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The Effect of Derivative Instruments on the Contagion of Stock Markets in Developing Countries

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The 2008 Great Financial Crisis increased the fluctuations in the stock market in the US and other countries that were linked together through various channels. In this regard, derivative instruments, as one of the main elements of the world's financial markets, had an essential role in reducing the stock market fluctuations and contagion of the crisis. The primary purpose of this study is to examine the negative effect of the derivative instruments on the contagion of stock markets in developing countries, including Brazil, India, China, and Russia, using monthly stock and futures indices over the 2007:01 to 2018:08. By considering the United States of America as the source of the crisis, the hypothesis was tested with the Copula function and Kendall's tau (rank correlation coefficient). The results have confirmed the hypothesis. According to the findings, we suggest that the economy moving towards openness should develop the derivative instruments to minimize the fluctuations as well as reduce the devastating effects of crisis contagion. Also, by upgrading the information of the investors and speculators, it can decrease the depth and intensity of the fluctuations that originated from international crises.

Keywords: Derivative Instruments, Financial Contagion, Stock Market, Developing Countries, Copula Function.
JEL Classification: G13, G15, G23, F30

1 Introduction

The financial crisis of 2008 originated from the US was quickly transferred to other countries and spread out around the world. The stock market is the first one that has been damaged by the financial crisis, its destructive effects spread out via macroeconomic fundamentals and pure contagion, and consequently, the financial investment decreased.[3] In this framework, what should be done

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[3] Although there is still no consensus on the definition of contagion, two different forms of that are defined in the financial literature, contagion via macroeconomic fundamentals, and pure contagion through the investors' behavior (Kaminsky et al. 2000, Masson, 1999, Forbes and Rigobon, 2002).

to reduce or take charge of the devastating effect of the crisis contagion? Based on the literature, it seems that the derivative instruments have an essential role in reining and limiting the contagion of the crisis. The instruments can reduce stock market volatility by providing a specific market for investors and speculators. Also, the risk from the market may be reduced by determining a forward rate and a value date at present that distributed the risk as time goes by. Furthermore, the transaction cost in the futures market is lower than spot markets. Therefore, the speed of entering new information into the futures market is higher, and through this, the futures market could provide a way to transfer information to the spot markets, which consequently reduce the volatilities of spot markets.

Some studies done over the effect of derivative instruments on financial market volatility have found ambiguous results. But, empirical studies have generally verified the negative impact of the derivative instrument on stock market fluctuation. Antonio and Holmes (1995) have examined the effect of futures on stock market volatility and showed that volatility has increased after the introduction of derivative instruments. Also, Bejarano et al. (2005), by examining Latin American financial contagion, have noticed two periods of financial contagion, the housing crisis in the US and the turbulence in the European bond market.

The purpose of the present study is to investigate the effect of the derivative instruments on the stock market contagion of selected developing countries. Based on the theoretical and empirical backgrounds, the hypothesis of this research is linked to the negative effect of the derivatives on stock market contagion. The present study is given in five sections. After the introduction in the first section, the following section focuses on theoretical and empirical backgrounds. In the third section, the methodology is introduced. The fourth section is devoted to the observed results, and consequently, the conclusions and policy implications are given in the fifth section.

2 Theoretical and Empirical Background

The 1997 currency crisis in Thailand quickly spread across East Asian, then to Russia and Brazil. Even the developed markets in North America and Europe and then all the world were affected by this crisis.

This crisis, which lowered income levels and living standards in many developing markets caused the financial contagion to be particularly important in financial studies.

The contagion is the transfer of the destructive effects of the crisis from one country or market to another. In other words, contagion is defined as a form of financial illness and an increase in the co-movement between financial markets after the crisis (Kyle, 2001). The separation of channels through which economic and financial crises have transferred is not easy, given the interactions among different countries. The study of the global effects of the financial crisis in East Asia and Russia has shown that financial and commercial mutual connection among countries is itself one of the significant factors of financial contagion. Also, Eichengreen et al. (1996) refer to the role of the debt market and mutual fund in the expansion of the financial crisis. Furthermore, the relative strength of financial and commercial links, the behavior of various investment groups, and the principles of macroeconomics are essential in financial contagion.

Warner (1994) has shown that the impact of the financial crisis on Mexico has been moderate due to its formerly discretionary monetary and fiscal policies, high liquidity, and low current account deficits. On the other hand, the economic infrastructures and macroeconomic fundamentals, as well as the political situation, foreign exchange markets, commercial, financial and geographic features, and central banks' policies are among the most important factors in the vulnerability of a country to financial contagion.

