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The U.S. Contagion Effects on Foreign Direct Investment Flows in Developing Countries*

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Abstract

This study aims to measure the lower tail dependence as risk contagion from the U.S. economy to 18 developing countries affecting FDI inflows using time-series data from 2005 to 2019. Firstly, we utilize four dynamic copula models, namely, Student-t, Clayton, rotated survival Gumbel, and rotated survival Joe, to measure the tail dependence structure between the U.S. and each developing country's real GDP growth. Secondly, we use the regression model to explore the contagion effects on FDI inflows. The results show that there is evidence of the tail dependence between the U.S and developing economies, indicating the presence of the contagion effects. Primarily, we observe that the degree of contagion effects of the global financial crisis varies across countries; a strong impact is observed in Chinese, South African, Russian, Colombian, and Mexican economic growth. Furthermore, we found significant contagion risk affecting FDI inflows positively in China, Indonesia, Columbia, Morocco, and negatively in the Philippines, Bulgaria, and South Africa. This study demonstrates the usefulness of the copulas model in terms of examining contagion. Our findings shed light on the influence of sound policies and regulations to cope with both positive and negative consequences of the contagion on the capital movement.

Keywords: Contagion, The U.S. Economy, Developing Countries, FDI

JEL Classification Code: C22, C51, F21

1. Introduction

The global financial crisis in 2008 was the worst economic disaster since the Great Depression of 1929. The crisis led to the Great Recession, where housing prices dropped more than the price plunge during the Great Depression. Although the recession ended, unemployment was still above 9%. International financial integration is commonly seen as increasing economic efficiency and growth, but it may increase the probability of suffering a systemic risk transmitting global shocks to different markets. There has been engaging discussion on the origin of financial crises and their cross-border transmission relating to questions like why some crises appear to be contagious and why some developing countries appear to be vulnerable to contagion significantly (Lowell et al., 1998). Since some bilateral trade partner of the U.S. and investment partners are developing countries or emerging market countries, the degree of economic linkages between the two possibly contributes to financial markets as the transmission of risk from the destination of the crisis to one another.

The role of foreign direct investment (FDI) has been increasingly important in the world market (Liu, 2012). FDI also has been considered a main source of capital flows in most developing countries. It can bring many kinds of development to host countries, such as generating economic growth, transferring new technology, forming human capital, and creating a competitive environment. Developing countries have been concentrated on FDI inflows in Southeast Asia and Latin American as the destination of FDI. Therefore, economists' interest in contagion surged during

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the financial crises spread across developing countries, affecting nations with apparently healthy fundamentals and vividly captures policymakers' concerns and frustrations with financial contagion (Edwards, 1996). With the global crisis in 2008, the first major one since the Great Depression, the contagion of the financial crisis has reappeared as an important issue. Although the crisis initially erupted in the credit market of the U.S., it has rapidly spread to developed countries since the last quarter of 2008 and was exposed to developing countries at the beginning of 2009. The temporary shrinking of business activity and a loss of consumer confidence for foreign banks have been observed in China (Lee & Wang, 2018). Most recent studies have pointed out contagion negatively on FDI, but some evidence shows the positive effect on FDI as it seems to be the safe haven of capital flows for investors. Lee and Wang (2018) similarly suggested that financial crises have a chance to stimulate foreign investment inflows.

In the previous studies, the economists interested the contagion effects since the Mexican devaluation in December 1994, which brought an abrupt end to capital flows to many Latin American economies and triggered speculative attacks on their currencies. The study previously found contagion evidence by focusing on asset prices' co-movements (Karolyi, 2003). Many works speculated on the connection between contagion and capital flows volatility (Calvo & Reinhart, 1996; Dornbusch et al., 2000). However, very few investigated the effect of contagion on capital flow volatility. There were studies about the determinants of private capital flows to developing countries during the 1970s to 1990s on whether there is evidence of contagion (Hernandez et al., 2001). Moreover, some also applied the regression to confirm that trade linkage, FDI, and international fund flows were essential drivers of sovereign contagion and competition effects in China (Zhang et al., 2019). The degree of economic linkages between the U.S. and developing countries has been examined in many previous works. Yet, it is not easy to quantify the actual degree of a contagion effect, and its impact on FDI flows in developing countries.

In this study, it proposes a significant improvement in research methodology to analyze a contagion risk effect. The main objectives are to measure the degree of contagion during the U.S. financial crisis in FDI flows of developing countries and investigate the impact of contagion effects whether it contributes positively or negatively to FDI in developing countries. Although there are only a few pieces of evidence to support the crisis's impact on FDI flows during the crisis time, the FDI flows in developing countries significantly dropped in the aftermath of the crisis in 2009. Since previous studies focused on only measuring the degree of contagion, this paper conducts comprehensive approaches on estimating the contagion effects of the U.S. financial crisis between 2008–2009 to FDI flows of developing countries and try to highlight the possible impact of the economic crisis in a broader sense on region level of time-series data covering 18 developing countries from four different regions during 2005–2019. The study mainly adopts four copula models, namely Student t, Clayton, rotated survival Gumbel, and rotated survival Joe, to analyze the lower tail dependence generated by the real GDP growth between the U.S. and each developing country.

