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EXAMINATION OF THE RELATIONSHIP AMONG STOCK, GOLD AND FOREIGN EXCHANGE MARKETS: COPULA FUNCTIONS APPROACH

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Abstract: *The purpose of this study is to analyze the relationship among stock, gold and foreign exchange markets using copula functions for the period April 2005- January 2015. The results indicated that there is no tail dependence between the stock and gold markets returns and thus the performance of these two markets are independent of each other. Moreover, there is lower tail dependence between foreign exchange and stock markets. Therefore, an increase in stock market return results in a decrease in the return of the foreign exchange market.*

Classification JEL: *G10, C32*

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1. INTRODUCTION

Financial markets are the most essential markets in each country. The conditions of these markets strongly affect the real economy and are affected severely by the other parts, though not necessarily in short term. One of the most important components of financial markets is the stock exchange. The stock exchange is an official market for buying and selling the companies' shares under particular laws and regulations. One of the tasks that contribute to this market is to adjust the prices of stocks and to speed up transactions (Imarhiagbe, Samuel, 2010).

Tehran stock Exchange is one of the most important components of capital market in Iran. This is an official reference for investigation by holders of stagnant savings. Various measures are to be considered for analyzing the function of stock markets. The most important decision making factor for investors in the stock exchange, is the stock price index. Many factors affect this index. Some of these factors are economic such as economic depression and prosperity; and some are non-economic ones such as war and peace (Karimzadeh, 2006).

The world index of gold price and foreign exchange (dollar) price are part of the most affecting factors that influence on economy and politic in each country.

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The international price of gold as an important variable represents many of the international monetary and financial developments. On the other hand, the exchange rate as one of the most important cost factors in the performance of an economy plays a major role in the function of economy. The changes in foreign exchange prices through changes in the relative price of domestic goods compared to foreign goods makes changes in the competitiveness power of domestic products and increase or decrease in the amount of imports and exports and foreign exchange revenues. In other words, the exchange rate determines the size and composition of a country's international transactions. The impact on the general level of prices by changing the price of goods in the basket of goods (CPI) and cost of production (raw materials and imported inputs) as well as single-product economy dependent on oil revenues is another function of foreign exchange rate (Vartabyan Kashani, 2013).

In this study we try to evaluate the relationship between fluctuations of return in the stock, foreign exchange and gold markets using the statistical model of copula functions. These functions examine correlation between variables in their boundaries, and are able to analyze the non-linear relationships.

2. THEORETICAL BACKGROUND

In general, the first and the most factor affecting decision making by investors in the stock exchange, is the stock price index. Therefore, it's important to know the factors affecting the stock price (Karim Zadeh, 2006). Naturally, many factors are involved in the formation of information and ideas about both sides of the market and ultimately affect the price of companies' stocks. Some of these factors are internal and others are due to the variables outside of the domestic economy. Accordingly, the factors affecting the stock price are classified into internal factors and external factors.

Internal factors include the factors affecting the price of shares in connection with the operation and the decisions of the company. These factors include the earnings per share (EPS), dividend per share (DPS), the ratio of price to earnings (P/E), the increase in capital stock splits and other corporate factors.

External factors, including factors outside the company's management authority, to maintain that affect company location. The causes of those events, events outside the company's decisions and affects the stock price. In general, these factors are divided into two categories (Pira'ee and Shahsavar, 2009).

Political factors such as war, peace, political and economic relations with other countries, the political foundations and the rise of rival political parties. Political factors affecting the stock price index is derived from the Behanot's theory. He believes that the intervention of the government is effective and efficient in unusual stock price index during the period of government intervention depends more on

the activities of government intervention in the stock exchange; and this information is more consistent with the impact of information pressure rather than the impact of price pressure. Maintaining state ownership has a positive impact on the stock price performance (Pakdayn Amiri *et al*., 2008).

The economic factors that affects severely the boom and the of the stock market so that in the period of economic growth by increasing investment in the shares of companies will increase with the growth of share prices and the recession reduced the companies stock price, because in this situation investment in financial assets with fixed income investors is preferred to investment in ordinary shares (Adjasi, C. *et al*., 2008).

2.1. The effects of gold price on the stock market

The gold price reflects the interaction of supply and demand in a market where many buyers and sellers are present relatively free to access of information. Since the price of gold is a good indicator to explain inflationary pressures, so the price of gold during the exchange market turmoil or political instability rising inflation stems. This shows the tendency of individuals to choose the type of assets in their portfolios to maintain its value.

However, the motivation of speculation in the gold market is also one of the reasons that affect the demand for gold and very short-term fluctuations in the market price are due to this type of demand, so the gold market alongside other asset markets could affect the stock market index (Eslamlou Bayan and Zare, 2006). On the other hand, according tothe portfolio theory, the gold price could affect the stock price index. The portfolio is the financial good of investors with several combinations of diversified financial holding stems. Investors are looking to keep the optimum combination of financial goods in their portfolio, and they can choose the right combination to achieve the expected revenues (KarimZadeh, 2006).