In the framework of the contagion literature, psychological and cultural issues as other affecting factors on the contagion were respectively examined by Barsade (2002) and Lucey et al. (2009). The psychological problems are related to the tendencies and behavior of a group, or even a person, through deliberate decisions or sometimes, unconscious and behavioral attitudes. The cultural issues imply that the countries with a lower cultural difference and broader economic connections have more contagion.

Even though there is a lot of empirical research into financial contagion, many channels of financial contagion are still unknown. The actions of rational and irrational investors and the motives that investors acted upon are essential in many studies.

Since the introduction of futures in the stock markets, there has been much debate about the effect of derivative transactions on spot market volatility. The lack of theoretical consensus on how derivative instruments affect the volatility has made this an important empirical issue. According to one theoretical view, speculative transactions in the derivative market keeps the volatility constant or even reduces it (Baldauf and Santoni, 1991; Antoniou and Foster, 1992; Pericli and Koutmos, 1997; Dennis and Sim, 1999; Rahman, 2001). According to this view, futures reduce spot market risk by creating a new investment opportunity, enhancing the market depth and efficiency, reducing transaction costs with increased liquidity, creating hedging opportunities, and reducing asymmetric information. In this case, increasing liquidity in the market allows investors to hedge and limit the volatility relating to disequilibrium. Also, the ability to transfer risk by futures markets reduces spot price volatility without the need for risk coverage. In this framework, however, an alternative view has been put forward by Friedman (1953) that speculation leads to price stability when speculators buy (sell) stocks when prices are low (high). Continuously, the price moves to its average level (Antoniou and Foster, 1992). According to the opposite view, derivative markets can increase spot market volatility (Antoniou and Holmes, 1995; Antoniou and Holmes, 1995). Under these circumstances, the use of this instrument is a means of speculation and consequently increases the speculative activities (Skinner, 1989). Given that one of the roles of futures markets is price discovery, if new market information is released in the futures market before the stock one, given the high liquidity of these markets and low transaction costs, low margins, and high response, prices respond more quickly to new information and, through an arbitrage process, adjustments to these prices are transferred to the spot market and lead to market instability (Rio & Smith, 2006) and possibly because of the strength and speed of impact, it also affects the capital of other countries and increases the volatility of stocks.

In general, investors are expected to reduce their demand for stocks and buy some new options with the introduction of the derivatives, in which case the stock price decreases. The disadvantage of this analysis, however, is that the option is a complement, not a substitute for the stock. Under these conditions, the option transaction increases the equilibrium stock price and reduces stock return volatility (Ingersoll and Ross, 1985). Based on Detemple and Seldeni (1991), investors have different views about the potential of the downward trend of the stock. Specifically, the first group of investors prefers a portfolio that is more profitable when assessing high risk, and hence they substitute stocks to achieve their optimum return, but when they assess the risk lower, they sell the option for buying more stocks. The second group of investors shows a stronger response to market structure changes when they evaluate the risk low. In this case, the total demand for the stock increases, the option as a complement for the stock, the stock becomes more valuable, the price increases, and the return volatility decreases. Therefore, the introduction of the option stabilizes the stock market.

According to Kodres et al. (2002), international investors are exposed to various risks in different countries. Investors do not sell their assets only in the country from which the crises come, but they also sell assets in other countries affected by the crisis. Moreover, the expansion of the crisis and the devaluation of financial assets may increase the risk of investment; hence, it is crucial to introduce a tool to control the risk and fluctuations of the financial market. In this regard, derivative instruments can affect the mechanism of transferring the destructive effects of the crisis with the reduction of financial market volatility and thereby, reducing financial contagion. Derivative instruments such as futures and options are the most essential tools to hedge the financial markets.

By using the GARCH model, Imen et al. (2012) have shown a significant increase in the dynamic correlation between 13 developed and developing stock markets. The results also indicate a high degree of financial integration among studied countries, especially during the financial crisis. Mollah et al. (2014) have investigated the global financial crisis contagion and verified it in 46 states of 63 countries. Shastri (2017) has investigated the correlation between the bond and stock markets in developing and developed countries by using the Copula function. Based on the results, the stock and bond markets in the studied countries had co-movements.

