of the crisis on Moroccan banks in terms of their contribution to systemic risk. By making a comparison between Moroccan banks, BMCE represents a large systemic importance in terms of the Marginal Expected Shortfall over the crisis period and after the crisis. The vulnerability of Moroccan banks measured by the ΔCoVaR increases before the crisis period but decreases during the crisis and stabilizes after the crisis. The AWB bank achieves a higher level of capital loss, which increases during the crisis, and continues to grow after the crisis.

In terms of classification, the ΔCoVaR, MES and SRISK measures classify BMCE and AWB as the most important in terms of contribution to systemic risk before, during and after the crisis. These three measures similarly classify the same banks in the top three ranks of banks most affected by systemic risk (see Table 3).

Table 3: Banks classification according to their contributions to systemic risk

	Rank	Banks	CoVaR	Rank	Banks	MES	Rank	Banks	SRISK
Pre-crisis period	1	BMCE	13,72	1	BMCE	1,69	1	AW	19577,29
	2	AW	7,13	2	CHI	1,55	2	BMCE	9588,75
	3	CP	5,97	3	AW	1,16	3	BMCI	6361,43
	4	BMCI	4,12	4	CP	0,98	4	CM	3825,09
	5	CHI	2,84	5	BMCI	0,74	5	CHI	3542,78
	6	CM	2,51	6	CM	0,52	6	CP	2133,96
Crisis period	1	BMCE	7,30	1	BMCE	2,62	1	BMCE	41726,19
	2	AW	3,79	2	AW	1,24	2	AW	24829,58
	3	CP	3,03	3	CP	1,13	3	CP	12035,07
	4	BMCI	1,93	4	CHI	0,99	4	BMCI	9110,05
	5	CHI	1,61	5	BMCI	0,75	5	CHI	8154,72
	6	CM	1,50	6	CM	0,67	6	CM	5945,10
Post-crisis period	1	AW	1,26	1	BMCE	1,90	1	AW	55713,85
	2	BMCE	2,34	2	CHI	0,98	2	CP	29695,49
	3	CP	0,96	3	AW	0,98	3	BMCE	24304,00
	4	BMCI	0,50	4	CP	0,79	4	BMCI	8146,21
	5	CHI	0,46	5	BMCI	0,66	5	CHI	5648,02
	6	CM	0,25	6	CM	0,40	6	CM	4919,06

4. EMPIRICAL FINDINGS

To investigate the dependence of systemic risk and bank-specific financial variables, we used an Ordinary Least Squares (OLS) regression. Models (1), (2) and (3) in Table 4 (Appendix2) use ΔCoVaR, MES and SRISK as dependent variables. The estimates show that there is a positive and statistically significant relationship between size and systemic risk as measured by the ΔCoVaR.

This result means that as the size of the bank increases, its vulnerability to systemic risk increases. Furthermore, size is positively associated with SRISK, the indicator that measures capital inadequacy. This suggests that any growth in size will lead to an increase in the sensitivity of the bank's equity and leverage to systemic risk in the event of a crisis. Furthermore, we find a negative correlation between leverage and systemic risk of Moroccan banks in all our specifications, which suggests that as the level of capitalization increases, banks are less sensitive to systemic risk. Regarding bank credit policy represented by the ratio of total loans to total assets, we find that credit risk is negatively related to the contribution to systemic risk and sensitivity to systemic shocks. However, we find a positive correlation between credit risk and SRISK. This result means from a systemic point of view that the more loans granted, the more the bank is exposed to a high level of funding shortfall in case of a crisis. As for the analysis of the relationship between market risk, measured by the beta coefficient, we find a positive relationship between beta, MES and SRISK. This result is expected, as the sensitivity of banks to market fluctuations increases, the systemic risk of banks increases. The VaR measure shows a positive and significant correlation with systemic risk exposure. However, we find a negative relationship between VaR and SRISK. Both measures quantify market risk, which justifies their positive correlations. The negative relationship between VaR and SRISK means that as the minimum loss for a risk level increases, the capital deficiency decreases. This result suggests that Moroccan banks are sound and adequately capitalized. The Dummy crisis variable introduced in our estimation is positive and statistically significant in all three models, showing that Moroccan banks were affected by the 2007-2008 financial crisis. Finally, the analysis of our macroeconomic variables shows that an increase in GDP growth is accompanied by an increase in systemic risk exposure in the case of Morocco. An economic growth increases the demand for bank loans, which favours the increase of credit risk and consequently of systemic risk. For the inflation variable, the systemic risk of banks is positively related to inflation. A high level of inflation increases the contribution of banks to systemic risk.

