



The cross-impact between financial markets, Covid-19 pandemic, and economic sanctions: The case of Iran

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Abstract

The main financial markets in the Iranian Economy include the stock exchange, foreign exchange, oil, and gold markets. The sharp fluctuations in these markets, especially those caused by the severe sanctions imposed on Iran in May 2018, and the pandemic outbreak of Covid-19 have led to more confusion and uncertainty among investors. One of the effective approaches to examine such unstable conditions is to study the co-movement(s) between markets to identify the leading variable(s). Thus, in the present study, Wavelet Coherence Analysis was applied to examine the co-movements between markets in a time period from September 2014 to June 2020, as an intense period of uncertainty in Iran. In other words, in this study, the markets were investigated in different sub-periods. Also, the Segmented Regression was performed to estimate the impact of sanctions and the Covid-19 pandemic on the co-movements of financial markets in Iran.

The results showed that the oil price had a low co-movement with the other three markets, i.e. stock exchange, exchange rate, and gold markets. Thus, the oil market can be a suitable alternative for risk aversion investors. Meanwhile, the oil market could also act as a source of finance for the government during the sanctions period. That possibly explains the recent decision by the Iranian government to use the oil market to finance its budget deficit. Between the exchange rate and gold price, the gold price was identified as the leading variable. While the exchange rate and gold price did not show a significant co-movement in stable conditions, they did show a significant co-movement in unstable conditions, as in times of sanctions

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or during a global pandemic and thus influenced the investors' portfolio risk. This result is important from a policy-making perspective. Based on this result, the policymakers can, especially during crises and unstable conditions, control the gold market and make it more stable by managing the foreign exchange market.

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1. Introduction

Financial markets in a closed economy, such as that of Iran, experience different conditions compared to the world's major financial markets. Iran has been under constant economic pressure due to various economic sanctions since 1980 and thereafter has experienced continued economic policy shifts, especially in the area of financial market policy. All of these factors have led to a shallow capital market, resulting in a situation where the financial markets, particularly the stock market, do not have a logical relationship with the other sectors of the economy and the rest of the world financial markets.

In recent years, the Iranian economy has experienced unprecedented challenges and tremendous pressure due to severe economic sanctions imposed by the United States and other international organizations. Furthermore, due to the limited access to oil revenues following the imposition of severe sanctions, especially those imposed during the presidency of Donald Trump, the increase in spending due to the recession caused by the sanctions, and the recent Covid-19 pandemic, the Iranian government has faced a significant budget deficit. Economic policy-makers have listened to economists and tried not to monetize this deficit. As a result of all the above-mentioned factors and the inefficiency of the policies adopted, macroeconomic indicators have been negatively affected. High inflation, high inflation expectations, rampant unemployment, deepening recession, and the increasing devaluation of the national currency clearly show the fragile state of the economy.

The increasing and unprecedented devaluation of Iran's national currency and the absence of a coherent policy to preserve the value of people's assets have led people to engage in unproductive activities, such as buying and selling currency, gold, and land. In an effort to discourage people from doing such activities, the Iranian economic policymakers encouraged people to invest in the stock market. Although this policy was first implemented during Ahmadinejad's presidency in the form of granting 'shares of justice' to the public, the Rouhani's government, following the tightening of sanctions preventing Iran from selling oil on international markets, has introduced a wave of policies to support markets, including the stock market, energy market, and, to some extent, gold market, as to reduce liquidity. This has caused people to invest in financial markets, especially the stock market, to maintain the value of their assets. Currently, more than 60% of Iranians (near 50 million people) are active in the Tehran Stock Exchange.

Iran's domestic financial markets include the stock market, gold market, and the foreign exchange market (mainly US dollars). Another financial market that has been introduced in Iran since 2012 is the Energy Exchange market. In this market, it is possible to sell both physical oil

and oil derivatives. All these four markets are always influenced by factors such as political news, economic sanctions, and the policies adopted by the Iranian government and central bank.

Another important point is that the measures introduced by policy-makers in Iran during economic crises have contributed to fluctuations in these markets, leaving investors in great confusion. Covid-19 pandemic is one of the most important recent events that has had a direct impact on economies around the world. With the growing spread of this pandemic and the increase in the number of cases, its negative effects on the world economy are gradually becoming more apparent. In this regard, [Sansa \(2020\)](#) found a significant relationship between the number of patients with Covid-19 and the Shanghai Stock Exchange Index and the New York Dow Jones.