Nathan et al. (1974) have studied the effects of the options on the Chicago Stock Exchange and shown that options helped to stabilize the stock markets. These results were confirmed by Skinner (1989) and many other researchers for England, Canada, Switzerland, and Sweden. Also, Danthin (1978) have shown that futures decrease market volatility and increase market efficiency since it reduces the cost of informed traders to respond to incorrect pricing. Froot et al. (1991) have indicated that the use of derivative instruments has increased the depth of the market due to the rapid spread of information. Reyes (1996), by considering the French and Danish stock indices, has shown that the volatility in these markets has declined. But thanks to the information increased in these markets; the speculators did not create instability in the markets. Lyroudi et al. (2000), by examining the effect of the derivative instrument on fluctuations in the Athens stock exchange, have proved that this instrument has made significant changes in the market fluctuations. By using the EGARCH model, they showed that the derivatives hurt the volatility of financial markets. Mallikarjunappa et al. (2008) have indicated that there was no evidence of stability or instability on the Indian stock index after the introduction of futures and options. By employing the ARMA and GARCH models, Jacobsen (2010) has examined the effect of a derivative instrument on the return of assets. According to this research, there is a significant and positive relationship between unexpected speculative shock and stock fluctuations. Also, based on this study, derivative instruments affect fluctuations. Ray et al. (2011) have also examined the effects of financial derivatives on stock market fluctuations in India. The results showed that fluctuations level in the period of introduction of the derivative instruments increased as compared with the periods before using the derivatives. Singh et al. (2015), by examining the effect of derivative instruments on the Indian currency market fluctuations, using the GARCH model, have verified that the existence of derivatives led to a decrease in foreign exchange market volatility in India.

3 Methodology

To test the hypothesis, a Copula function and Kendall's tau have been employed. A Copula is a multivariate cumulative distribution function for which marginal probability distributions for random variables are uniform. These functions are used to define the correlation and co-movement between two or more random variables (Schmidt, 2006). Due to this characteristic, Copulas are widely used in modeling the risk. According to Sklar's Theorem, any multivariate joint distribution can be written in terms of univariate marginal distribution functions and a Cupola that describes the dependence structure among the variables (Sklar, 1973). Based on Fisher's random number generation, if X is a continuous random variable with a distribution function F, then U=F (X) has a uniform distribution in the interval [1, 0] (Patton, 2002). Then based on Sklar's theorem, for any d-dimensional distribution function, F, with marginal CDFs $F_1 . F_2, \dots, F_d$, there is a d-dimensional copula, C, such that

$$F(x_1, x_2, \dots, x_d) = C(F_1(x_1), \dots, F_d(x_d)) \quad (1)$$

And the copula function is:

$$C(u_1, u_2, \dots, u_d) = F(F_1^{-1}(u_1), \dots, F_d^{-1}(u_d)) \quad (2)$$

In this relation, F_i^{-1} is an inverse function of the marginal distribution and $U \sim Unif(0,1)$ (Nelsen, 1999). With some algebraic calculations to obtain the density function, the dependence structure will be as follows:

$$\frac{\partial^d F(x_1, x_2, \dots, x_d))}{\partial x_1 \partial x_2 \dots \partial x_d} = \frac{\partial^d C(F_1(x_1), \dots, F_d(x_d))}{\partial x_1 \partial x_2 \dots \partial x_d} f_1(x_1) . f_2(x_1) \dots f_d(x_d) \quad (3)$$

Or

$$f(x_1, x_2, \dots, x_d) = C(u_1, u_2, \dots, u_d).f_1(x_1).f_2(x_1) \dots f_d(x_d) \quad (4)$$

The above equations mean that the joint density function is the multiplication of the copula density and the density of the single-variable margins. Hence, we can say that Copula has all the information about the dependence structure.

In financial literature, Pearson Linear Correlation Coefficient is one of the methods used to determine dependence (For example, studies by Bertero et al. (1990), Baig et al. (1999)). But in the following years, Stambaugh (1982), Boyer et al. (1999), Forbes and Robin (2002) showed that this coefficient provides the results with bias when the mean and variance of variables are not constant. Embrechts et al. (2001) and McNeil et al. (2005) showed that simple correlation coefficients only provide accurate measurements for elliptical distributions, and an alternative method for measuring correlation should be adopted if the distribution of variables is not elliptical. Rank correlation coefficients (Kendall'sτ and Spearman's ρ) are very much considered in solving the mentioned problems. Rank correlations are also useful in measuring the dependence structure among the copulas.

Although each of the copulas has its dependence parameter, they are not easily comparable. For example, the Clayton and Gumbel Copula parameters are respectively in the intervals (0,∞) and (1,∞), but the correlation coefficient is in a more limited interval (-1, 1) (Horta et al., 2008).

