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A New Cointegration Econometric Analysis for Contagious and Volatility Spillovers of Subprime Crisis Effects

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Abstract We examine spillover effects of the recent U.S. financial crisis on five emerging Asian countries by estimating conditional correlations of financial asset returns across countries using multivariate GARCH models. We propose a novel approach that simultaneously estimates the conditional correlation coefficient and the effects of its determining factors over time, which can be used to identify the channels of spillovers. We find a dominant role of foreign investment for the conditional correlations in international equity markets. The dollar Libor OIS spread, the sovereign CDS premium, and foreign investment are found to be significant factors affecting foreign exchange markets.

Keywords: *subprime crisis, contagion, volatility of stock returns, VAR*

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1. Introduction

The last decade was marked by a very serious crisis that was triggered in the United States in summer 2007; this crisis is seen as the most serious long; is widespread in all sectors of the US economy and quickly spread to the outer world markets. This phenomenon has been associated with this great and wide failure is the contagion which is resulting in the abolition of national barriers and financial globalization.

Thus, the subprime crisis was transmitted via the US market contagion to other developed and emerging markets; Indeed, among the most significant consequences, we can cite market volatility; This volatility is noticed especially on emerging stock markets that have seen financial turmoil after the outbreak of crisis. The subprime crisis has taken an important place in the work and empirical studies in recent years; made by several authors interested in its consequences, particularly the volatility and its transmission outside of America.

We try in this work to test the volatility of stock returns caused by the latest crisis. In this regard, we go through some tests to study the integration between different markets, as we test the relations of causality and feedback between the variables studied during the crisis.

2. Subprime Crisis and Contagion

The subprime crisis was triggered in America in 2007; made in this year entered the history of humanity with the word "subprime", which can be associated with the word surprise; this is the real estate crisis in the USA.

The origin of the failure of "subprime" applied to the American market; we can call this failure by the great recession because it causes a slowing economy ... Thus, subprime loans are loans to debtors reduced creditworthiness or risky. These coming impose a higher interest rate; this rate increase was associated with a decline in real estate prices, leading to a failure to pay many borrowers, so the subprime theory of failure.

Indeed, a set of financial and banking institutions have seen successive bankruptcies. Another financial procedure was considered a cause among other last crisis; this is the "securitization" of transforming a credit to a debt security or obligation that can be bought or sold by any investor. We summarize the triggers origins of crisis: the real estate bubble or the ample liquidity, rising asset prices and securitization...

The subprime crisis has affected the US economy like other economies; indeed, its serious consequences forwarded to international markets, emerging and developed; Most of the American and European financial institutions have recorded substantial write-downs of assets down sharply both also for the stock market: Direct losses on subprime loans. The impairment of assets: the crisis worsened in 2008 with a loss of 7.6 billion euro's in the first quarter alone due to write downs of 12 billion euro's; In fact, the German banks have been hit the "Deutsche Bank" which announced 2.5 billion euro's impairment on the first quarter of 2008. British banks, unless the particular case of Northern Rock, temporarily nationalized by the government, have not carried that less

than 5% depreciation of their assets, but the situation could be reversed with the reversal of the English real estate market. French banks are more resistant, although, according to "Citigroup", should spend 4.2 billion euro's of depreciation 2008.

Slow activities of banks and the market.

The IMF released a report on financial stability in the world amounting about 945 billion dollar as the cost of the crisis to the global financial system, including more than half of the banks. A general slowdown in the global economy has repercussions on inflation was relatively high for emerging and developing countries;

Indeed, the forecast inflation rate for developed countries was 0.3% in 2009 against 3.5% in 2008, and for the emerging and developing were 5.8% and 9.2% respectively. The effects of the banking crisis were broadcast on the stock market; indeed, stock prices of some banks were hit during the summer of 2007 which led to lower major stock indexes such as Dow Jones, CAC 40 and FTSE NIKKEI.

We can conclude that the savings that are rare escaped from the financial and banking crisis. So we can see that the crisis spread to the world via the phenomenon of contagion and its transmission channels. It is therefore useful to identify these key mechanisms or channels as well as the effects of the contagion in financial markets in particular;

The crisis finds it easier to spread from one economy to another and with lightning speed and sometimes instantaneous. This interdependence has transformed a local origin crisis into a global crisis. It is now called a systemic crisis [1]. The contagion can be considered as the extension of financial market turbulence from one country to the other spaces outside world.

In addition, the World Bank provides two definitions:

Restrictive Definition: "Contagion is the transmission of shocks to Other Countries or the cross-country correlation, beyond Fundamental link Among the Countries and beyond common shocks." very restrictive Definition: "Contagion occurs when cross-country correlation Increase crisis times relative to tranquil times". Thus the transmission of shocks are made through certain channels of contagion that may be in the form of financial, economic and political issues between countries, or as investor behavior may explain the spread of crises [2].