Now, the question that begs to be answered is whether the financial markets in Iran can be a safer place to invest than other markets and whether they can attract investors. This issue has attracted more attention since the economic sanctions were tightened in 2018, forcing individuals to look for a suitable market to maintain the value of their assets. In addition, Covid-19 pandemic has made the situation more difficult for investors.

Investors can avoid huge losses by diversifying their portfolios. Diversification should not be done with assets that have similar moves because the accumulation of these assets can make a profit or loss ([Markowitz, 1952](#)). An understanding of the co-movement of financial markets can provide investors with a great deal of information to be able to determine the optimal investment portfolio ([Akar, 2011](#)).

An important point is that the co-movements between financial markets do not always happen in the same way. In other words, two markets that may move together at the present may move in opposite directions later. Therefore, it would be essential for all investors to have an accurate prediction of the movements of markets toward and against each other. Indeed, a stable and safe market, in which less movement takes place in comparison to other markets, can be a financially safe choice for an investor, especially in the event of unanticipated and sudden shocks in the economy. Therefore, studying financial markets and encouraging investors to have a lower-risk portfolio have become particularly important in the current context of the Iranian economy. The main question is how policymakers can help investors in the Iranian financial markets in these exceptionally difficult circumstances.

Investigating the co-movement of financial markets with each other can partially answer this question. In fact, understanding that co-movement is valuable for investors, policy makers and portfolio managers ([Arfaoui & Rejeb, 2017](#)). Therefore, the main purpose of this study was to examine the co-movements between four financial markets, i.e. the stock, oil, foreign exchange, and gold markets, in the Iranian economy from September 29, 2014 to June 4, 2020. This period was divided into four critical sub-periods: The pre-Joint Comprehensive Plan of Action (JCPOA) period, the post-JCPOA period, the withdrawal of the United States from the JCPOA and the return of sanctions, and finally the beginning of the Covid-19 pandemic.

In this study, we used Wavelet Coherence Analysis (WCA) to determine, first, how markets interacted with each other in the short-, medium-, and long-term periods and, secondly, which market was the leading market. Understanding the co-movements between different markets (variables) is important, but it is equally important to examine the impact of other factors, such as sanctions and a pandemic outbreak, on these co-movements. Accordingly, after calculating the co-movements of each pair of variables, the impacts of the imposition of new sanctions in 2018 and the onset of the Covid-19 outbreak on the co-movements of variables in the financial markets of Iran were investigated using segmented regression.

There are a few studies that have used WCA to study the co-movement of financial markets (e.g., [Ftiti, Guesmi, & Abid, 2016](#); [Mensi, Hkiri, Al-Yahyaee, & Kang, 2018](#); [Huang, An, Huang, & Jia,](#)

2018; Gourène & Mendy, 2018; Khochiany, 2018; Pal & Mitra, 2019; Amalia & Purqon, 2019). In Iran, only two studies have investigated this topic (Khochiany, 2018; Nademi & Khochiany, 2017). The present study differs from the existing studies in the following three ways. First, the interaction between the energy exchange market and other assets in Iran, as a developing country, was studied, which was not done in any of the previous studies related to Iran. Secondly, the movements of financial markets were examined separately for different sub-periods (time scales). Thirdly, the impact of sanctions and the Covid-19 pandemic on these co-movements were examined as well. These two factors have not been studied in any of the available studies in the literature.

By showing the beginning of the movement of a market, the results of the present study can help both investors and policy-makers predict which markets will co-move in different time periods and in what direction and whether their co-movement will affect a third market. The policy-makers can also use this analysis to determine which market is causing the fluctuations observed in another market and what can be done to stabilize the second market. These two latter points are important because, in order to reduce liquidity, inflation, and the budget deficit, investors should move towards the markets which are safer for investment.

The remainder of this article is organized as follows. The second section provides some factual information about financial markets in Iran. In the third section, the related literature is reviewed. The fourth section is devoted to the research methodology. Empirical results and discussion are presented in Section 5. The last section offers some concluding remarks.