Kendall's τ and Spearman's ρ are defined as follow:

$$\rho_{spearman}(X_1, X_2) = 12 \int_0^1 \int_0^1 (C(u_1, u_2) - u_1 u_2) du_1 du_2 \quad (5)$$

$$\tau_{kendall}(X_1, X_2) = 1 - 4 \int_0^1 \int_0^1 \frac{\partial C(u_1, u_2)}{\partial u_1} \frac{\partial C(u_1, u_2)}{\partial u_2} du_1 du_2 \quad (6)$$

Different types of copula in literature and the studies of Nelson (1999) and Joe (1997) were used to modeling the dependence structure. But Gumbel, Frank, Clayton, and t-Student Copulas have mostly used in financial and insurance market studies. The Gumbel copula is defined as follows:

$$C_G = (u, v; \delta) = exp\left\{-\left[(-lnu)^\delta + (-lnv)^\delta\right]^{\frac{1}{\delta}}\right\} \quad , \quad \delta \in [1, \infty) \quad (7)$$

3.1 This copula has a lower tail dependence and upper tail independence.

Conversely, the Clayton copula is characterized by an upper tail dependence and lower tail independence:

$$C_{cl} = (u, v; \theta) = \{u^{-\theta} + v^{-\theta} - 1\}^{\frac{-1}{\theta}} \ , \quad \theta \geq 0 \tag{8}$$

3.2 And, the Frank copula has lower and upper tail dependences:

$$C_f = (u, v; \alpha) = \frac{-1}{\alpha} ln \left[1 + \frac{(e^{-\alpha u} - 1)(e^{-\alpha v} - 1)}{e^{-\alpha} - 1}\right] \tag{9}$$

The Frank Copula has asymptotic tail independence. Unlike Frank Copula, Gumbel and Clayton Copulas show the dependency on one of the tails and have asymmetric dependence.

Finally, the t-Student copula is symmetric and shows the tail dependence:

$$C(u, v; V, \rho) = \int_{\infty}^{t_V^{-1}(u)} \int_{\infty}^{t_V^{-1}(v)} \frac{1}{2\pi\sqrt{1-\rho^2}} \left\{1 + \frac{S^2 - 2\rho st + t^2}{v(1-\rho^2)}\right\}^{\frac{-v-1}{2}} dsdt \tag{10}$$

The coefficient of tail dependence in this copula is equal to:

$$\lambda_l = \lambda_u = 2\left[1 - t_{v+1}(\sqrt{(v+1)(1-\rho)/(1+\rho)}\right] \tag{11}$$

In this relation, t_{v+1} is a standard univariate t distribution with a v+1 degree of freedom. Two random variables with copula C (u,$v; v, \rho$), even in a non-correlation state, can have asymptotically tail dependence. The correlation coefficient is zero, and $v \rightarrow \infty$ means independence. If the correlation coefficient is opposite zero, then $v \rightarrow \infty$, so, the Copula is normal with tail independence. It is better to use Gaussian Copulas (Clayton, Gumbel, and Frank) or t Copula when the variables have a symmetrical dependence structure. In general, if dependence was seen more on the left of the distribution, the Clayton Copula is more appropriate, and the Gumbel Copula is used if the dependence is greater on the right of the distribution (Trivedi and Zimmer, 2005). Clayton and Gumbel Copulas cannot be used to model a negative relationship. But the use of the above copulas helps solve the problem since there usually is a positive dependence between the stock returns. Frank Copula is symmetric and has advantages as compared with the Gumbel, Clayton, and t Copulas because it offers a more straightforward estimate of the dependence structure due to its simple analytical form. It is also suitable for variables with poorly dependence structure (Trivedi and Zimmer, 2005).

In the following, a two-stage method is used for testing the hypothesis. Firstly, the ARMA-GARCH model is estimated for each country, and accordingly, the filtered returns are extracted. Then, for these returns, proper distribution is identified by Akaike criteria. Secondly, the Copula function is estimated depending on the distributions, and Kendall's rank correlation coefficient is calculated for each pair of series. The null hypothesis is the absence of financial contagion:

$$\begin{cases} H_0 = \Delta\tau = \tau_{crisis} - \tau_{pre-crisis} \leq 0 \\ H_1 = \Delta\tau = \tau_{crisis} - \tau_{pre-crisis} > 0 \end{cases} \quad (12)$$

The data of this study include the stock indices and futures transactions. The stock indices of NIFTY50 and CHINA50 represent the top 50 Chinese and Indian companies, respectively. The index of S & P500 tracks the stocks of 500 large-cap US companies. The stock index of BOVESPA is for the top 60 Brazilian companies. Finally, the RTSI is the Russian stock exchange index. By using these indices (P_{it}), the stock return (R_{it}) is calculated as follows:

$$R_{it} = \ln(P_{it}/P_{it-1}) \quad (13)$$

4 Empirical Results

Before anything, the descriptive statistics of the stock returns and futures are presented in the tables (1) and (2).