2.2. The effects of exchange rate on the stock market

Mutual influence of money and capital markets can be accomplished through different ways. Some are:

2.2.1. Net foreign assets

The increase or decrease in net foreign assets affects money and capital market of countries. This effect increases the foreign assets by foreign debt and exports, and leads to a reduction of reserves through imports. In the first case, the growth of foreign exchange will reserves increases the monetary base but also will balance supply and demand for the foreign exchange.

2.2.2. Input and output flows

Although many developing and emerging economies effort in order to guide the flow of capital into the country, and in particular, to attract foreign direct investment or formation of portfolio, but at the same time, these flows can destabilize the market when the country is facing economic problems.

2.2.3. Instability of stock index

Creating the price bubbles on the stock exchange which are caused by the sudden collapse of stock prices, money and capital markets experience sharp fluctuations and volatility in other sections of the economy, including the foreign exchange market spread. This situation is particularly true in countries or global stock market in which the stock market is linked with other regional or global stock markets. However, careful control of listed companies and non-profit real estate prevent and spin and so is the stability of the exchange (Mojarrad, 2004).

3. RESEARCH METHODOLOGY AND DATA

3.1. Research methodology

We know that by a having common distribution, it is not difficult to have access to marginal distributions. But this is more complicated in the case of obtaining

a joint distribution and studying its properties when its marginal distributions are given. In order to build multivariate data variable when marginal distributions are given as single variety, different approaches have been presented. In this paper, we introduce for this case, a tool called the Coppola function.

3.2. Data

The data of this research are collected from the Statistics Center Website and also from the Central Bank of the Islamic Republic of Iran. The data (monthly data), refer to the period 2005-January 2015.

Since the aim of this study is to study the relationship between the return of financial markets (stock markets, gold and foreign exchange) using the approach of the copula functions, variables used in this article are: monthly-data of stock price index, the foreign exchange price and the gold price.

3.3. Copula function

The Copula approach has been proposed for dependency analysis of time series (Embrechts, Mcneil, and Straumann, 2002). The copula method is based on a non-linear mapping. Copula function was introduced for the first time by Sklar (1959) in the case of functions that link univariate distributions to the multivariate

distributions. In other words, joint function, is a cumulative distribution is multivariate whose marginal distributions are distributed identically over the interval [0,1]. Now we present Sklar's theorem in the case of two-variables (Tae-Hwy Lee *et al.*, 2013).

3.3.1. Sklar's Theorem

Suppose that $F_{x,y}$ is a distribution function with margins F_x and F_y, in this case, for each x, y in R there is the copula function C, so that $F_{x,y}(x, y) = C(F_x(x), F_y(y))$.

According to the Sklar's theorem, the copula function could make the possibility that marginal distribution and correlation relationship are formulated for the multivariate stochastic variable. In addition, other important properties of copula function are to allow modeling dependencies between variables in extreme values, in other words, in their tail dependence.

3.3.2. Tail dependence

The overall dependency structure shows linear correlation and can be expressed based on the combined coefficient distribution function of *F*. While sometimes we are interested to study the position, which is particularly important in the economic-financial data. In this case, we use a form of dependence that is known as the tail dependence. In fact, the tail dependence measures the dependency between variables on a high-fourth (quarter) on the right and the bottom one-fourth (quarter) on the left side on $I^2 = [0, 1]^2$. The tail dependence describes the dependency relationship between large amounts (small) of a variable with large amounts of (small) of another variable that are defined as upper (lower) tail dependence.

Consider that $X = (X_1, X_2)^T$ is a two-dimensional random vector, so *X* have a high dependence on the sequence when:

$$\lambda_U = \lim_{u \to 1} P[X_1 > F_1^{(-1)}(u_1) \mid X_1 > F_1^{(-1)}(u_1)]$$

Where F_i^{-1} is the reverse cumulative distribution function for X_1. As a result, if $\lambda_U = 0$, *X* is not depended to the upper tail. In addition, $X = (X_1, X_2)^T$ have low dependence on the trail when:

$$\lambda_L = \lim_{u \to 1} P[X_1 \leq F_i^{(-1)}(u_1) \mid X_1 \leq F_i^{(-1)}(u_1)]$$

3.3.3. Normal Copula

Song (2000) describes the distribution function of Copula normal family function in the equation below:

$$C^{Ga}(u_1, u_1; \rho) = \psi_\rho(\psi^{-1}(u_1), \psi^{-1}(u_1))$$

Where ψ_p is the standard normal distribution bivariate with the correlation coefficient $\rho \in (0, 1)$.

The normal joint function shows tail dependence.

3.3.4. Archimedes Copula

Archimedes copula is an important type of copula functions having a simple structure and different analysis specification s.