Indeed, we distinguish some types of infection, namely:

• The fundamental contagion: This type is explained by two effects. The first is the "monsoon effect" (Moonsonal effect); thus, countries undergoing simultaneous crises because of the existence of common shocks (rise in US interest rates, lower oil prices). The second effect is "spillover effect"; it is bound by the interdependence between countries by the existence of financial and trade links between them [3]...

• Emotional contagion: this form of contagion highlights the crisis transmission from one country to another is related to the behavior of investors and macroeconomic fundamentals. It is also called "pure", and because of the absence of the above factors to failure. This form is introduced by "Masson (1998-1999).

• Shift contagion introduced by "Forbes and Rigobon" (2000), they define contagion as the significant increase of the links between financial markets due to a specific shock to a country or group of countries;

In 2008, the subprime crisis has been globalized and spread through a number of mechanisms mentioned above, many financial institutions have been affected and nearly as "Frederic Mac," Lehman Brothers "AIG ... That is why, several authors interested in the phenomenon of contagion consideration during the current crisis.

This is the severity of the current crisis and its rapid spread to the world, several economists have chosen to follow the contagion effects of these financial problems through many countries is considered bitch is the second phase of crisis subprime.

Thus, Horta and al. [17], examined the crisis and that its results contagion in financial markets of developed countries while using the copula model and stock indexes MSCI G7. These authors found that the effects of contagion are different to other countries depending on the level of integration between the US and these countries. On the work of Idier (2008), they are articulated contagion steps in the subprime crisis context of EU especially in European markets...

Also, Asian and emerging markets have been hit by the effects this has negative results on their financial places including asset returns have become very vulnerable ... We can also mention the recent study of "Bong-Han Kim," "Hyeongwoo Kim" and "Bong-Soo Lee" , who used the conventional model Bekk and Mgarch in order to identify the phenomenon current crisis contagion in ASIAN FINANCIAL markets while using stock indices and the foreign exchange ratios of the five emerging Asian countries (Indonesia (IN), Kore (KR), the Philippines (PH), Thailand (TH), and Taiwan (TW)) with the EU. They found that the spillover of crisis, which began with the collapse of Lehman Brothers, the financial places of emerging countries are not negligible and that they are very vulnerable to external shocks due to the crisis [9].

In addition, these authors have emerged some factors can be as transmission channels; Indeed, FDI, foreign trade with the US and the strong relationship of the currencies of this group of countries with the US dollar, are designed as channels that have important roles in the US subprime crisis contagion, made, FDI is the main form of capital flows in certain countries [11].

Furthermore recent transmission mechanisms, we can't forget the securitization transaction which plays a major role in the spread of the subprime crisis to the rest of the world; indeed, it leads to doubt exacerbate international investors against mortgage securities called RMBS (Residential Mortgage Backed Securities) on US residential real estate and against packet diversified receivables called CDO (Collateralized Debt Obligations).

The crisis contagion to other countries can't be independent of the concept of volatility; the latter is the major consequence of crises and especially the last crisis "subprime". The latest crisis has been the subject of several studies and empirical studies in recent years; indeed, a number of authors were interested in analyzing the crisis and its consequences, and its transmission via contagion [14];

For example, For example, the increase in volatility is 3.17% in the US, 2.64% for Hong Kong and 2.46%, 2.32% and 2.22% respectively for Argentina, Singapore and Japan, as 0.85% for Malaysia. For Indonesia, Taiwan, Kore, Brazil Mexico and Shanghai have experienced high levels of volatility ie 1.96%, respectively, 1, 92%, 1.84%,

1.76%, 1.63% and 1.33%. These volatilities have been associated with impairment indices. It is therefore useful to examine the concept of volatility fallen crisis effects on financial markets.

3. The Returns Volatility Stock during the Subprime Crisis

Among the most significant consequences of the recent crisis appears the "lower market values of certain countries in relation to the decline in US stock market"; that's volatility. In made, it is one of the very important concepts to be studied in recent years; well, it takes a considerable place in decision-making in a country;

Some authors have defined volatility by variability of any variable under consideration. High volatility is considered a symptom of disturbances due to which the transactions of stock market values are not at fair value and the market is not working properly.

This is linked strongly by the uncertainty and risk; thus, finance fluctuations in asset prices estimated to assess market risk, those unpredictable reflect uncertainty. In addition, the volatility some recognized features; it is variable in time and also autocorrelation, therefore the volatility of the past has impact on the volatility of today;

It can be asymmetric and tends to cluster; indeed, the asymmetry of volatility is a phenomenon widely studied in empirical work; augment it more after negative shocks after positive shocks. Made in the negative and positive shocks are always followed with each other, we are talking about the combined volatility.

3.1. Historical Volatility

This volatility is calculated using past prices. In order to study the volatility of a stock, observe the share price evolution of the asset in fixed periods (daily, weekly ...).