This research will have a contribution in two parts. First is the economic contribution, which evaluates the contagion effects of the U.S. financial crisis on FDI of each developing country by measuring the degree of contagion with the tail distribution. Second is the econometrics contribution, which is to measure contagion by using the time-varying copulas model. This methodology is the only one that can be used to estimate the lower tail dependence as a contagion parameter. To analyze the lower tail dependence structure between the U.S. and each developing country, this study employed four copula models: Student t-copula (symmetric association of tail dependence), Clayton copula, rotated survival Gumbel, and rotated survival Joe (lower tail dependence), to measure the degree of contagion. Besides, we attempt to investigate the impact of the degree of contagion on FDI in developing countries. Since FDI inflows are affected by many factors simultaneously, this study also applied the regression model to test other FDI determinants.

This paper's organization is as follows: Section 2 reviews the literature and describes the analysis's econometric methodology. Section 3 defines the variables and data descriptions. Section 4 discusses the empirical results, and in Section 5, the conclusion is drawn.

2. Literature Review and Econometric Methodologies

2.1. Literature Review

There are a large number of empirical studies to investigate the relationship between FDI and financial crises. Most of them relate to examining the pattern of FDI activity during one particular financial crisis, such as the Asian financial crisis in the period 1997–1999 and the current global financial crisis in period 2008–2012. Since capital mobility was increased, studies proliferated to examine why capital flow, especially to developing economies, is more volatile in emerging economies than in advanced countries (Thu, 1998; Wie, 2006; Alfaro et al., 2007).

Since contagion has been an area of interest among economists, hence recently, there are a significant number of researches focusing on examining the "interdependence," "co-movements," or "linkage" between financial markets for various crises (Calvo & Reinhart, 1996; Dornbusch et al., 2000). Recent studies also note that the different patterns of volatility exhibited by different capital flows and research the factors behind the volatility dynamics. For example, Neumann et al. (2009) found that the opening of financial markets affect the different types of capital flows, and the further opening of financial markets tends to increase the volatility of FDI in emerging countries. On the other hand, Broto et al. (2011) suggested that global conditions have differential impacts on FDI, portfolio investment, and other types of investment flows. Same as Engle and Rangel (2008), they estimated conditional volatilities of different types of capital flows to examine the effect of various domestic and global factors on the volatility of capital flows and highlighted on the volatility of the portfolio and other investment have become increasingly significant relative to global factors since 2000. However, there have been few studies that focused on the effect of contagion on FDI inflows. Thus, this study has examined the dependence structure of the crisis from the U.S. to each developing country and investigates its impact on FDI inflows to those developing countries whether it significantly affects the volatility of FDI inflows.

Considering the research methods, different approaches have been developed to measure contagion between the markets, for instance, analysis of cross-market correlation coefficients, GARCH framework, cointegration, and Probit models. The cross-market correlation coefficient is the most straightforward method that measures the correlation in returns between two markets during a stable period. It tests a significant increase in this correlation coefficient after the shock. Correlation coefficients increase, which means the transmission mechanism between the two markets increased, and contagion occurred (Forbes & Rigobon, 2001). King and Wadhwani (1990) tested for an increase in cross-market correlation coefficient between the U.S., U.K., and Japan when the global financial crisis happened, and they founded that the correlations increase significantly. Also, Lee and Kwang (1993) developed this analysis for 12 major markets and found further contagion that the average weekly cross-market correlation increased after the crash. Calvo and Reinhart (1996) likewise used a cross-market correlation coefficients approach to test the contagion after the Mexican currency crisis in 1994.

Regarding the GARCH framework, it is used to estimate the variance-covariance transmission mechanism across countries. For example, some research applied this method to find evidence of significant spillovers across markets after the U.S. stock market crash in 1987 (Chou et al., 1994; Hamao et al., 1990). Edwards (1990) estimated the augmented Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model and showed significant spillovers from Mexico to Argentina. Chiang et al. (2007) used the dynamic conditional correlation generalized autoregressive heteroskedasticity (DCC-GARCH) model to study nine Asian stock-return data series from 1990 to 2003; the dynamic correlation coefficient was significantly increased during the crisis period. The cointegration test based on Vector Autoregression (VAR) model is used to test for a long-run relationship between markets after a shock. This method employs the same basic procedures as above, but it changes in the cointegrating vectors between stock markets instead of the variance-covariance matrix. For example, Longin and Solnik (1995) examined seven countries from OECD countries from the period 1960–1990 and presented the average correlations in stock market returns between the U.S. and other countries. Last, the Probit model is also used to test for contagion and simplifying assumptions and exogenous events to identify a model and directly measure changes in the propagation mechanism. Some papers used Probit models to test how a crisis in one country affects the probability of crisis occurrence in other countries. They summarized the Exchange Rate Mechanism (ERM) countries in 1992–1993 suffered from a speculative attack increases when another country in the ERM is under attack, and they argued about the propagation of shock primarily transmitted through trade (Eichengreen et al., 1996; Kaminsky & Reinhart, 1998).