2. Financial markets in Iran

The markets studied in this study included foreign exchange, gold, stock, and oil markets. Of these, three markets, i.e. the foreign exchange, gold, and stock markets, are affected by both global events and domestic policies. However, the oil market is affected by a wide range of global events and follows a very different trend from other domestic financial markets in Iran. During September 29, 2014 to June 4, 2020, there were considerable fluctuations in this market. The biggest drop in oil prices occurred with the onset of the Covid-19 outbreak, which triggered a global recession and consequently a decline in oil demand. However, this did not last long because of the reduced crude oil production by OPEC, increased crude oil imports by China, and promising preliminary results on the development of a coronavirus vaccine.¹

For a more detailed analysis of the co-movements between financial markets in Iran, the time period was divided into four sub-periods, namely, the pre- JCPOA period (before July 2015), the post-JCPOA period (from July 2015 to May 2018), the US withdrawal from the JCPOA and the return of sanctions (from May 2018 to June 2020), and the beginning of the Covid-19 outbreak (from February 2020 to June 2020). Fig. 1 shows the percentage of changes observed in the variables considered in this study during these four sub-periods.

2.1. The pre- JCPOA period

Economic sanctions against Iran began in 1980 after the Islamic Revolution and following the occupation of the US embassy in Iran. These sanctions, imposed by the United Nations, the

¹ U. S. Energy Information Administration.



Fig. 1. Changes of exchange rate, gold, oil and stock price in Iran (2014–2020).

Source: Research finding.

European Union, and the United States, entered a new phase when Iran insisted on developing its nuclear program in 2006 and have gradually expanded over the years.

From 2006 to 2012, during Ahmadinejad's presidency, financial market volatility increased with increasing tensions between Iran and the rest of the world, especially with the escalation of the dispute over Iran's nuclear program. The impact of sanctions on the Iranian economy was clearly evident during this period, especially in 2012. In 2012, due to the sharp decline in oil revenues following the trade and financial sanctions and the formation of high inflation expectations, the foreign exchange (mostly dollar) and gold markets fluctuated widely and prices rose sharply (Nademi & Khochiany, 2017). With the increase in speculative activity, the value of transactions in the stock market also increased by 70% compared to the previous year.²

From 2013 to July 2015, during the incumbency of Rouhani, the prospect of reaching a global agreement and the easing of sanctions brought relative stability to financial markets.

2.2. The post-JCPOA period

From mid-2014, shortly before the JCPOA agreement, the entire Iranian economy, especially the financial markets, experienced relative stability (Fig. 1, 2015–2018). The reason for this period of relative stability can be attributed to the positive outcomes of an initial nuclear agreement between Iran and the world powers and a higher degree of optimistic expectations resulting from the continuation of nuclear talks.

After the JCPOA, the release of some Iranian frozen assets blocked in foreign countries allowed the central bank of Iran to intervene more actively in the foreign exchange market and be able to stabilize this market. In fact, Iran's foreign exchange policy has turned into the managed floating policy. Therefore, under normal economic conditions, when the dollar reserves held in the central bank are sufficient, the central bank of Iran intervenes in the market and creates stability if necessary.

The price of gold in Iran is a function of two variables, the foreign exchange market and the world price of gold. More specifically, when the foreign exchange rate is stable, the price of gold coins in Iran will be a direct function of the world price of gold. After the JCPOA, the price of gold coins in Iran was relatively stable and fluctuated only slightly thanks to the stability in the US dollar-Rial exchange rate and the decline in the global price of gold.

The stock market was also influenced by the JCPOA. The total market index and investment in the banking sector and the oil industry grew during the post-JCPOA period. However, some other influential industries, such as the petrochemical and automotive industries, did not change. Overall, the stock market fluctuations were mild during this period.

2.3. The US withdrawal from the JCPOA and the re-imposition of sanctions

In late 2016, with Donald Trump winning the presidential election and the increased likelihood of the United States pulling out of the JCPOA agreement, the relative stability which characterized the financial markets in the previous period was shattered and the foreign exchange market started to follow a very gentle upward trend. This change in the foreign exchange market was gradually reflected in the changes in the gold market. Since early 2018, both the foreign exchange and gold

² Central Bank of Iran Reports.

markets have experienced rapid growth, although slightly declining in some periods due to the policies introduced by the central bank.