3.2. Implied Volatility

This volatility is calculated from the price of existing options in the future underlying studied. Thus, this type acts as a preacher since the value date of the implied volatility than historical volatility announced future.

Volatility in both forms can be measured by a number of theoretical approaches; we can mention:

• Beta: Beta is an instrument for measuring the asset volatility and estimate its sensitivity compared to the market. The higher the beta, the more volatile the asset is on the market; thus, if it is equal to 1 then the action is as volatile as market.

• Standard deviation: This indicator measures the volatility of a security. The standard deviation is typically used for the construction of other indicators. Over this instrument, the higher the data are scattered and volatility is important.

• The GARCH model: This model is introduced by Engel (1982); it takes into account the variability of errors in decline.

Market volatility is determined by some explanatory factors, whether structural or cyclical;

Structural explanatory factors: profitability, ratio "price / earnings per share" and leverage;

The others are cyclical: the interest rate, inflation and stock market anomalies;

The subprime crisis has led to the significant increase in disturbances in financial markets in the United States; Indeed, with the new architecture of global economic and financial system, characterized by globalization and the removal of barriers between the various international markets; its disturbances, particularly the volatility of financial returns were quickly circulated outside the US market;

The risks of increased volatility are shared internationally and dissemination of information that are good or bad is very quick and easy because of the strong trade and financial relations between the regions.

As made, the most recent example of the role of the interdependence of markets, especially in developed countries, is the case of reaction of European financial squares and North Americans following the announcement of a possible Greek bankruptcy.

This news led to a significant decline in stock prices in Europe as in the United States. Therefore interdependence is sometimes regarded as volatility transmission mode. Also, higher volumes of transactions between stock markets may be the cause of the spread of yield fluctuations; indeed, these transactions are considered the transmission channels of the volatility and the informational tool or in other words the rapid and massive flow of information between the stock markets.

In the years 2007-2008, the volatility of asset prices has seen a significant increase, which made him a major indicator of financial stress in the different segments of financial markets in the world, as a key to explain the situation the balance within the affected countries; Indeed, the level of the concept, help Policy-Makers to reposition itself in the economic processes and many base their strategies.

Indeed, liberalization and dependence policies have made these countries highly vulnerable to external shocks and volatility risks of contagion. One consequence of this contagion is the evolution of financial market indices different places of the world; indeed, yields have fallen sharply since 2007 mainly major international indices (NASDAK, CAC40 and SetP).

Several empirical studies have an interest in the analysis of volatility associated with contagion study; so the two concepts are strongly related. Indeed, several authors have sought to examine the transmission of volatility through the contagion. They used several models, we can list among:

• Stochastic Volatility Model
• Model with regime change
• The GARCH
• The model "copula"

The first authors who are interested in this issue Engel, Ito and Lin (1990), they used a GARCH model to study the effects of transmission of intra-daily volatility of the exchange rate between the Japanese and US markets. Indeed, they have led to a result that returns and volatilities day of a market are correlated with those of the other night market; For their part, Hamao and Al in 1990, used the ARCH model to study the effects of the volatility of returns, while exploring the relationship between the New York markets, London and Tokyo. Made in, they studied the effect of volatility of returns of the indices of

these markets and their transmissions from one market to another. Their estimates showed the New York price volatility transmission effects to Tokyo and London to Tokyo but not from Tokyo to New York or London.

Bekaert and Harvey (1997) investigated the effects of volatility in emerging market equities; and they examined the integration of this group of countries with the world. These authors used multivariate GARCH model in their studies.

Kamel Bensafta and Gervasio Semedo (2008) also studied the international transmission of shocks between stock markets. They examined the integration of financial markets, in terms of average transmission phenomenon and variance in normal times and in times of financial crisis. The goal of their contribution is to provide an analytical framework to simultaneously study the various aspects of modeling equity returns i.e. the average transmission modes and variance, the existence of contagion in times of crisis and the dynamics of the correlation of markets; They used the returns of representative market indices twelve financial markets i.e. S & P 500 (US) FSTE100 (UK) Nikkey2500 (Japan), CAC40 (France), SPTSX (CAN) ... for the April 1984 period to December 2005.

They came to show that the average transmission and volatility is unidirectional starting from developed markets to emerging markets transmission point of view;

For their part, Tanizaki and colleagues (2009) analyzed the effects of transmission of volatility of stock prices between countries such as Japan, the United States and the United Kingdom using a stochastic volatility model. They found that the volatility of the US stock market interacts with that of the English market. Also, the volatility of the Japanese equity market interacts with that of the English market. In addition, inter-transmission between Japan and the United States is seen at the stock price.

In the same context, our modest study is based on a VAR model to study the integration of emerging and developed markets and the transmission of volatility and spillovers.

4. Methodology and Data

To examine the volatility and contagion during the subprime crisis, we go through some basic tests, namely:

• The correlation test; made in, we will determine the increase in correlations during periods of crisis.