Besides, another approach has been applied to some research recently, which is the probability models. The copula function, which describes the dependency structure of variables, is the most important financial correlation modeling tool. Compared with traditional dependency measurement, copula can characterize non-linear or asymmetric dependency and measure tail dependency. Vine copula models are flexible for high dimensions using a cascade of bivariate copulas. They were found to be beneficial to the standard multivariate copulas. Also, the vine approach is more flexible as it can select bivariate copulas from a parametric family. Besides, vine copulas can also be used to measure non-conditional and conditional dependence structures, tail dependence, etc. (Liu et al., 2019). For example, Xu and Gao (2019) evaluated the risk contagion effects between the Chinese stock market and six other stock markets, including developed and emerging markets, from January 2006 to December 2018. They applied the dynamic Markov state transition Copula model to describe the asymmetrically dependent structure of markets, which derived the time-varying lower tail dependence coefficients (Xu & Gao, 2019).

2.2. Econometric Methodologies

2.2.1. Copula Functions and Tail Dependence

A copula is a function that links univariate marginals to their multivariate distribution. Since it is always possible to map any vector of random variables into a vector with uniform margins, we can split that vector's margins and a digest of dependence. Since Sklar's Theorem (Sklar, 1959) gave the first definition of a copula, it has two critical implications. First, it ensures that the copula is unique whenever the margins are continuous, usually in financial applications. Second, it shows that a copula can be constructed from any distribution function with known marginal distributions. With copula functions, various multivariate distributions can be revealed from the marginal probability distribution of a set of random variables along with different dependence among the random variables.

Let $H(x_1, x_2)$ is the joint distribution function of random variables x_1 and x_2. Sklar (1959) stated that a unique copula function can capture the dependence structure among the random variables and can be used as a function of this copula function and marginal distribution functions for random variables. Thus, there should be a unique copula function $C(u_1, u_2; \theta)$. Additionally, if the margins are continuous, then C is unique. So that

$$H(x_1, x_2) = C(F_1(x_1), F_2(x_2); \theta), \tag{1}$$

where $F_1(x_1)$ and $F_2(x_2)$ are the distribution function of x_1 and x_2; and θ is copula dependence parameter.

The two copula classes which are broadly used are elliptical and Archimedean. The elliptical family captures the dependency of symmetry on both left and right tails, while the Archimedean family can capture only one parameter or only one tail. In the beginning, consider the elliptical family first: the widely used copulas in this family are the Gaussian Copula and the Student-t copula. The Archimedean family, Gumbel, Clayton, Joe, and Frank, are also widely applied. The density of these copulas can be found in Nelson (2007).

- Tail Dependence

Tail dependence is more of a theoretical construction than a directly estimated measure, although it is possible to estimate tail dependence (Xu & Gao, 2019). The upper and lower tail dependence, τ^U and τ^L, respectively, are defined as the conditional probability of an extreme event,

$$\tau^U = \lim_{u \to 1-} \left[X > F_X^{-1}(u) \mid Y > F_Y^{-1}(u) \right], \tag{2}$$

$$\tau^L = \lim_{u \to 0+} \left[X < F_x(u) \mid Y < F_Y(u) \right], \tag{3}$$

where the limits are taken from above for τ^U and below for τ^L.

Tail dependence measures the probability X takes an extreme value given Y takes an extreme value. When the crisis occurs, the effect can be measured by using the lower tail, which takes particularly simple form when working in copulas, and is defined:

$$\tau^U = \lim_{u \to 0+} \frac{1 - 2u + C(u,\, u)}{1 - u}, \tag{4}$$

$$\tau^L = \lim_{u \to 0+} \frac{C(u,\, u)}{u}, \tag{5}$$

where the coefficient of tail dependence is always in [0, 1] since it is a probability. When τ^U (τ^L), is 0, then the two series are upper or lower tail independent. When the value is non-zero, the random variables are tail dependent, and higher values indicated more dependence during the crisis. The equation to generate the contagion as lower tail dependence is set as follows:

$$\text{Con}_{it} = \lim_{u \to 0+} \frac{C(u_{1t} + u_{2t})}{u}, \tag{6}$$

where is the quarterly contagion generated from lower tail dependence measurement, subscript represents to a host country or developing countries (i = 1, 2, ..., 18; t is a time subscript).

- Time-Varying Copulas

The Copula usually can be either be static and dynamic (time-variant). The benefit of the dynamic copula is to capture the dependence across the market, which can help policymakers better understand co-movement between markets more clearly.

The econometrics literature contains a preponderance of the evidence that the conditional volatility of economic time series changes through time. This, therefore, motivates recent studies to consider whether the conditional dependence structure also varies through time (Patton, 2012). In this study, we construct the dynamic Copula through the dynamic conditional correlation of Engle and Gonzalo (2008), which has the following structure:

$$R_t = \text{diag}(Q_t)^{-1/2} Q_t \text{diag}(Q_t)^{-1/2}, \text{S} \tag{7}$$

$$Q_t = (1 - \omega_1 - \omega_2)\bar{Q}_t + \omega_1 (z_{t-1} z'_{t-1}) + \omega_2 Q_{t-1} \tag{8}$$

where R_t is a time-varying conditional matrix, $\bar{Q}_t = \left(\sum_{t=1}^{T} z_t z'_t \right) / T$, is the standardized variables (GDP growth of the U.S and developing countries). ω_1 and ω_2 are the estimated parameters. The dependence structure is then modeled using copulas with conditional correlation R_t (Kim & Jung, 2016).