5. CONCLUSIONS

The systemic risk is present in the Moroccan banking system, its existence is essential for the sustainability and development of financial activities related to this system. After conducting an empirical study on the 6 Moroccan banks. Our empirical results indicate that BMCE and AWB are the two Moroccan banks that contributed the most to the systemic risk during the three periods of our study: pre-crisis, crisis and post-crisis, due to the high level of capital loss. Our results relatively confirm those of zakaria (2015) who found that BMCE, BCMI and AWB are the three Moroccan banks that contribute to systemic risk. The work of (Wong and Fong, 2011), (Benoit and al., 2013) and (Girardi and Ergun, 2013) corroborate our results. However, our findings are at odds with those of (Adams and al., 2014) who conclude that the crisis was transmitted to US financial institutions from commercial banks.

Our methodology relied on three main measures of systemic risk namely: ΔCoVaR, MES, SRISK. After the statistical tests performed, it was found that there is a negative and statistically significant relationship between ΔCoVaR, MES and the size of Moroccan banks, while for SRISK, the relationship is positive, which confirms the results of (Huang and al., 2012) and (Roengpitya and Rungcharoenkitkul, 2011). However, our results are in contradiction with those of (Lopez-Espinoza and al., 2015) who find that bank size does not affect the increase in systemic risk.

Moreover, banks with a high level of capital inadequacy contribute more to systemic risk. Similarly, as the level of capitalisation increases, banks become less susceptible to systemic risk.

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Appendix 1

Figure 1: Evolution of the ΔCoVaR

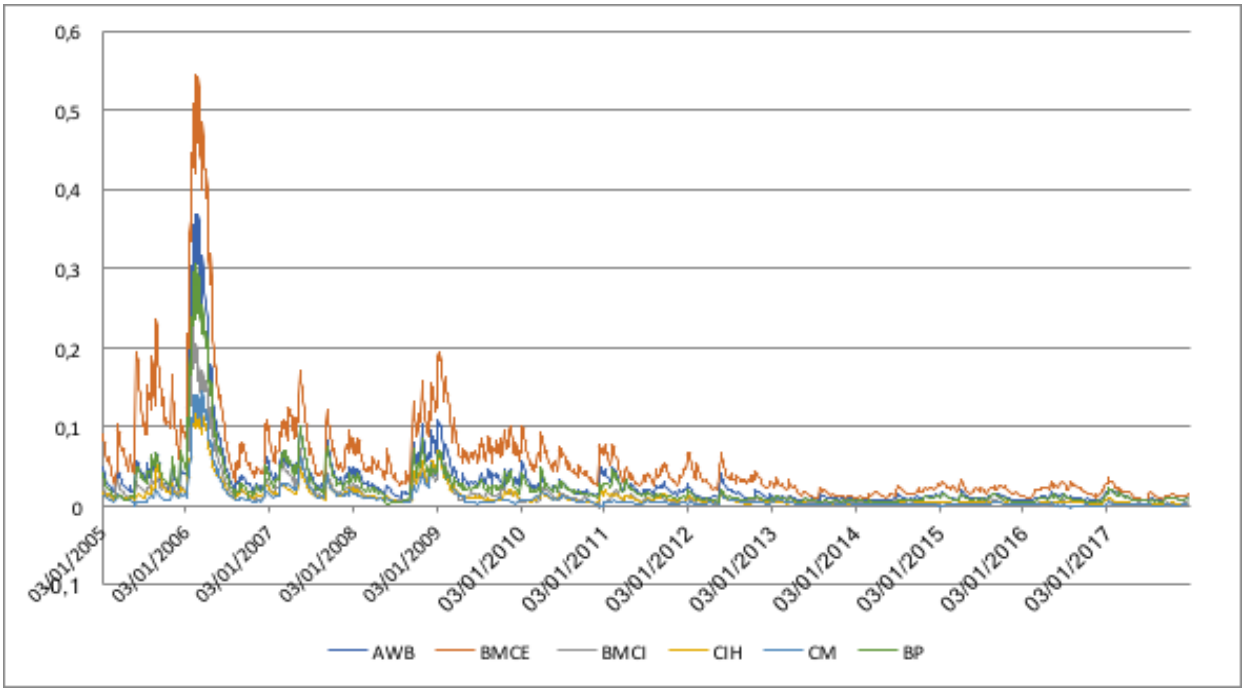

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Figure 2 : Evolution of the MES.