• Co-integration test invented by Johnson (1991-1995) which we will try to know the degree of integration of financial places in question during the subprime crisis and the contagion of market volatility between financial markets. The basic variable used in our study is none other than the market index.

• We also spend Cointegration test and VECM.

• Another test, the Granger causality test which we seek to highlight the different relationships between stock exchanges in question.

• Finally, we test the impulses functions to know the reactions of such markets to shocks in another definite.

4.1. The Correlation Test

Measurement and volatility contagion between financial markets

The correlation can be defined as a significant increase of the correlation coefficients between markets; made in it can describe the significant increase in terms of co-movements in yields of financial assets between periods of crisis and calm.

To examine the integration of financial markets, we can directly study the correlation coefficients yields different series of stock market indices.

The more the coefficient is close to unity, the more markets are integrated i.e. the hypothesis of integration is therefore accepted the existence of the phenomenon of contagion. The correlation coefficient is calculated in this manner

$$\rho = \frac{\mathrm{cov}(Y_t, X_t)}{\rho_{X_t}\rho_{Y_t}}$$

4.2. Unit Root Test

This test allows us to examine the stationarity of the series studied, and this through testing Augmented Dickey Fuller (ADF);

The assumptions of this procedure are as follows:

H_0: to level series is non-stationary;

H_1: serial stationary level;

Thus, the ADF test includes three steps:

First step: Estimation of a model with a constant and a trend

$$X_t = \rho_1 X_{t-1} + \cdots\cdots + \rho_p X_{t-p} + \gamma + \lambda_t + \varepsilon_t$$

The significance of the trend we test if it is significantly different from 0, the null hypothesis H_0 is tested;

If H_0 is accepted then the level series is not stationary. We must therefore distinguish and repeat the test on differentiated series.

If H_0 is rejected, then the level series is stationary; the test is completed and therefore the modeling by the series level;

If the trend is not significant, we go to step 2.

Step Two: Model estimation without trend and constant

$$X_t = \rho_1 X_{t-1} + \cdots\cdots + \rho_p X_{t-p} + \gamma + \varepsilon_t$$

We test the significance of the constant, if it is significantly different from 0, we test the null hypothesis H_0;

If H_0 is accepted, we can say that the series is not stationary level; therefore, we must differentiate and repeat the test with the differentiated series.

If H_0 is rejected, the series is stationary level, we will continue modeling this series; If the constant is not significant, proceed to Step 3;

Third step: estimating the model without no consistent trend

$$X_t = \rho_1 X_{t-1} + \cdots\cdots + \rho_p X_{t-p} + \varepsilon_t$$

We test the null hypothesis H_0 directly.

Acceptance of H_0 series reflects the non stationary level; then the need for differentiation; the procedure is continued by the separate series.

If we reject H_0, the level series is stationary, so we model in this series.

For each series, the lag order is determined from the shape of the partial autocorrelation correlogram and the

information criteria method. The latter is to select from among a number of models estimated for a number of delay from 0 to h (h being the maximum delay) one whose delay (p) minimizes or maximizes the criteria of Akaike (AIK) and Schwarz (SC). After the unit root test, we determine the optimal number of delays to remember in the vector auto-regression (VAR) model in order to apply the Cointegration test.

4.3. Autoregressive Models VAR

Given two non-stationary series X_t *and* Y_t ; the absence of co-integration between the two and the existence of causality between their first differences DX_t *and* DY_t allows us to estimate a VAR model.

The autoregressive model with 2 variables p and delays: VAR (p) is written:

$$\Omega_t = A_0 + A_1\Omega_{t-1} + \cdots\cdots + A_p\Omega_{t-p} + V_t$$

The matrix form is written in the following form:

$$\begin{matrix} X_t \\ Y_t \end{matrix} = \begin{matrix} \alpha_{0X} \\ \alpha_{0Y} \end{matrix} + \begin{matrix} \alpha_{1X}\,\beta_{1X}\,X_{t-1} \\ \alpha_{1Y}\,\beta_{1Y}\,Y_{t-1} \end{matrix} + \begin{matrix} \alpha_{2X}\,\beta_{2X}\,X_{t-2} \\ \alpha_{2Y}\,\beta_{2Y}\,Y_{t-2} \end{matrix} + \cdots\cdots + \begin{matrix} \alpha_{pX}\,\beta_{pX}\,X_{t-p} \\ \alpha_{pY}\,\beta_{pY}\,Y_{t-p} \end{matrix} + \begin{matrix} \varepsilon_{Xt} \\ \varepsilon_{Yt} \end{matrix}$$

The variables X_t and Y_t are stationary;

Both ε_{X_t} and ε_{Y_t} disturbances are homoscedastic white and non auto-correlated noise. The two equations can be estimated using OLS one independently to each other. It is better to make a Granger causality test before modeling with VAR method.

Les variables X_t et Y_t sont stationnaires ;

This model allows the integration of short-term fluctuations around the long-term equilibrium through Cointegration test.