The bivariate Archimedes copula is as follow:

$$C(u_1, u_1) = \varphi^{[-1]}\{\varphi(u_1) + \varphi(u_1)\}$$

That is continuously highly productive and has the generative function $\varphi : [0,1] \to [0, \infty]$ so that $\varphi(1) = 0$ is a function decline and reverse of $\varphi^{[-1]}$ as the equation below:

$$\varphi^{[-1]}(t) = \begin{cases} \varphi^{-1}(t) & \cdot \le t \le \varphi(\cdot) \\ \cdot & \varphi(\cdot) \le t \le \infty \end{cases}$$

φ is strong when $\varphi(0) = \infty$. It is worth noting that the one-sided derivatives of exist and is a convex function. In particular, and mean one-way derivatives on the border of the dimension of.

Three types of Archimedes copula are commonly used: Clayton Copula (Clayton, 1978), Frank Copula (Frank, 1979), and Gamble Copula (Gamble, 1960), which will be discussed n below:

Clayton Coppola

This copula function has an asymmetric distribution, so that negative tail dependence is more than the positive tail dependence.

$$C_C(u_1, u_1) = \max[(u_1^{-\theta} + u_1^{-\theta} - 1]$$

Which the generating function is as follows:

$$\varphi(t) = \theta^{-1}(t^{-\theta} - 1), \quad where \ \ \theta \in [-1, +\infty)$$

in which the dependence on the top tail is $\lambda_{uc} = 0$ and the dependence on the bottom tail is $\lambda_{lc} = 2^{-\theta^{-1}}$.

Gamble Copula

This type of function as well as Clayton Copula has an asymmetric distribution. But unlike Clayton Copula, the dependence on the positive tail is more than the dependence on the negative tail.

$$C_G(u_1,u_1)=\exp(-[(-\ln(u_1))^{\theta}+(-\ln(u_1))^{\theta}]^{\theta^{-1}})$$

This function Coppola has a generating function as follows:

$$\varphi(t)=(-\ln(t))^{\theta},\quad \theta\geq 1$$

Therefore, in Gamble Coppola function, the dependence on the top tail is $\lambda_{u_G}=2-2^{-\theta}$ and the dependence on the bottom tail is .

Frank Copula

This type of Copula function illustrates a symmetric mode of Archimedes Copula as the following equation:

$$C_F(u_1,u_1)=\frac{1}{\theta}\ln\left(1+\frac{(e^{-\theta u}-1)(e^{-\theta u_t}-1)}{e^{-\theta}-1}\right)$$

with the generating function:

$$\varphi(t)=-\ln\left(\frac{e^{-\theta t}-1}{e^{-\theta}-1}\right),\quad \theta\neq 1$$

Due to the symmetry of the Frank Copula in this function depends on the top tail $\lambda_{u_F}=0$ and the dependence on the down tail will be $\lambda_{l_F}=0$.

4. DATA ANALYSIS

As mentioned above, the tail dependence is a measure to study the extent to variables in their extreme pathways. The use of copula functions that they show tail dependence. Since the aim of this study is to evaluate the relationship among foreign exchange (USD) return, gold and the stock markets, and especially to assess the extent extreme pathways changes, we apply the copula functions that show as well tail dependence.

First we calculate the correlation between the stock market and other variables tail for four copula functions that show the tail dependence. The results are shown in Table 1. Now we select the appropriate joint function based on maximum likelihood criterion for each pair of variables.

Table 1
The results of estimated copula functions

		Copula Functions			
Variables	*Characteristics*	*Clayton*	*Gamble*	*Frank*	*Normal*
Stock-Gold	Parameter	1.014	-0.074	0.031	0.052
	Log likelihood	-17.75	-17.833	-17.87	0.16
Stock-USD	Parameter	-0.25	1.006	-0.74	0.7
	Log likelihood	4.80	1.82	2.62	0.14

According to Table 1, for stock and gold relationship, normal copula with maximum likelihood function (0.16), has the best performance among other functions. Since normal copula shows tail dependence, we can conclude that there is no correlation between stock market return and gold return. Thus, when the stock market returns have been increased, gold market returns have not been increased and vice versa. This means that when stock index has been fallen and the stock market return has been decreased, the return of gold market has not been decreased.

Regarding the criterion of maximum likelihood, to study the tail dependence between the stock market return and dollar return, the Clayton copula function (log likelihood 4.80) is chosen. Since Clayton copula function indicates a lower tail dependence and upper tail independence, then increase in the stock market return results in decrease in foreign exchange market return. This means that the foreign exchange market reaction is negative to the stock market and the growth of stock indices could lead to a drop in foreign exchange (dollar) market.

CONCLUSION

The examination of relationship among stock, gold and foreign exchange markets is of special importance. This study used the copula functions to do so because these functions are able to formulate such dependency in non-linear form. The results indicated that normal copula has the best performance among other functions. It means that there is no correlation between stock market return and gold return. Thus, when the stock market returns have been increased, gold market returns have not been increased and vice versa. To study the tail dependence between the stock market return and dollar return, the Clayton copula function was chosen. Since Clayton copula function indicates a lower tail dependence and upper tail independence, then increase in the stock market return results in decrease in foreign exchange market return.

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