Table 1

Descriptive statistics of stock returns index

	RCHINA50	**RNIFTY50**	**RBOVESPA**	**RRTSI**	**RSP500**
Mean	0.007544	0.001586	0.00398	-0.003787	0.005893
Median	0.006343	0.009894	0.00409	0.001824	0.010236
Maximum	0.247376	0.169166	0.156733	0.266842	0.107723
Minimum	-0.306665	-0.296067	-0.284971	-0.449138	-0.169425
Skewness	-0.660791	-0.686779	-0.525656	-0.801567	0.041683
Kurtosis	7.412543	4.525201	4.747318	6.160045	-0.77802

Source: Research Findings

Table 2
Descriptive statistics of stock futures index

	RCHINA50	RNIFTY50	RBOVESPA	RRTSI	RSP500
Mean	8190.052	109.6402	26813.94	5956.172	1668.289
Median	8482.5	110.1243	26970.07	6065.755	1514.375
Maximum	23200	156.4002	44729.16	6984.43	2917.5
Minimum	0	53.632	10138.05	3830.09	734.25
Skewness	4818.55	20.8604	9144.529	726.5337	526.2931
Kurtosis	0.199373	-0.532697	0.143931	-0.894066	0.450679

Source: Research Findings

Based on the skewness and kurtosis statistics in the mentioned tables, in general, the variables are not normally distributed, even though the US and Brazilian stock indices are close to the normal distribution.

To represent more details, Figures (1) and (2) illustrate the co-movements of the stock indices altogether and separately for each country, respectively. According to these Figures, all indices have co-movement with the US stock index. The trend of Stock returns also shows a critical point in the tenth month of 2008. However, for more accurate modeling, the starting point of the crisis is considered to be September 2008. Therefore, the pre-crisis period is from January 2007 to August 2008 (Horta et al., 2008), and the United States is the source of the 2008 financial crisis.