It is valid only if all coefficients are significant and that all the restoring forces are negative.

4.4. Cointegration Test

This test is based on the values of a resulting matrix of the parameter estimates maximum likelihood calculating the statistical Johansen following:

$$Q_r = -T \sum_{i=r+1}^{n} Ln(1-\lambda_i)$$

With

T : Observation number

r : 0,…... K-1

λ_i : The largest value

Q_r The "trace statistic" and she checked the following two assumptions:

H_0: no Cointegration relationship between sets.

H_1: the presence of at least one Cointegration relationship.

If trace is below the critical value given to the chosen threshold, we accept H0 showing the existence of at least one Cointegration relationship between the studied series. The VAR model is easier to use for studying multiple series; made by researchers no longer need to have endogenous and exogenous variables in their studies.

4.5. Granger Causality Test

Causality Granger (1969) implies that X causes Y if the prediction of Y based on knowledge of past joint of X and Y is better than the prediction based solely on the knowledge of the past of Y (Lardic and Mignon (2002)).

Failure means that the causal past of Xt variable provides no information on variable Yt. The method then is to specify a VAR (vector auto regression) bivariate.

$$X_t = \alpha_X + \sum_{i=1,k} \beta_{X,t} X_{t-i} + \sum_{i=1k} \varphi_{X,1} Y_{t-i} + \varepsilon_{X,t}$$

$$Y_t = \alpha_Y + \sum_{i=1k} \beta_{Y,t} Y_{t-i} + \sum_{i=1,k} \varphi_{Y,1} X_{t-i} + \varepsilon_{Y,t}$$

With: k is the number of model delays

We have two hypotheses to be studied; made in order to identify causality in the sense of Granger, we test the null hypothesis H_0 which states that (Xt) does not cause (Yt). Also, we test whether all coefficients are zero jointing and using test Fischer;

Applying the same test on the equation, we test whether (Yt) cause or not (Xt) Granger. If the series are not stationary, we apply the Granger causality test on the series in first differences; The equations are in this case:

$$\Delta X_t = \alpha_X + \sum_{i=1,k} \beta_{X,t} \Delta X_{t-i} + \sum_{i=1k} \varphi_{X,1} \Delta Y_{t-i} + \varepsilon_{X,t}$$

$$\Delta Y_t = \alpha_Y + \sum_{i=1k} \beta_{Y,t} \Delta Y_{t-i} + \sum_{i=1,k} \varphi_{Y,1} \Delta X_{t-i} + \varepsilon_{Y,t}$$

To examine the volatility and its effects, we use Granger causality tests, the functions of impulse responses; it lets us know the stock exchanges in response to shocks in another market.

This model was used under most studies that interested in the volatility of returns and spillovers between different places.

4.6. The Impulse Responses Functions

This method is based on the innovations of the estimated VAR model. Including the estimated values, and these innovations are different depending on the order in which the variables are placed in this model.

These features show that stock market volatility causes disturbances on the fluctuations of the volatility of the market and the other markets.

Contribution to the modeling of the effects of volatility spillovers and contagion. We take as daily data of stock market indices of emerging and developed the following countries: USA, Canada, France, Germany, Italy, United Kingdom, Japan, Australia, Argentina, Mexico, China, Indonesia, India, South Korea. The study period lasts for 6 years, 2004 to 2009;

Before correlation analysis between various stock indexes, we determined the specific crisis period; for this, we use the graphical method to limit the period falls noting the common problems dates of each stock index;

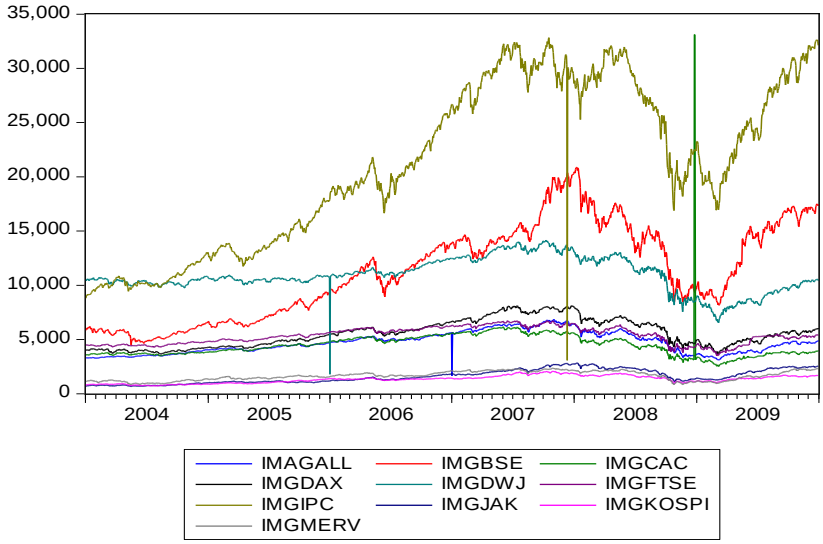

Figure 1. Volatility of different indices during the crisis period

The year 2007 was as the point of beginning of the crisis in the financial positions; for most indices, we see an upward variation throughout the analysis period.