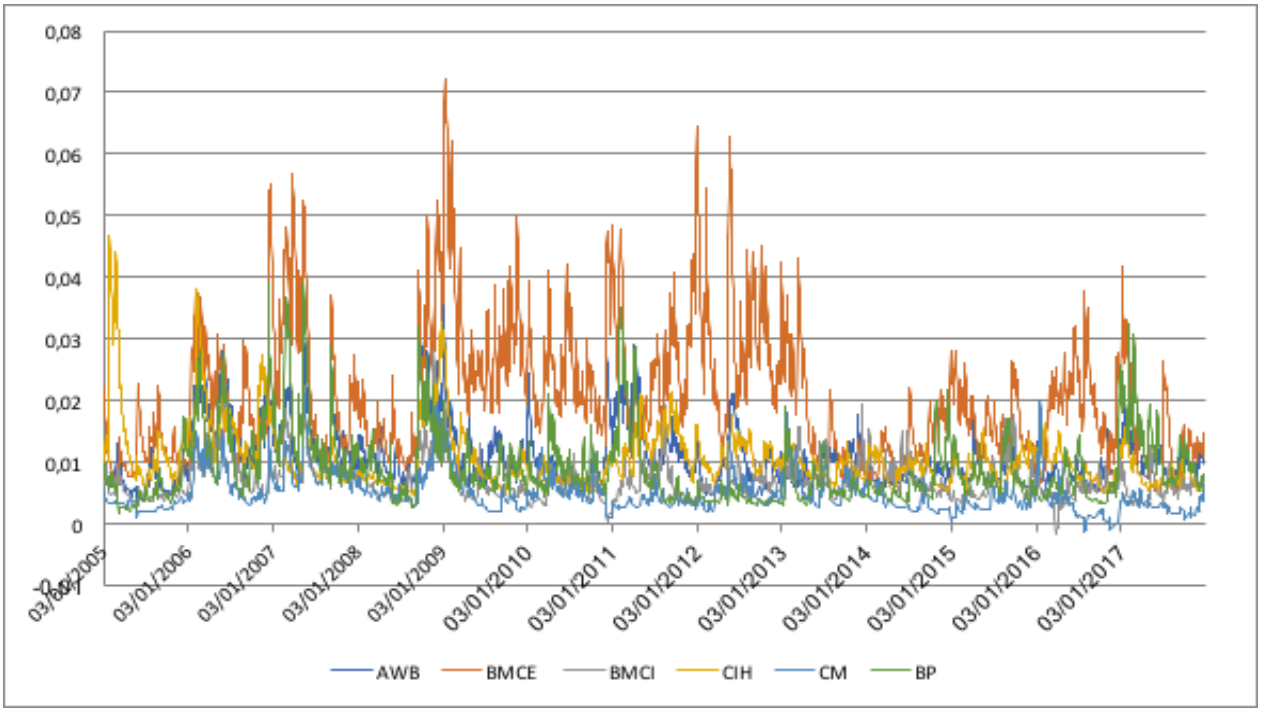
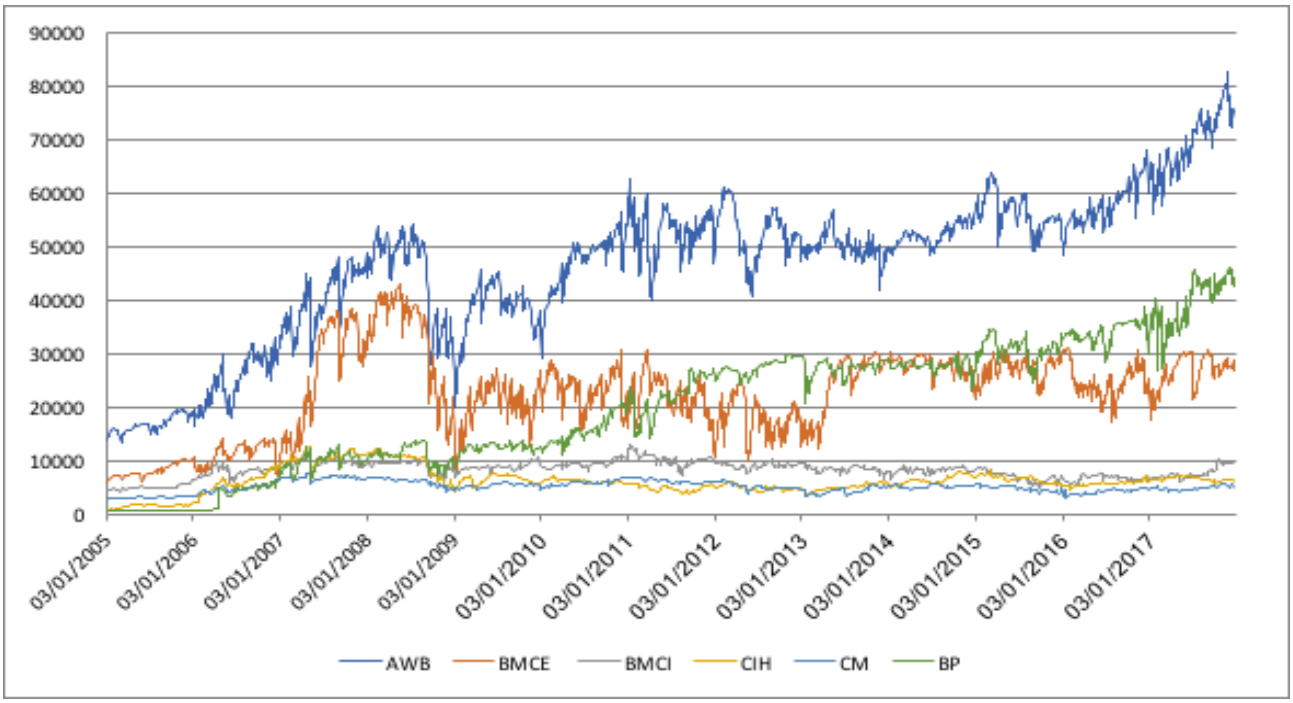