The stock market also benefited from this growth. The fluctuations in this market increased a month after the withdrawal of the United States from the JCPOA agreement, but in most cases, investment in the stock market had a positive return. Overall, despite their ups and downs, all of these three markets, namely, the foreign exchange, stock, and gold markets, went through a similar process. One of the reasons for continued growth in these markets in Iran, especially during the beginning of the sanctions, was that people rushed to these markets to maintain the value of their assets, which led to increased speculative demand in these three markets.

A closer examination of the Iranian financial markets, especially in times of crisis (e.g., since May 2018), revealed that financial markets were influenced not only by external shocks (economic sanctions and the Covid-19 outbreak) and the investors' excitement but also strongly by the measures taken by policy-makers.

In fact, the results of the analyses showed that the co-movement of financial markets in Iran was directly influenced by the political and economic decisions made by the Iranian policy-makers. Any hasty and ill-informed decision by the policy-makers led to sharp fluctuations in the markets. The main policies adopted by the Iranian government with the onset of the economic crisis (re-imposition of sanctions in 2018) were as follows:

- 1 Implementing a single exchange rate policy (Rouhani's government tried to stabilize the market at an exchange rate of 42,000 Rials to one US dollar. A policy that failed in practice for a variety of reasons, including the generally rent-seeking structure of the Iranian economy. This policy resulted in massive rents, the loss of foreign exchange reserves, the outflow of foreign currency, and the formation of a parallel exchange market for foreign currency);
- 2 Starting the presale of gold coins and issuing bond certificates for the presale of gold coins;
- 3 Changing the governor of the central bank;
- 4 Reducing interest rates;
- 5 Raising petrol prices;
- 6 Launching open market operations, selling bonds to compensate for the budget deficit, and increasing interest rates on bonds;
- 7 Supporting the stock market, liberalizing the 'shares of justice' for sale by individuals in the stock market, and selling the government shares in banks, insurance companies, and refineries in the form of exchange-traded and mutual funds.

Nevertheless, other policies, such as cracking down on economic disruptors, who were accused of exploiting the foreign exchange and gold markets, created temporary stability in the financial markets. Overall, the policies pursued since the onset of the crisis were found to be highly volatile and simplistic, leading to sharp fluctuations in financial markets. The inability of policymakers to curb fluctuations resulted in a growing expectation that the financial market prices would continue to increase. Later, the change of the governor of the central bank and the implementation of some policies, such as recognizing the informal/black foreign exchange market and moving the Iranian foreign exchange offices from the UAE to Iraq and Afghanistan, created some stability in the financial markets, but the stock market fluctuations gradually began to increase as the risk of investment in the exchange and gold markets increased sharply. Meanwhile, the reduction in interest rates on bank deposits and government support for the stock market increased investors' attention to the stock market.

In brief, it can be stated that the financial markets faced considerable fluctuations during this period.

2.4. The beginning of the Covid-19 pandemic

With the outbreak of Covid-19 and further intensification of the recession, the foreign exchange, gold, and stock markets initially experienced a slight decline but then followed an upward trend. As Fig. 1 shows, the fluctuations in the foreign exchange and gold markets before February 2020 were not much different from those after February 2020; however, the total stock market index reached its highest level since the foundation of the Tehran Stock Exchange and experienced significant growth. Although this situation was not very stable and the stock market went through many fluctuations, the fact that the stock market reached its peak during this period of global economic uncertainty is particularly thought-provoking since during this period, due to the fall in oil demand and prices, Iran could hardly even sell oil below world prices and the oil revenues fell sharply.

In addition, with the closure of many businesses following the Covid-19 outbreak, the government tax revenues dropped steeply. Moreover, the increase in both health expenditures and livelihood assistance to the people most affected by the outbreak led to a more severe budget deficit. This sequence of events led to the formation of high inflation expectations among the people. Thus, encouraged by the government's protectionist policies in the stock market, the people rushed to invest in the stock market more enthusiastically than before, hoping to make a profit and maintain the value of their assets. The influx of small investors into the stock market and the sharp increase in the total market index created a very fragile condition.