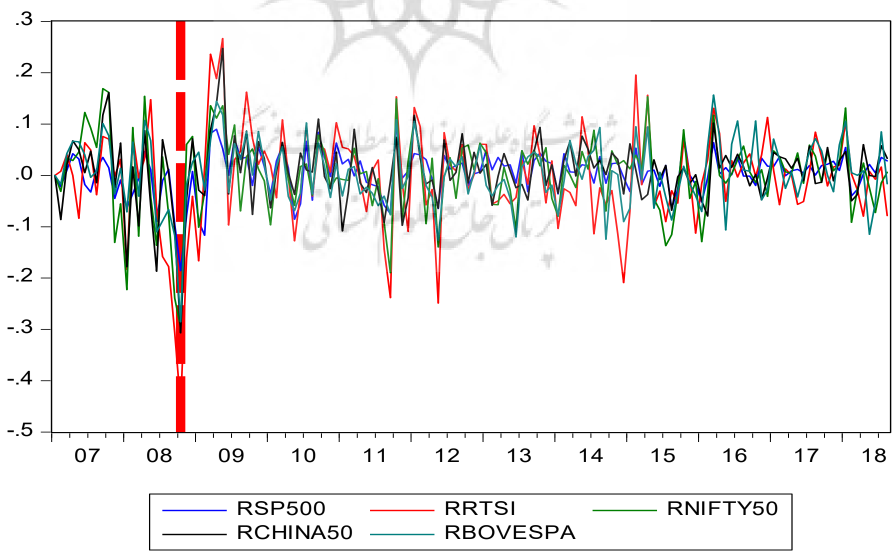

Figure 1. Co-movements of stock return indices. *Source:* Research Findings

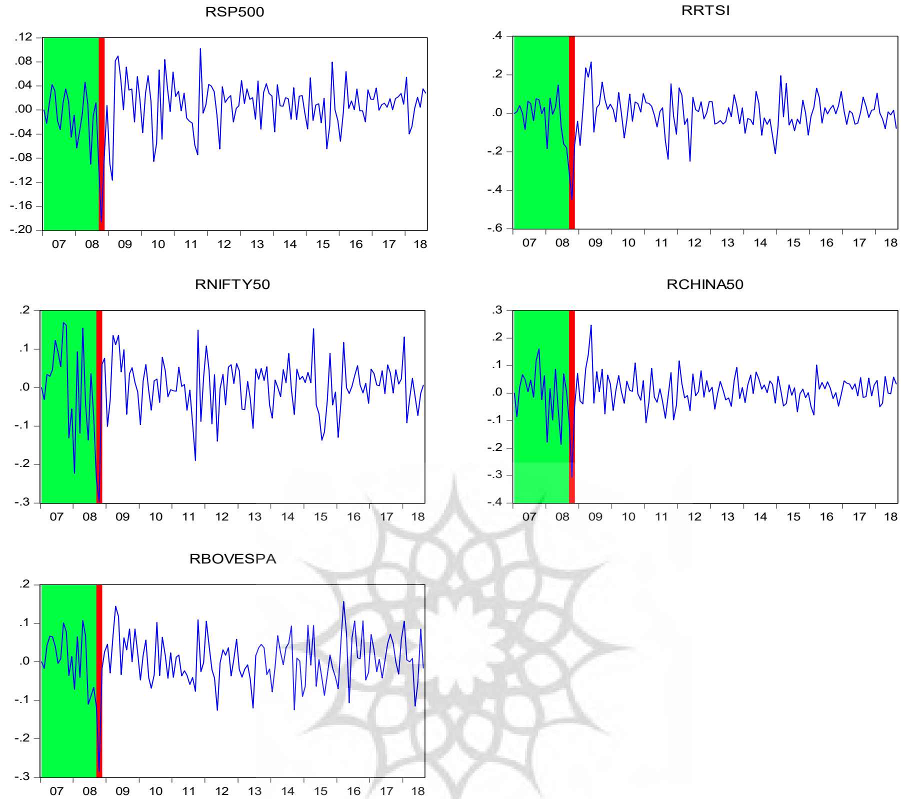

Figure 2. Return Indices for the studied countries. *Source:* Research Findings

Before estimating the model, the tests of studied data stationary are presented in Tables (3) and (4). The results show all the indices are stationary, according to the Dickey-Fuller test.

Table 3
Dickey Fuller's unit root test for stock returns indices

Country	Symbol	Dickey-Fuller (DF)	p-Value	Null Hypothesis
China	RCHINA50	-11.18712	0.0000	Lack of unit root
Brazil	RBOVESPA	-9.755671	0.0000	Lack of unit root
United States	RSP500	-9.997740	0.0000	Lack of unit root
India	RNIFTY50	-10.51245	0.0000	Lack of unit root
Russia	RRTSI	-8.523799	0.0000	Lack of unit root

Source: Research Findings

Table 4
Dickey Fuller's unit root test for futures indices

Country	Symbol	Dickey-Fuller (DF)	p-Value	Null Hypothesis
China	RCHINA50	-10.73821	0.0000	Lack of unit root
Brazil	FBOVESPA	-10.24468	0.0000	Lack of unit root
United States	FSP500	-10.61810	0.0000	Lack of unit root
India	FNIFTY50	-11.13393	0.0000	Lack of unit root
Russia	FRTSI	-9.924282	0.0000	Lack of unit root

Source: Research Findings

The next step is to assess the significance of the ARCH effects. Table (5) indicates the test done by using ARCH-LM statistics. According to the results, the existence of the ARCH is not rejected, and therefore, we can use the GARCH model for dependence modeling by considering heteroskedasticity.

Table 5
ARCH-LM test results

Countries	Statistics	Calculated statistics	P-Value
China	F	11.406931	0.0000
	Obs*R-Squared	13.838080	0.0000
Brazil	F	21.821565	0.0000
	Obs*R-Squared	21.823923	0.0000
United States	F	9.177741	0.0029
	Obs*R-Squared	8.723984	0.0031
India	F	21.51696	0.0000
	Obs*R-Squared	18.85092	0.0000
Russia	F	11.50178	0.0009
	Obs*R-Squared	10.76086	0.0010

Source: Research Findings

In the following, the existence of contagion for each country is tested, and the results are presented in Table (6).