2.2.2. Specification of the Multiple Regression Model

Multiple linear regression is an approach to modeling the relationship between a dependent variable and more than one explanatory variable (or independent variables). After we get the lower tail dependence variable as representative of the contagion effects, this study applies the regression model to investigate the impact of the contagion effects on FDI of developing countries. Also, other control variables are added to avoid the omitted variable problem. These variables are Gross Domestic Product (GDP), trade openness, inflation, and exchange rate. The model specification is defined as follows:

$$Y = X'\beta + e \tag{9}$$

where Y is the FDI, X represents the vector of explanatory variables, β represents path coefficients or regression weights.

3. Data Description

3.1. Variables and Data Description

In this paper, we generate tail dependence using the bivariate copula model between two variables: the percentage of GDP growth quarterly of the U.S. and the percentage of GDP growth quarterly of each developing country. The tail dependence parameter will represent the risk contagion. To investigate the contagion effects, the control variables of FDI inflows from the U.S. to developing countries that we used are market size, trade openness, exchange rate, and inflation; all variables are retrieved from www.ceicdata.com and the World Bank – World Development Indicator. Table 1 presents the control variables of FDI, including contagion generated from dynamic copula models. The selected developing countries include 18 countries, consisting of China, India, Indonesia, Thailand, and the Philippines from the Asia region, Russia, Poland, Hungary, Romania, and Bulgaria from the Europe region, Brazil, Mexico, Argentina, Chile, and Colombia from the North-South America region, and South Africa, Egypt, and Morocco from the Africa region, including the U.S. as an origin of the crisis for the year 2005–2019 (quarterly data). All variables are transformed into natural logarithm before using in the regression model.

Table 1: Definition of Variables

No	Variable	Description
1	Con	Contagion is measured by lower tail dependence generated by bivariate copulas
2	Market	Real GDP per capita (USD)
3	Open	Trade openness is measured by the ratio of the export plus import relative to GDP of the developing country
4	Exchange	Exchange rate (USD)
5	Inflation	Price index which is measured Consumer Price Index (CPI)
6	FDI	FDI inflows (USD)

3.2. Descriptive Statistics

Basic summary descriptive statistics of the percentage of GDP growth quarterly of the U.S. and the percentage of GDP growth quarterly of each developing country are presented in Table 2. The mean is significantly different from zero for the economic growth for all countries. As shown, the average of some sample countries is higher than other countries in the same region, especially in China, since it has been an economic leader of the global supply chain in the past decades compared to India, Thailand, Indonesia, and the Philippines. Likewise, Romania has also reached the highest average GDP growth among the sample countries in Europe. However, the U.S. experienced a slowdown in its economy since the global crisis occurred. Both minimum/maximum and the standard deviations indicate that there is notable time-series variation in the variables. For example, Romania hit a maximum of 26.13% of GDP growth compared to all sample countries. However, during the global crisis period in 2009, its GDP growth was affected the most, with a decline of −35.496%.

Additionally, as shown in Table 2, almost all countries have negative values for skewness. China, South Africa, Morocco, and Colombia sign a more significant probability of large decreases, suggesting those distributions contribute to long left tails, including the U.S. Meanwhile, there is evidence for positive skewness for Thailand, Argentina, Chile, and Egypt that those distributions have long right tails. Most countries' kurtosis is lower than 3, excepting Egypt and Morocco, suggesting that it does not have a heavy-tailed distribution.

4. Empirical Results and Discussion

4.1. Unit Root Test

Stationary is an essential requirement for time-series analysis. The unit root test is the most effective method for testing the stationary of a time series. Therefore, the Augmented Dickey-Fuller (ADF) test. The null hypothesis is that the sequence is not stationary (i.e., there is a unit root). The statistical value is greater than the critical value, leading to acceptance of the null hypothesis. All variables' tested values are all greater than the different critical values, with 1% significant levels, indicating no unit root in the natural logarithm of the data. The preprocessing data with a logarithm is an effective way to eliminate nonstationary data.