3. Literature review

In the last decade, the study of financial markets has been a major topic of economic research. Many studies have been done in this regard. The study of co-movement of financial markets is one of the branches of applied research in these markets and has recently attracted a lot of attention.

Table 1, shows related research by more details. These studies can be categorized into three groups: Global or domestic markets, method of analysis, and bilateral or multilateral co-movements.

In some studies, the co-movement of the financial market is analyzed in a particular country (e.g., Aggarwal, 1981; Kim, 2003; Gilmore, Mcmanus, Sharma, & Tezel, 2009; Mishra, Das, & Mishra, 2010; Zhao, 2010; Akar, 2011; Hussin, Muhammad, Hussin, & Razak, 2012; Baig, Shahbaz, Imran, Jabbar, & Ain, 2013; Fallahi, Panahi, & Karimi Kandoleh, 2018; Amiri & Falahi, 2015; Nademi & Khochiany, 2017; Huang et al., 2018; Khochiany, 2018; Amalia & Purqon, 2019). However, in some other studies, several countries are being studied. Of course, this type of studies have been done in two ways: Some researchers have studied the co-movement of financial markets using either global or some specific countries data (e.g., Nieh & Lee, 2001; Samanta & Zadeh, 2012; Ftiti et al., 2016; Arfaoui & Rejeb, 2017; Yarovaya & Lau, 2016; Mensi et al., 2018; Gourène & Mendy, 2018; Bhatiai & Mitra, 2018; El Abed & Zardoub, 2019; Pal & Mitra, 2019). Others have examined the co-movement of a financial variable (for example, the stock market) in several countries) e.g., Chen, 2018; Abounoori & Tour, 2019).

In order to investigate the co-movement of financial variables, studies usually use either econometric or WCA techniques. The dominant econometric method used in these studies is the Dynamic Conditional Correlation- Generalized Autoregressive Conditional Heteroscedastic-

Table 1
Review of selected studies that have attempted to analyze co-movements between financial markets.

Authors	Method	Variables	Countries	Main result
Aggarwal (1981)	OLS	Stock, exchange rate	USA	Positive relationship
Nieh and Lee (2001)	VECM	Stock, exchange rate	G-7 countries	No relationship
Kim (2003)	VECM	Stock, exchange rate	USA	Negative relationship
Gilmore et al. (2009)	VECM	Gold, stock	USA	Long run relationship
Mishra et al. (2010)	VECM	Stock, gold	India	No Relation
Zhao (2010)	VAR-GARCH	Stock, exchange rate	China	Not a stable long-term equilibrium relationship
Akar (2011)	DCC-GARCH	Stock, gold, exchange rate	Turkey	Negative relationship
Hussin et al. (2012).	VAR	Oil price, exchange rate and Islamic stock	Malaysia	Positive relationship between oil price and Islamic stock
Samanta and Zadeh (2012)	VARMA	Oil, Gold, the US dollar, and stocks	World	Existence of co-movements
Baig et al. (2013)	VECM	Gold, oil, stock	Pakistan	No significant relationship
Fallahi et al. (2018)	DCC-GARCH	Stock, Gold, US Dollar	Iran	High correlation between gold and US dollar but low correlation between stock and two others
Amiri and Falahi (2015)	DCC-GARCH	Oil, gold, the US dollar	Iran	Time variation correlations for all pairs
Arfaoui and Rejeb (2017)	simultaneous equations system	Oil, gold, US dollar and stock market	World	Significant interactions between the all parties
Yarovaya and Lau (2016)	AG-DCC-GARCH	Stock market	UK, BRICS and MIST emerging markets	Conditional correlation among the stock markets exhibits higher dependency when it is driven by negative shocks to the market
Chen (2018)	Bayesian dynamic latent factor model	Stock market	developed and emerging markets	Relation between stock markets
Bhatiai and Mitra (2018)	GO-GARCH	Oil, stock market	G-7 and Brazil, Russia, India, China and South Africa	Dynamic correlation between crude oil and stock markets
El Abed and Zardoub (2019)	A-DCC-GARCH ^a	Gold, S&P500 index, weighted U.S. dollar index against major currencies	World	Substantial time variation correlations for all pairs
Abounoori and Tour (2019)	DCC-GARCH	Stock markets	Iran, USA, Turkey, and UAE	Relationship between stock market of Iran, Turkey, and UAE
Ftiti et al. (2016)	Wavelet coherence	Oil, Stock	G7 countries	Interdependence between oil price and the stock market is more pronounced in the short and medium terms