Table 6
Results of financial contagion

Pair of Countries	p-value	$\Delta\tau$
China/ USA	0.00171	0.07238
Brazil/ USA	0.0019	0.0953
India / USA	0.00971	0.03824
Russia / USA	0.0002	0.2126

Source: Research Findings

The results given in Table (6) confirm the existence of contagion between each country, and the US is accepted. Consequently, given the existence of the contagion, we test the hypothesis. Before doing so, at first, the correlation coefficients are estimated and given in Table 7. Based on this table, the model of all countries is ARMA (0, 0)-GARCH (1, 1).

Table 7
Results of correlation coefficients

Country	Stock Return Index	ARMA (p,q)-GARCH (r,s) Model
China	RCHINA50	ARMA(0,0)- GARCH(1,1)
Brazil	RBOVESPA	ARMA(0,0)- GARCH(1,1)
United States of America	RSP500	ARMA(0,0)- GARCH(1,1)
India	RNIFTY50	ARMA(0,0)- GARCH(1,1)
Russia	RRTSI	ARMA(0,0)- GARCH(1,1)

Source: Research Findings

The filtered data are needed to apply the derivatives in the model and testing the hypothesis. The residuals of the above-estimated model are employed to extract the filtered information. The filtered return distributions are used as inputs to estimate the copula model as well as the Kendell coefficients. Table (8) shows the Akaike statistics for the filtered returns distribution during the crisis period by taking the derivative instruments into account.

Table 8
The filtered returns distribution during the crisis period with derivative instruments

Index	Logistic	Normal	Ext-value min	t-student	Ext-value max
RCHINA50	352.318	340.94	140.73	229.014	254.865
RBOVESPA	813.285	817.895	798.35	288.577	488.607
RSP500	400.43	1122.165	1090.07	228.569	881.124
RNIFTY50	201.92	354.176	265.360	228.96	94.42
RRTSI	273.479	245.846	208.896	229.528	784.182

Source: Research Findings

As shown in Table (9), the distribution of the filtered returns of the Chinese and Russian stock exchanges is a logistic one. Similar to the t-Student distribution, the logistic one indicates a heavy-tailed distribution. On the other hand, based on the results, the distributions of Brazil, the US, and Indian are normally distributed.

Table 9
Distribution of filtered return by taking the derivatives into consideration

Index	Proper distribution
RCHINA50	Logistic
RBOVESPA	Normal
RSP500	Normal
RNIFTY50	Normal
RRTSI	Logistic

Source: Research Findings

By identifying the proper distributions, the next step is to estimate the appropriate Copulas. The estimated copulas parameters with Akaike statistics are presented in Tables (10) and (11).

Table 10
Estimates of Copulas after the crisis and before introducing the derivative instruments

Pair of Countries	**Index**	**Criterion**	**Clayton**	**Frank**	**Gumbel**	**Normal**	**t-student**
USA/ China	C-RSP500/C-RCHINA50	MLE fit	1.167	3.746	1.583	0.68	0.68 & (3)
		AIC	36.71	35.16	46.03	44.28	50.70
		LL	20.41	19.63	25.06	23.15	27.40
USA / Brazil	C-RSP500/C-RBOVESPA	MLE fit	1.22	3.91	1.62	0.62	0.62 & (6)
		AIC	43.03	36.98	47.17	46.79	47.008
		LL	23.56	20.54	25.63	24.41	25.56
USA / India	C-RSP500/C-RNIFTY50	MLE fit	1.6170	4.851	1.808	0.688	0.68 & (8)
		AIC	67.48	54.195	61.036	62.65	62.108
		LL	26.39	29.14	32.56	32.34	33.105
USA / Russia	C-RSP500/C-RRTSI	MLE fit	1.39	4.31	1.69	0.72	0.72 & (40)
		AIC	44.14	43.70	53.22	57.50	55.27
		LL	24.12	23.90	28.66	29.77	29.68

Source: Research Findings

Table (11): Estimates of copulas during the crisis period after introducing the derivative instruments

Pair of Countries	Index	Criterion	Clayton	Frank	Gumbel	Normal	t-student
USA / China	RSP500/RCHINA50	MLE fit	0.57	2.09	1.28	0.21	0.21& (6)
		AIC	6.05	9.61	9.31	9.30	8.22
		LL	5.08	6.86	6.70	5.66	6.16
USA / Brazil	RSP500/ RBOVESPA	MLE fit	0.07	0.34	1.03	0.05	0.05 & (8)
		AIC	3.80	3.73	3.72	1.64	2.73
		LL	0.14	0.18	0.19	0.192	0.68
USA / India	RSP500/ RNIFTY50	MLE fit	0.06	0.29	1.03	0.07	0.07 & (40)
		AIC	3.45	3.82	4.03	2.01	4.37
		LL	0.32	0.13	0.03	0.007	0.13
USA / Russia	RSP500/ RRTSI	MLE fit	0.43	1.65	1.21	0.13	0.13 & (5)
		AIC	3.46	4.07	6.05	4.39	4.07
		LL	3.78	4.08	5.07	3.21	4.08