Table 2: Descriptive Statistics for the Percentage of GDP Growth Quarterly

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
USA	0.48815	1.35500	4.09500	–4.79200	2.53121	–0.80934	2.24442
Asia							
China	3.60217	7.42000	13.81000	–16.60000	10.70501	–0.98409	2.25844
India	1.81730	2.28400	13.38900	–9.77500	5.58414	–0.28980	2.70496
Thailand	0.93745	0.4865	12.271	–7.79500	5.20047	0.217472	2.04894
Indonesia	1.37205	2.13850	4.21000	–3.57400	2.42570	–0.46163	1.68405
Philippines	1.84312	1.23650	14.24600	–13.03300	9.54911	–0.00024	1.18904
North-South America							
Brazil	0.52503	0.30100	5.09800	–5.12300	2.53670	–0.01995	2.19826
Argentina	0.88667	–1.31200	19.96800	–11.51400	8.49668	0.77608	2.48713
Mexico	0.57072	1.12350	5.65000	–9.07700	3.46104	–0.44745	2.26340
Chile	0.95347	-0.16750	10.10700	–6.56100	5.94222	0.31438	1.54277
Colombia	1.26085	3.85200	10.91300	–14.48100	8.19049	–0.86403	2.20940
Europe							
Russia	1.19438	6.47850	10.23600	–19.87400	10.06005	–1.10577	2.42510
Poland	1.48898	2.46400	16.08900	–15.52600	9.85264	–0.39112	2.08737
Hungary	0.86947	3.77100	12.11700	–17.35600	8.58564	–0.87270	2.28097
Bulgaria	2.08297	6.73850	22.67300	–25.25900	16.01413	–0.66839	2.02294
Romania	3.29910	8.80900	26.13800	–35.49600	21.13795	–0.74942	1.98884
Africa							
Egypt	1.50517	1.76000	13.72400	–8.75100	4.46651	0.40323	3.26684
Morocco	1.08493	1.46150	3.90000	–3.42100	1.65066	–0.94334	3.26264
S. Africa	0.59542	1.78150	3.90000	–5.92900	2.78780	–0.96708	2.57565

Table 3: Unit Root Test

Country	GDP	FDI	Contagion	Market	Open	Exchange	Inflation
USA	–17.007***	–	–	–	–	–	–
Asia							
China	–20.119***	–3.509***	–8.703***	–6.258***	–3.051***	–5.237***	–5.796***
India	–17.688***	–4.372***	–15.359***	–2.812***	–2.925***	–6.777***	7.0175***
Thailand	–13.855***	–5.176***	–21.600***	–2.263***	–3.478***	–6.126***	–5.996***
Indonesia	–24.068***	–4.978***	–18.686***	–2.415***	–2.934***	–7.609***	–8.008***
Philippines	–71.322***	–3.762***	–21.066***	–2.660***	–2.288***	–6.249***	–7.402***
North-South America							
Brazil	–7.440***	–3.656***	–16.081***	–2.617***	–3.683***	–6.590***	–5.299***
Argentina	–16.487***	–4.623***	–18.081***	–2.778***	–3.103***	–4.410***	–
Mexico	–31.029***	–4.031***	–26.560***	–3.269***	–3.067***	–7.578***	–3.725***

Table 3: (Continued)

Country	GDP	FDI	Contagion	Market	Open	Exchange	Inflation
Chile	–42.132***	–2.646***	–22.356***	–2.738***	–3.072***	–7.312***	–3.330***
Colombia	–35.089***	–3.611***	–16.101***	–2.334***	–3.480***	–7.283***	–3.953***
EU							
Russia	–16.321***	–4.462***	–8.251***	–2.741***	–3.276***	–6.591***	–2.833***
Poland	–44.585***	–6.813***	–25.162***	–2.843***	–3.002***	–7.107***	–4.575***
Hungary	–19.444***	–6.004***	–17.040***	–3.224***	–3.483***	–7.439***	–4.493***
Bulgaria	–27.145***	–3.419***	–17.926***	–2.347***	–3.145***	–6.538***	–4.994***
Romania	–22.120***	–3.203***	–13.130***	–2.822***	–3.134***	–6.884***	–4.374***
Africa							
Egypt	–12.205***	–3.202***	–21.082***	–3.283***	–2.969***	–7.845***	–3.858***
Morocco	–10.859***	–3.528***	–13.614***	–2.313***	–3.458***	–6.448***	11.021***
S. Africa	–15.065***	–5.985***	–8.251***	–2.575***	–3.360***	–7.153***	–3.215***

Note: ***, ** and * indicate the rejection of the null hypothesis at 1%, 5%, and 10% significance level, respectively.

4.2. Dynamic Copula Estimation Results

In this section, we aim to examine the existence of the contagion effects of the U.S. global financial crisis on developing countries' markets. We consider four copula models to measure the tail dependence between the U.S. and each developing country, whether there is a contagion effect between each pair of countries. Student t copula, dealing with symmetric association of tail dependence, Clayton copula, rotate survival Gumbel, and rotate survival Joe, dealing with asymmetric and lower tail dependence. To find the best fit copula functions, we consider the Akaike Information Criterion (AIC) and the lowest value of AIC, indicating the best copula function. The comparison is provided in Table 4.

The Student-t copula is chosen for Thailand, Indonesia, the Philippines, Brazil, Argentina, Mexico, Chile, Egypt, Morocco, and South Africa, reflecting symmetry in their economy pairs' correlations. However, the Clayton copula was selected for China, India, Colombia, Russia, Hungary, and Bulgaria. In contrast, the survival Joe copula was selected by Poland and Romania, indicating that the link between the two countries' economies is likely asymmetrical in Asia, South America, and Europe. Over time, the highest average tail dependence belongs to China and South Africa, with values 0.92 and 0.90, respectively. The lowest one belongs to Indonesia, with a maximum of 0.23.

The estimation parameter results are reported in Table 5. We can observe that all estimated parameters are positive and significant, indicating a dynamic pattern of dependence. We also observe that the degree of contagion effect of the global financial crisis varies across countries.