Table 1 (Continued)

Authors	Method	Variables	Countries	Main result
Nademi and Khochiany (2017)	Wavelet coherence	Stock, gold, US dollar	Iran	Negative correlation between stock and US dollar but positive correlation between gold, US dollar in short-run
Mensi et al. (2018)	Wavelet coherence	Oil, gold, stock	Brazil, Russia, India, China and South Africa	Stock co-move with the oil price but no co-movement between stock and gold
Huang et al. (2018)	Wavelet coherence	Oil, stock	China	The coherence of oil-stock nexuses is tremendously different in short time scale
Gourène and Mendy (2018)	Wavelet coherence	Oil, stock	South Africa, Egypt, Morocco, Nigeria, Kenya	Low co-movement
Khochiany (2018)	Wavelet coherence	Stock, US dollar	Iran	Negative correlation in long run
Pal and Mitra (2019)	Wavelet coherence	Oil, automobile stock	World	Co-movement between oil price and automobile stock
Amalia and Purqon (2019)	Wavelet coherence	Oil, stock	Indonesia	High co-movement between oil prices and stock of Adaro Energy Tbk

Source: Our own elaboration.

^a Asymmetric DCC-GARCH.

ity (DCC-GARCH) method (e.g., Akar, 2011; Amiri & Falahi, 2015; Yarovaya & Lau, 2016; El Abed & Zardoub, 2019; and Abounoori & Tour, 2019). Also, various other methods in econometrics have been used by researchers (e.g., Aggarwal, 1981; Nieh & Lee, 2001; Kim, 2003; Gilmore et al., 2009; Mishra et al., 2010; Zhao, 2010; Hussin et al., 2012; Samanta & Zadeh, 2012; Baig et al., 2013; Arfaoui & Rejeb, 2017; Chen, 2018; Bhatiai & Mitra, 2018). However, several studies, particularly in recent years, have used WCA method for the co-movement analysis of financial markets (e.g., Ftiti et al., 2016; Nademi & Khochiany, 2017; Mensi et al., 2018; Huang et al., 2018; Gourène & Mendy, 2018; Khochiany, 2018; Pal & Mitra, 2019; Amalia & Purqon, 2019).

On the other hand, some studies have examined the co-movement of a pair of stock-exchange rates (e.g., Aggarwal, 1981; Nieh & Lee, 2001; Kim, 2003; Zhao, 2010; Khochiany, 2018; El Abed & Zardoub, 2019), the co-movement of a pair of stock-gold price (e.g., Gilmore et al., 2009; Mishra et al., 2010), the co-movement of a pair of stock-oil price (e.g., Ftiti et al., 2016; Huang et al., 2018; Gourène & Mendy, 2018; Bhatiai & Mitra, 2018; Pal & Mitra, 2019; Amalia & Purqon, 2019), the co-movement of stock, the exchange rate, and gold prices (e.g., Akar, 2011; Fallahi et al., 2018; Nademi & Khochiany, 2017), the co-movement of stock, oil, and gold prices (e.g., Baig et al., 2013; Mensi et al., 2018), the co-movement of stock, the exchange rate, and oil prices (e.g., Hussin et al., 2012), the co-movement of exchange rate, gold, and oil prices (e.g., Amiri & Falahi, 2015), and the co-movement of the exchange rate, stock, gold, and oil prices (e.g., Samanta & Zadeh, 2012; Arfaoui & Rejeb, 2017).

Overall, it seems that only two studies have examined the co-movement between four variables, including the exchange rate, stock, gold, and oil prices. It should be noted that both of these studies have used global data and econometric methods. Nonetheless, in the present study, we examined the co-movement of oil prices with the exchange rate, stock, and gold prices at the country level and in a developing country (Iran). In addition, WCA methods were used in data analysis.

Accordingly, the contributions of the present study can be summarized as follows: First, the correlation between the energy exchange market in Iran and other assets was analyzed, which had not been done in any of the previous studies in Iran. Secondly, the co-movements between financial markets were studied not only for the whole period but also separately for different sub-periods. Thirdly, the impact of sanctions and the Covid-19 pandemic on the co-movements was examined.