Thus, the main period of volatility between 2007 and 2009, we are seeing upward movement variability; During this period, the stock market indices especially dowjones, Dax, MIB, S_P, Merval are very volatile; Taking the example of the Mexican index, volatility reached deep troughs and high peaks, same thing for certain indices of developed countries such as Italy, the United Kingdom, too, for the index of Argentina (MERVAL), which saw volatility declining trends and rising during the period of American crisis. For cons, the Chinese index is somewhat volatile during the same period. We can say that throughout the period 2007-2009, emerging markets and industrialized saw a collapse. The French index does not seem very volatile, in fact, it is not influenced by external shocks, except between the year 2008-2009 was characterized by a peak of volatility.

The correlation: evidence of contagion effects of volatility of stock indices and those fallen From the table below, we see that there is a significant increase in correlation coefficients between indices of different places financial United States and France, Germany, Japan, Argentina, Canada, Indonesia, China, United Kingdom, Australia and India ... and especially after 2007; take for example the ratio between the US index dowjones and London (FTSE) which is equal to 0.867; thus, the two exchanges are strongly and positively correlated throughout the crisis period.

Also, an example of 0.968 which represents the correlation between the index of Australia and that of Germany. This very high coefficient may reflect the transmission of a crisis through different channels of trade and financial flows, exposure to a common creditor, or a common clash between the two markets ...

This does not prevent the decrease of these coefficients between certain markets; for example, the US financial market is not highly integrated with that of Indonesia, Mexico and India and for the low correlation coefficients between them ...

For example, there are some places that are integrated with places and with no other place like Indonesia, it is highly correlated with emerging countries and low with America and developed European countries. Indeed, the correlation coefficient between the index and the JAK American DWJ is equal to 0.460, too, with the Italian and French index, it is weakly correlated with each other to know the respective coefficients of 0.162 and 0.272 ...(see Table 1 for details)

Table 1. Correlations between different indices

	Dwj	Cac	Dax	Mib	Merv	Ipc	Ftse	Bse	Jak	Kosp	Nik	S_p	Shng	ALL
Dwj	1	0.546	0.812	0.873	0.729	0.485	0.867	0.496	0.460	0.582	0.840	0.804	0.552	0.864
Cac		1	0.531	0.566	0.455	0.342	0.583	0.322	0.272	0.385	0.580	0.508	0.292	0.554
Dax			1	0.653	0.902	0.861	0.900	0.857	0.815	0.912	0.739	0.953	0.792	0.968
Mib				1	0.580	0.241	0.850	0.243	0.162	0.357	0.947	0.661	0.235	0.757
Mer					1	0.853	0.874	0.857	0.837	0.890	0.649	0.916	0.700	0.898
Ipc						1	0.662	0.948	0.945	0.941	0.384	0.823	0.812	0.773
Ftse							1	0.672	0.603	0.749	0.896	0.904	0.552	0.937
Bse								1	0.974	0.952	0.371	0.812	0.844	0.777
Jak									1	0.934	0.273	0.778	0.867	0.733
Kosp										1	0.496	0.880	0.833	0.846
Nik											1	0.748	0.308	0.807
S_p												1	0.675	0.942
shng													1	0.718
All														1

Generally, a remarkable integration is found between the different markets in question. Then the subprime crisis has followed most of the country and it may be the result of strong relationships and financial and commercial ties

between the United States and other developed, industrialized and emerging countries. Indeed, the latter, despite their autonomy, contagion and the transmission of shocks cannot be negligible; made in the intensified trade integration of these economies to the US economy, which accounts for 25% of world imports has the effect of increasing the degree of this transmission.

Emerging and industrialized countries had access to abundant external financing mainly from the US and Europe, and in a context of liberalization and market opening. Also, these countries are designed to be net importers of capital and therefore they cannot be immune to shocks broadcast major financial markets; especially the subprime crisis and its fallen. Cointegration: evidence of contagion and volatility.