4.3. Regression Results

In the previous section, we focused on quantifying contagion from the U.S. to developing countries to define it as one of the factors affecting FDI inflows. However, related literature identifies many other factors that affect FDI inflows to avoid the omitted variables problem (Jun & Sing, 1996; Cohen, 2007; Campos & Kinoshita, 2008). To investigate the other known determinants, which are the macroeconomic variables associated with FDI inflows, we used control variables consisting of market size, trade openness, exchange rate, and inflation. Moreover, we applied the regression model in this section, adding the contagion variable as one determinant.

Since heterogeneity could happen across countries, we performed the regression model country and report regression results in Table 6. We find both positive and negative effects and significant coefficients for contagion effects in 7 out of 18 countries, including China, Indonesia, the Philippines, Colombia, Bulgaria, Morocco, and South Africa. The positive and significant coefficients in the majority of the countries in Asia and Africa regions. The positive relationship highlighted that contagion could be an advantage for FDI inflows. This study found significant evidence that contagion can benefit FDI inflows in developing countries such as China, Indonesia, Colombia, and Morocco. Calderon and Didier (2009), had given rise to a specific perspective, arguing that when financial crises circumscribed mainly to the emerging market, foreign investors in developed markets were not affected by liquidity constraints during these episodes and can still access financial resources. They, therefore, can take

Table 4: Model Selection

Country	Student *t*		Clayton		Survival Gumbel		Survival Joe	
	Avg. tail	AIC	Avg. tail	AIC	Avg. tail	AIC	Avg. tail	AIC
Asia								
China	0.93	91.64	0.92	–320.41	0.92	–135.38	0.92	–317.52
India	0.49	47.39	0.35	33.45	0.35	36.20	0.36	34.33
Thailand	0.28	15.35	0.28	28.66	0.27	31.28	0.27	29.94
Indonesia	0.23	11.97	0.23	18.12	0.23	19.96	0.23	18.15
Philippines	0.68	55.03	0.67	71.02	0.67	81.56	0.23	69.74
North-South America								
Brazil	0.47	33.28	0.45	53.72	0.46	55.06	0.46	53.86
Argentina	0.31	19.27	0.31	35.24	0.31	37.15	0.31	36.07
Mexico	0.81	88.82	0.78	118.71	0.78	130.62	0.78	118.46
Chile	0.57	42.30	0.56	70.35	0.55	73.06	0.56	69.44
Colombia	0.86	83.17	0.86	–26.13	0.86	38.67	0.86	–25.47
EU								
Russia	0.89	84.75	0.88	–120.29	0.88	–23.68	0.88	–118.76
Poland	0.79	68.75	0.77	46.15	0.77	73.20	0.77	45.59
Hungary	0.93	96.88	0.93	–329.31	0.93	–157.46	0.93	–326.50
Bulgaria	0.82	73.29	0.84	–44.21	0.84	14.25	0.84	–43.93
Romania	0.78	64.13	0.77	18.90	0.77	49.14	0.77	18.04
Africa								
Egypt	0.32	22.20	0.44	49.79	0.48	56.41	0.44	49.88
Morocco	0.62	46.94	0.53	47.06	0.55	50.85	0.52	46.96
S. Africa	0.90	127.29	0.90	162.15	0.90	181.39	0.90	162.21

Note: Numbers in the bold present the best dynamic copula result.

Table 5: Time-Varying Copula Estimates

Country	Selected Copula	θ_{11}	θ_{12}	Average of Tail
Asia				
China	Clayton	0.010 (0.000)***	0.990 (0.000)***	0.92
India	Clayton	0.424 (0.000)***	0.575 (0.000)***	0.35
Thailand	Student t	0.426 (0.000)***	0.573 (0.000)***	0.28
Indonesia	Student t	0.316 (0.000)***	0.683 (0.000)***	0.23
Philippines	Student t	0.330 (0.000)***	0.669 (0.000)***	0.68
North-South America				
Brazil	Student t	0.320 (0.000)***	0.679 (0.000)***	0.47
Argentina	Student t	0.364 (0.000)***	0.635 (0.000)***	0.31

Table 5: (Continued)

Country	Selected Copula	θ_{11}	θ_{12}	Average of Tail
Mexico	Student t	0.315 (0.000)***	0.684 (0.000)***	0.81
Chile	Student t	0.321 (0.000)***	0.678 (0.000)***	0.57
Colombia	Clayton	0.010 (0.000)***	0.990 (0.000)***	0.86
E.U.				
Russia	Clayton	0.010 (0.000)***	0.990 (0.000)***	0.88
Poland	Survival Joe	0.044 (0.041)	0.768 (0.000)***	0.77
Hungary	Clayton	0.056 (0.031)*	0.294 (0.273)	0.93
Bulgaria	Clayton	0.132 (0.039)***	0.282 (0.121)**	0.84
Romania	Survival Joe	0.154 (0.051)***	0.443 (0.135)***	0.77
Africa				
Egypt	Student t	0.323 (0.000)***	0.676 (0.000)***	0.32
Morocco	Student t	0.316 (0.000)***	0.683 (0.000)***	0.62
S. Africa	Student t	0.352 (0.000)***	0.647 (0.000)***	0.90

Note: ***, **, and * indicate the rejection of the null hypothesis at 1%, 5%, and 10% significance level, respectively. The parentheses () present the standard error.