4. Methodology

In this study, we sought to examine the co-movements between financial markets in Iran as well as the impact of important events, such as economic sanctions and the Covid-19 pandemic, on those co-movements.

In order to investigate the co-movement of financial markets, studies often use either DCC-GARCH or WCA techniques. [Vacha and Barunik \(2012\)](#) compared the results of these two methods by examining the co-movement of energy commodities. Since in their studies all variables were positively correlated, the mean correlation coefficients obtained from these two methods were close together. For the following two reasons, in this paper, we used the WCA method: The weakness of the DCC-GARCH method is that although it recognizes the time-varying correlation dynamics of the pair of variables, it is not able to show the significance of this correlation at any point in time. However, in the WCA method, through the Monte Carlo method, the areas with significant coherence can be identified. In the WCA method, unlike the DCC-GARCH method, it is possible to examine data coherence at different periods. Also, it specifies the leading variable.

Segmented regression was also used to examine the impact of two significant events, i.e. the re-imposition of sanctions in May 2018 and the outbreak of Covid-19 in February 2020, on the co-movement of financial markets in Iran. In what follows, these two methods are explained.

4.1. Wavelet coherence analysis

In the studies of financial markets co-movement, wavelet coherence is usually used ([Nademi & Khochiany, 2017](#); [Ftiti et al., 2016](#); [Mensi et al., 2018](#); [Huang et al., 2018](#); [Gourène & Mendy, 2018](#); [Khochiany, 2018](#); [Pal & Mitra, 2019](#); [Amalia & Purqon, 2019](#)). Wavelet is a zero mean function that is located in time and frequency. There are two types of wavelet transforms, the Continuous Wavelet Transform (CWT) and the Discrete Wavelet Transform (DWT). DWT is more useful for noise reduction and data compression while CWT is used for more types of analyses. In addition, many time series do not have a normal distribution and it is advisable to use CWT in their analysis ([Grinsted, Moore, & Jevrejeva, 2004](#)).

In wavelet analysis, Morlet wavelets are commonly used because they are easily located in time and frequency. This wavelet is defined as:

$$\psi_0(\eta) = \pi^{-1/4} e^{i\omega_0\eta} e^{-\eta^2/2} \quad (1)$$

where, ω_0 is dimensionless frequency and η is dimensionless time.

From the combination of the two CWTs, the Cross-Wavelet Transform (XWT) and a measure of Wavelet Coherence (WTC) are obtained. XWT can determine the common power and the relative phase in the time-frequency space while WTC can determine significant coherence between series, even if their common power is low. In WTC analysis, significant levels are calculated using the Monte Carlo method.

Based on Torrence and Webster (1999), wavelet coherence between two series of x_n and y_n is defined as (2):³

$$R_n^2(s) = \frac{|S(s^{-1}W_n^{XY}(s))|^2}{S(s^{-1}|W_n^X(s)|^2) \cdot S(s^{-1}|W_n^Y(s)|^2)} \quad (2)$$

where, W_n^{XY} is the Cross Wavelet Transform of x_n and y_n . S is smoothing operator.

In this article, this relationship was used and the necessary analyses were performed.

4.2. Segmented regression

Segmented regression is one of the methods used to analyze the changes in trend and obtain the estimates of the overall intercept. Segmented regression can be expressed as Eq. (3) (Wagner, Soumerai, Zhang, & Ross-Degnan, 2002):

$$Y_t = \beta_0 + \beta_1 * time + \beta_2 * intervention1 + \beta_3 * time after intervention1 + \beta_4 * intervention2 + \beta_5 * time after intervention2 + e_t \quad (3)$$

where, Y_t : is the time series related to the co-movement of each pair of financial variables.