Based on the unit root test, we noticing the different series are first order integrated, in fact, they are stationary in first difference;

In this regard we summarize the test results ADF on differentiated series in this Table 2 and in Table 3:

Table 2. Model VAR decision

	Dwj	Cac	dax	mib	merv	Ipc	ftse
Model	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend
Probability	0.0000	0.0000	0.0000	0.000	0.0000	0.0000	0.0000
Stationnarity	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	bse	**jak**	**kosp**	**nik**	**s_p**	**shng**	**ALL**
Model	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend	with constant and with trend
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Stationnarity	Yes	Yes	Yes	Yes	Yes	Yes	Yes

- **Model VAR**

Table 3. VAR estimation Results

Variables	coefficients	Student stat.	Probabilité*	significativity
Cac	4019.598	22.99664	0.0000	Yes
Dax	0.018696	1.791335	**0.0734**	**No**
Mib	-0.142664	-1.681471	**0.0929**	**No**
Merv	0.160053	15.43242	0.0000	Yes
Ipc	0.285307	2.650655	0.0081	Yes
Ftse	-0.033261	-5.367048	0.0000	Yes
Bse	-0.102118	-1.485903	**0.1375**	**No**
Jak	-0.077791	-5.096009	0.0000	Yes
Kospi	0.505811	3.560298	0.0004	Yes
Nik	-1.000991	-5.868228	0.0000	Yes
S_p	-0.077965	-4.259874	0.0000	Yes
Shng	0.390929	16.68978	0.0000	Yes
All	0.512789	20.90327	0.0000	Yes
R^2	0.917508			
R^2 Ajusté	0.916870			
F	1437.569			
Probabilité F stat.	0.000000			
N **	1564			

*: The significance level of 1% and 5%.

** N is the number of observations.

The VAR model application allows us to draw the picture above; While observing the different probabilities s series in question, and in relation to the 5% level. We find that all variables are significant except the CAC, DAX and FTSE have higher probabilities of 0.05;

In the overall model is significant because the probability of F statistic is equal to 0.0000, which is below the 5% threshold. For the VECM Model all results are indicated in Table 4.

Table 4. VECM test results

Condition	Dwj	Cac	Dax	Mib	Merv	Ipc	Ftse	Bse	Jak	kospI	Nik	s_p	shng	All
Significativity	-0.308	-0.160	-0.876	-0.1165	-1.275	-0.0854	-0.928	-0.174	-1.561	-0.945	-0.198	-0.330	-0.326	-1.000
Force rappel<0	--	--	--	--	--	--	--	--	--	--	--	--	--	--

From the table above, the coefficients are significant at the 5% level.

The restoring force is always negative, hence writing VECM is validated; we can deduce that there is a long-term interdependent relationship between different financial places in question; which plays a major role in the spread and the rapid spread of volatility of returns of stock market indices from one market to another. Passing of the financial center of the United States to other stock markets in developed and emerging countries.

4.7. Test JOHANSON

Johanson test is based on two statistics aimed to identify the number of Cointegration relationships: Statistics track and Statistics eigen value.

So the test assumptions are:

H_0: Presence of at least one Cointegration relationship

H_1: Lack Cointegration relationship between sets

Table 5. Cointegration test results

N of Cointegration relation	Valeur propre	Trace statistique	Valeur critique 5%
none *	0.147449	661.3454	342.9451
Au plus 1	0.049093	414.2458	336.0265
Au plus 2	0.038660	336.2707	334.9837
Au plus 3	0.036061	275.1985	285.1425

There are at most three Cointegration relations; the Cointegration relationship reflects the existence of permanent channels in the transmission of shocks between the countries, where the transmission of crisis from one country to another; in other words, this is evidence of a rapid transmission of volatility and it's fallen.

The presence of Cointegration relations can be interpreted as the existence of permanent channels of propagation of volatility between the countries in the sample; thus, contagion during the subprime crisis has been strongly linked by the volatility phenomenon. The sense of Granger Causality.

In this test, we want to know it he has interdependencies between financial centers; made in, we are faced with two hypotheses to be tested

Thus, the test assumptions are:

H_0: X index does not cause the other index Y

H_1: X index because another index Y

The made to observe a significant causal relationship between two variables, allows knowing which market has the power to influence the other advantage.

If market volatility Y because the sense of Granger realized volatility of the market X, we can deduce that past values of the volatility of Y have significant explanatory power for predicting better market volatility X.

This relationship tends to be viewed as a form of transmission of volatility between stock markets. We summarize the results of this test in the Table 6 below:

Table 6. Causality relation summary

Variables	DWJ	CAC	DAX	S_P	MIB	MERV	FTSE	IPC	JAK	NIK	KOSPI	BSE	SHGN	ALL
DWJ		-	+	+	+	+	+	-	-	-	-	-	-	+
CAC	+		+	+	-	-	+	+	-	+	+	+	+	+
DAX	+	-		-	-	+	+	+	-	-	-	+	-	-
S_P	+	-	+		+	+	+	+	+	+	+	+	-	+
MIB	+	-	+	-		+	-	+	+	-	+	+	-	+
MERV	-	-	-	-	-		-	+	-	-	-	-	-	-
FTSE	+	-	-	+	-	+		+	-	-	-	+	-	-
IPC	+	-	+	-	+	+	+		+	-	+	+	+	-
JAK	+	-	+	+	+	+	+	+		-	-	+	+	-
NIK	+	-	+	+	+	+	+	+	+		+	+	-	-
KOSPI	+	-	+	+	+	+	-	+	+	-		+	-	-
BSE	+	-	+	+	+	+	+	+	-	-	+		+	-
SHGN	+	+	-	-	+	+	+	+	+	-	-	+		-
ALL	+	-	-	+	+	+	+	+	+	+	+	+	-	

If the odds are less than 5%, then we reject H 'there is Granger causality between stock indices and the probabilities are above 5%, while accepting H and in this case there is no causal relationship between stock market indices. Indeed, we can remark that caused the United States to any other country.