Source: Research Findings

Comparison of the Coppola parameters for the crisis period before taking the derivatives into account with copulas parameters after introducing the derivatives shows that the Coppola parameters have decreased after the introduction of the derivative instruments in all the countries. It indicates a reduction of the contagion after the introduction of the derivative instruments. The appropriate copulas for each pair of countries are presented in Table (12).

Table 12
Proper Copula

Pair of Countries	Copula
China/ USA	Frank
Brazil/ USA	Clayton
India / USA	t-Student
Russia / USA	Gumbel

Source: Research Findings

As stated, in addition to the copula parameters, Kendall's correlation coefficient is the other method to examine the dependence. The rank correlation coefficients before and after the introduction of the derivative instruments are presented in Tables (13) and (14), respectively.

Table 13
Rank correlation coefficients before introducing derivative instruments

Pair of Countries	Clayton	Frank	Gumbel	Normal	t-Student
China/ USA	0.36	0.38	0.36	0.47	0.43
Brazil/ USA	0.45	0.42	0.42	0.48	0.49
India / USA	0.41	0.42	0.39	0.52	0.51
Russia / USA	0.36	0.35	0.36	0.42	0.44

Source: Research Findings

Table 14
Rank correlation coefficient (τ) during crisis after introducing derivative instruments

Pair of Countries	Clayton	Frank	Gumbel	Normal	t-Student
China/ USA	0.27	0.23	0.19	0.12	0.16
Brazil/ USA	0.073	0.033	0.032	0.075	0.051
India / USA	0.13	0.19	0.15	0.101	0.102
Russia / USA	0.07	0.05	0.02	0.06	0.06

Source: Research Findings

A comparison of Table (14) with Table (13) proves the negative effect of the derivative instruments on the co-movement and contagion. Finally, the research hypothesis is examined and presented in Table (15). According to the results, $\Delta\tau$ in the US / India is larger than those for other pairs. It means that the derivative instruments can have a significant effect on the reduction of financial contagion in India. On the other hand, $\Delta\tau$ for the US/China is the least. In this framework, the size of the derivative instruments' effect on the contagion is different from one country to another.

The results in the table (15) indicate that the null hypothesis of the no negative effect of the derivative instruments on the contagion is rejected. So, the research hypothesis is verified.

Table 15
The Hypothesis Test

Pair of Countries	p-value	Δτ
China/ USA	0.011184	0.20
Brazil/ USA	0.000042	0.29
India / USA	0.000003	0.399
Russia / USA	0.001529	0.37

Source: Research Findings

5 Conclusions and Policy Implications

The primary purpose of the present study is to examine the effect of the derivative instruments on the stock market contagion using monthly stock indices and stock futures for the developing countries, including Russia, China, India, and Brazil, during the period 2007:1-2018:08. For this, we have employed the Copula function as well as Kendall rank correlation coefficients.

There are two different views regarding the effect of derivatives on the contagion. The first view is linked to a positive effect of the futures on the spot market fluctuations. The second one is related to the negative effect of the futures on the contagion. In the framework of the latter view, the futures attract minor actors to the market. Furthermore, the transaction cost in the futures market is lower than spot markets. Therefore, the speed of entering new information into the futures market is higher, and through this, the futures market could provide a way to transfer information to the spot markets, which consequently reduce the volatilities of spot markets.

The results of this study indicate that both the copula dependence parameters and the Kendall rank correlation coefficients have decreased by considering the derivative instruments. It means a negative effect of the derivative instruments on the stock market contagion. Given the results of the present study, the derivative instruments should be developed, especially when the economy moves toward openness. In this case, the stock markets can be immune and resist the fluctuation originated from the external sources. The other policy is to promote the information content and social responsibility of stock companies so that the informed speculators use the financial instruments, which consequently make the depth of the fluctuations less than before. For instance, financial derivative instruments are not widely used and developed in Iran's stock market, but the stock market has historically influenced by global financial crises. Developing derivative instruments and informing investors to make use of these instruments can make the financial markets safe from the crises.

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