Figure 3 : Evolution of the SRISK.



Appendix 2:

Table 4

	Model (1)		Model (2)		Model (3)	
Dependent variable	**ΔCOVAR**		**MES**		**SRISK**	
VARIABLES	**OLS**		**OLS**		OLS	
Total Assets	0.330***	0.372***	0.0444	0.0593	0.861***	0.871***
	(0.0994)	(0.0927)	(0.0424)	(0.0405)	(0.0334)	(0.0319)
Leverage	-1.376***	-1.031***	-0.532***	-0.409***	-0.000730	0.0863
	(0.233)	(0.223)	(0.0993)	(0.0972)	(0.0782)	(0.0765)
Credit risk	-0.585**	-0.566***	-0.274***	-0.264***	1.128***	1.153***
	(0.227)	(0.212)	(0.0968)	(0.0928)	(0.0763)	(0.0730)
Value-at-risk 95%	0.221	0.0613	0.506***	0.447***	-0.298***	-0.352***
	(0.201)	(0.189)	(0.0856)	(0.0825)	(0.0675)	(0.0650)

Beta	-0.0573	-0.0397	0.436***	0.442***	0.0833***	0.0870***
	(0.0804)	(0.0749)	(0.0343)	(0.0327)	(0.0270)	(0.0257)
Crisis	0.837***	0.658***	0.342***	0.276***	0.411***	0.352***
	(0.124)	(0.119)	(0.0529)	(0.0521)	(0.0416)	(0.0410)
GDP		0.668***		0.224***		0.0813*
		(0.122)		(0.0533)		(0.0420)
Inflation		0.264***		0.110**		0.158***
		(0.0991)		(0.0433)		(0.0341)
Constant	-13.64***	-15.01***	-4.404***	-4.885***	-7.112***	-7.409***
	(1.601)	(1.504)	(0.682)	(0.657)	(0.538)	(0.517)
Observations	302	302	302	302	302	302
R-squared	0.389	0.473	0.579	0.620	0.888	0.899