The draws us here that the CAC does not cause the majority of other indices, this can be explained by the made the French financial market tends to move in the opposite direction of the other global stock seats; it is difficult to capture the direction of causality between this market and others. Indeed, to this index the alternative hypothesis is always rejected except for his relationship with the Chinese index.

Almost the same conclusion regarding the Japanese index that has no causal relationship between a number of clues, which can be inferred that the Japanese market has no influence on most markets global capital such as for example, the Chinese market, Indonesian, Italian ... So, if we observe the index of Australia (ALL), the causal hypothesis is rejected except for the US market, Canadian, French and Italian; we can say at this point that the volatility in the market has no effect on other emerging markets especially.

Similarly, the Mexican financial market, has a great influence on other markets in question; in fact, the causal hypothesis is accepted for all relationships in this index with the other variables except for his relationship with Dow Jones, the last relationship does not necessarily reflect the lack of relationship between the two places; it may be that the relationship is indirect or we can say that the US market is the most influential as that of Mexico (looking at the test results, noting that the assumption that CPI Dowjones cause is accepted. Thus, for the Granger causality test, we can say that there is strong correlation between the different dynamic markets, so the volatility and these effects are transmitted from one market to another very easily especially between two countries whose deep trade and financial relations; such as the volatility of the US index was promptly forwarded outside the country.

Thus, the developed and emerging European countries are very dependent with the United States, reinforcing contagion and transmission of return volatility of Dow Jones ... We see from this table that there is a high degree

of integration between the different financial places in question and saw the causal relationships between the various indices, for example, between the CAC 40 and Dow Jones or DAX and Dow Jones or even between S_P and MIB. We could say that during the subprime crisis, a strong integration is found between the different countries of the world, which facilitates the contagion and dissemination of shocks. After the various tests that we applied, we deduce the existence of the phenomenon of contagion and transmission effects of volatility during the subprime crisis and especially between 2007 and 2009. Indeed, the financial impact and economic issues related to the volatility of stock returns, having as origin the subprime crisis in the United States, were transmitted in a remarkable way to other countries of the world especially who are highly financially or commercially linked with the country of origin of crisis.

Last Granger causality test gives us an idea of the existence of a dynamic interaction between these markets and shows that there are direct and indirect causal links between different stock places but they do not allow us to know the magnitude of the reactions between markets;

A method can help us do it; it is the method of impulse responses functions;

Study of the functions of impulse responses

Applying this test, we used to know the market reactions to shocks in another definite market;

In fact, we get the following figures for each index compared to others;

Observing, figures on responses clues shock that of Australia (Appendix), we find that all the clues reactivate positively and significantly except the French index; indeed, the CAC 40 was not affected by the shocks transmitted to the Australian financial market; thus, innovation and disruption that hit the market in Australia, have profound magnitude particularly in the Mexican market, Indonesian, German ...

Indeed, the figures to own response functions of the other indices shock of this index; we show that the indices of the emerging countries have responded in a meaningful way with the volatility of CAC40. The same for the other European indices Moreover, taking the answers of the FTSE, it does not influence on the European continent indices (CAC, DAX ...); the response functions are negative; by cons, other emerging clues reactivate significantly and positively with changes in the index.

This can be interpreted as the result of the deep relationship between the United Kingdom and those countries; then the FTSE Volatility quickly spread outside of Great Britain while spreading with effects of spillovers to emerging and developed financial markets. For Asian and emerging evidence, they have reactions considerably high amplitude between them; indeed, the response functions are mostly significantly positive;

5. Conclusion

In our study and to analyze the transmission of volatility between the various stock exchanges, we go through a number of tests related to the VAR model; they allow us to show the profound interdependence and the high levels of integration between the stock market and the USA in emerging and developed markets;

The test correlations we help to achieve these results interdependence between markets used in the work; indeed, we noticed a significant increase in correlations between the various markets, especially between emerging markets and the US market ... This has allowed us to conclude that periods of high correlation are associated with periods of high volatility. However, as demonstrated by Forbes and Rigobon [12], the correlation test is not sufficient to prove the existence of contagion, for this we have made some other tests like the Cointegration test (test Johanson) and VECM to indicate the existence of contagion during the crisis period mainly between 2007-2009; Also, we see a high amplitude scattered in different market volatility.

The last method gives us a magnifying glass on the dynamic interactions between markets used in the work ... There are clues that are not influenced by external shocks such as the French index, the German index and the US index ...

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