Table 6: Estimation Results of the Contagion Effects on FDI Inflows

Country	Intercept	Con	Market	Open	Exchange	Inflation
Asia						
China	47.8966***	27.3981***	1.4054***	0.5352***	–2.5345***	–6.2671***
	(2.3337)	(6.0719)	(0.2358)	(0.1430)	(0.3717)	(0.9269)
India	24.2988***	–0.0812	–0.0458	–0.4067	–1.58714*	1.6995 ***
	(3.6717)	(0.0504)	(0.3184)	(0.4747)	(0.7991)	(0.5870)
Thailand	44.0835 ***	0.1058	0.4823	–1.4749	–1.3248	–2.8974
	(10.3601)	(0.0679)	(0.7788)	(1.2179)	(0.9216)	(2.0764)
Indonesia	–10.3543***	0.1001**	2.7301***	3.6133***	0.0848***	–0.5645
	(2.7889)	(0.0478)	(0.2060)	(0.4150)	(0.0303)	(0.3580)
Philippines	–32.0509***	–0.2634*	2.7494***	3.3267 ***	2.6952***	1.6920***
	(4.2242)	(0.1556)	(0.2571)	(0.7066)	(0.7187)	(0.5791)
North-South America						
Brazil	4.5929**	0.01162	1.65063***	0.6825*	0.0738	0.6051*
	(1.7508)	(0.0367)	(0.2210)	(0.3654)	(0.2456)	(0.3317)
Argentina	4.92522	0.0039	1.3913***	1.4619***	–0.0433	–
	(3.1835)	(0.0642)	(1.4619)	(0.3816)	(0.0507)	
Mexico	8.0997*	–0.2598	1.1028*	1.7958 ***	–0.1985	–0.2473
	(4.7013)	(0.1733)	(0.6500)	(0.4983)	(0.5190)	(0.6790)
Chile	26.4353***	–0.01145	2.0113**	–0.2790	–1.5464	–2.3929
	(9.3790)	(0.1991)	(0.9131)	(0.6867)	(0.9931)	(1.6139)

Table 6: (Continued)

Country	Intercept	Con	Market	Open	Exchange	Inflation
Colombia	11.9598***	30.2779***	1.1708***	1.08100**	0.5542**	–0.5518
	(3.1059)	(5.9089)	(0.2481)	(0.4494)	(0.2689)	(0.4257)
Europe						
Russia	12.4947	–12.1513	2.0262***	-0.1889	1.1611	–2.5495**
	(7.8272)	(15.9772)	(0.5975)	(1.2596)	(0.8049)	(0.9723)
Poland	31.7867***	–1.1871	2.1274*	1.9573	1.4304	–8.4945***
	(4.2156)	(3.7134)	(1.0755)	(1.2990)	(0.9216)	(2.2795)
Hungary	–51.0364***	4.7737	8.7629***	2.7821	3.3836***	–8.8221***
	(13.6049)	(10.7898)	(1.3764)	(2.8830)	(0.8232)	(1.5568)
Bulgaria	36.4182***	-1.6365*	2.4287 ***	0.7420	-1.4786***	–8.5831***
	(2.5381)	(0.9318)	(0.6393)	(0.6135)	(0.5229)	(1.0645)
Romania	30.7004***	0.6249	1.9022***	–2.5889***	2.2060***	–3.6472***
	(2.4439)	(0.7302)	(0.4359)	(0.9274)	(0.5663)	(1.1457)
Africa						
Egypt	27.0616***	–0.2259	–0.3392	–0.3107	1.1201	–0.6910
	(7.8332)	(0.1555)	(1.2160)	(0.8119)	(1.3721)	(1.4797)
Morocco	19.6167***	0.1116*	–0.4620	1.7675**	–0.4815	–0.1990
	(3.7017)	(0.0633)	(0.9497)	(0.7884)	(0.8894)	(2.2905)
S. Africa	–1.3022	–2.1402**	0.7009	3.4345***	–1.3155	1.2664
	(8.4250)	(0.7772)	(1.2144)	(0.9846)	(1.2135)	(1.5079)

Note: ***, **, and * indicate the rejection of the null hypothesis at 1%, 5%, and 10% significance level, respectively. The parentheses () present the standard error. In the case of Argentina, we exempted the inflation variable.

advantage of cheaper investment opportunities in financially constrained domestic markets. Consequently, there is an increase in foreign acquisitions in crisis-affected countries.

On the other hand, we also document negative and significant coefficients in some countries such as the Philippines, Bulgaria, and South Africa. This can imply that when the financial crisis spread to the rest of the world, both the owners of firms in developing countries and the potential foreign buyers in developed countries have been affected by the severe liquidity constraints. Inevitably, FDI inflows in some emerging economies decreased significantly during the crisis (Nunnenkamp & Spatz, 2002). Thus, it is expected that fire sale FDI may not be observed if the main source countries have been involved in the financial crisis.

Regarding the other control variables, their coefficients vary across countries, excluding the market size. Most of the literature has proved that FDI inflows are positively and significantly associated with host countries' market size and potential (Wheeler & Mody, 1992; Nunnenkamp & Spatz, 2002; Campos & Kinoshita, 2008). Explicitly, a positive coefficient indicates the more prominent market size for developing economies leads to an increase in FDI inflows. Some foreign investors are willing to seize the potential markets to establish the production of goods and services. On the other hand, the coefficients of the GDP growth variables in the African region were insignificant. This is consistent with Borensztein et al. (1998), whose study revealed that the productivity-enhancing benefits of FDI hold only when a sufficient absorptive capability for advanced technologies is available to the host countries.

For trade openness, we expect a positive relationship between trade openness and FDI inflows. Trade liberalization can benefit foreign investors, causing flexible trade barriers and trade restrictions imposed by host countries. Hence, the supply changes and policies from government institutes that lead to their economies' openness, the greater the likelihood of receiving a large total of FDI in terms of quantity and quality. Our coefficient results are mixed, but most of the countries have shown positive and significant results. Indonesia, the Philippines, and South Africa tend to have the advantage of international trade, attracting more FDI inflows. Tung and Thang (2020) also found a positive relationship between trade openness and FDI inflows in the African region as trade openness offers domestic companies the chance to enter a different and more sizable market. This corresponds to Cung (2020) that developing countries could maintain high economic growth rates by attracting FDI inflows and increasing exports of goods and services. However, we noticed the negative and significant only in Romania, since the maximal values of FDI net inflows were registered between 2004 and 2008, followed by a sharp decrease in 2009–2011 during the global financial crisis. Also, the E.U. integration proved to have importance for FDI inflows in some E.U. countries. The FDI inflows are supposed to rise after integration, while the host country is still at the early stages of development and then reduce and gradually replaced by portfolio investment as the country grows (Luca, 2009).

The exchange rate and inflation rate are also considered as macroeconomic factors, affecting FDI inflows since macroeconomic stability involves low inflation and stable currency. Most sample countries, especially in the European region, show negative and statistically significant coefficients for inflation. The negative relationship indicates that high and volatile inflation increases the uncertainty and leads to higher investment risk. At the same time, Froot and Stein (1991) explained that the unfavorable exchange rate coefficient causes internal financing to be cheaper than external financing, which is beneficial to host countries (China, India, and Bulgaria), resulting in a decrease in capital costs. Qamruzzaman et al. (2021) also found that continual FDI inflows lessen the volatility in the foreign exchange market. On the other hand, the positive relationship in other countries between exchange rate and FDI inflows suggests that the host currency's appreciation attracts the FDI inflows due to higher purchasing power of the domestic consumers and an increase in the real wealth of multinational firms, known as relative wealth channel.

5. Conclusions

In this study, we measure the tail dependence as a contagion effect using the real GDP growth between the U.S. and each developing country and investigate its relationship to FDI inflows. This paper covers 15 years (2005–2019), which includes the global financial crisis period. The results have shown some meaningful results for policymakers because developing countries are in great need of foreign capital, contributing to sustainable growth to their economies.

We use the correlation of the real GDP growth in each pair of countries, examined by four copula functions from the measurement of risk contagion. In most countries, we find that the dynamic tail coefficient of the U.S. economy and developing countries is high in some countries, especially in China, Hungary, and South Africa. However, at the regional level, we noticed that the European region has a higher average contagion risk than other regions. There was a specific contagion effect between the U.S. economy and developing countries, but the degree of effect in different markets varied at different times. When specific risk events occur in a rugged country like the U.S., changes in investor sentiment will impact other developing economies through capital movement. Besides, considering developing countries, the U.S.'s contagion effects can happen either positively or negatively in different countries.

Furthermore, we investigate the relationship between the contagion effects and FDI inflows in developing countries using a regression model, including controlling for market size, trade openness, exchange rate, and inflation. We find a significant and positive relationship between the contagion effects and FDI inflows in China, Indonesia, Columbia, and Morocco, which means an increase in contagion effect will encourage more FDI flows to those countries. In contrast, a significant and negative relation is founded in the Philippines, Bulgaria, and South Africa, leading to FDI flows affected by risk contagion in vice versa. We have evidence of other determinants on FDI inflows. The results are mixed in different countries. FDI inflows in most countries of this study are associated with large market size, high level of trade liberalization, low inflation, and stable currency.

This study contributes to the risk contagion literature by measuring the tail dependence between developed economies, the U.S., and developing economies in different regions. The empirical result confirms that the contagion effects from the U.S. to developing countries increased significantly, especially in the European region. However, the contagion effects can be both positively and negatively involved in FDI inflows for each of the given countries. These results can help government institutes and firms determine which countries can catch up with the advantages of the contagion effects or dampen their economies by changes in investors' sentiment. These analysis could also help policymakers cope with foreign investment to mobilize timely external liquidity of sufficient magnitude during the crisis period and significant implications for risk management.

Consequently, prudential policies and sound regulation are essential tools for risk awareness under uncertain circumstances and help both government and firms reach optimal decisions. Furthermore, this study can prove the usefulness of the copulas model in terms of investigating contagion. Finally, future studies should consider the different contexts of crisis or consider other economies, especially developed economies. Further research is interesting to explore the contagion effects of the COVID-19 pandemic to capital movement across countries.

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