The two variables *intervention 1* and *intervention 2* were used to indicate the occurrence of two events, i.e. sanctions and the onset of the Covid-19 outbreak. Therefore, each component of Eq. (3) can be defined as follows:

Intervention 1: is a variable that equals zero for the sub-periods before May 2018 and 1 for the sub-periods after May 2018;

Intervention 2: is a variable that equals zero for pre-Covid-19 outbreak sub-periods and 1 for post-Covid-19 outbreak sub-period;

β_0 : shows the initial level of the co-movement between a pair of variables at the beginning of a sub-period;

β_1 : indicates the changes in the co-movement of each pair of variables before May 2018;

β_2 : shows the new level of the co-movement of each pair of variables after May 2018;

β_3 : shows the changes in the co-movement of each pair of variables after May 2018;

β_4 : indicates the new level of the co-movement of each pair of variables at the onset of the Covid-9 outbreak;

β_5 : shows the changes in the co-movement of each pair of variables after the outbreak of the Covid-19 pandemic;

e_t : is the error term.

Eq. (3) can be estimated by the OLS method.

5. Empirical results

5.1. Data

In this study, gold prices, exchange rates (US dollar), Tehran Stock Exchange index, and OPEC oil prices were used. The data collected had high frequency (weekly) and covered a period

³ See Grinsted et al. (2004) for more details.

Table 2
Result of unit root test.

H_0 : data has a unit root	% Δ Exchange rate	% Δ Oil prices	% Δ Gold prices	% Δ stock prices
Test statistic (prop.)	-13.6 (0.00)	-9.18 (0.00)	-12.3 (0.00)	-5.52 (0.00)

Source: Calculated based on the data.

of time between September 29, 2014, and June 4, 2020. This period coincided with the eleventh government of the Islamic Republic of Iran during which important political and economic events occurred. This period consisted of one year before the JCPOA, the period of Post-JCPOA, the period of US withdrawal from JCPOA and the return of sanctions and begging Covid-19 epidemic. In this short period of time, due to the very important events, the financial markets of Iran fluctuated sharply and confused investors, as described in Section 2 this paper.

These data were collected from the portals of the Ministry of Industry, Mines, and Trade of Iran and the Tehran Stock Exchange (TSE). The function $y_t = 100 [\log(p_t) - \log(p_{t-1})]$ is used to calculate the return on variables. Before starting the data analysis, the stationary test was performed over time to ensure the stability of the statistical features (mean, variance, and covariance). For this purpose, the Augmented Dickey-Fuller (ADF) test was used. The results in Table 2 show that all the series were stationary at level.

5.2. Wavelet coherence results

Graphs in wavelet coherence analysis have three dimensions, time (horizontal axis), period (vertical axis), and the intensity of coherence (colors in the figure). The periods are 4, 8, 16, 32, 64, 128, 268 and 612 days. The yellow spots, surrounded by a black line, are areas that show high intensity and significant coherence. In each figure, there is a cone-shaped curve, meaning that the results shown outside this cone cannot be trusted. The relative phase relationship is shown as arrows, such that in-phase is pointing right and anti-phase is pointing left. If the direction of the arrows is right and down or left and up; then, the first variable is leading. If the direction of the arrows is right and up or left and down; then, the second variable is leading. Figs. 2–7 show the results of wavelet coherence analysis for the pairs of exchange rates, gold prices, stock prices, and oil prices.

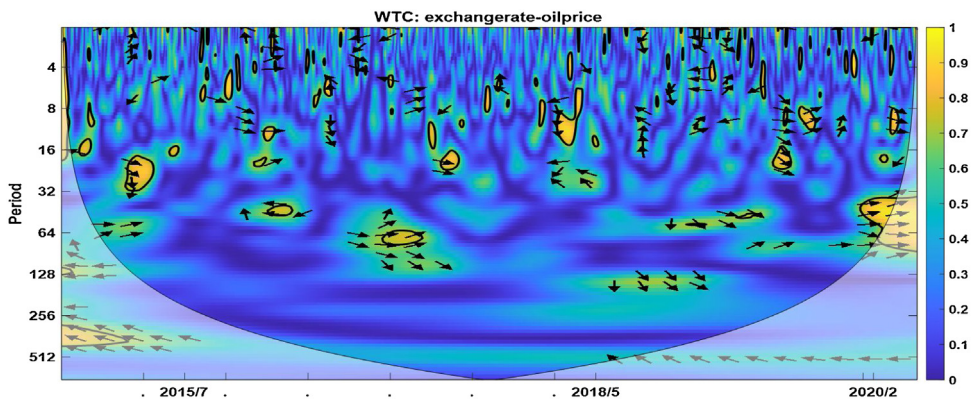


Fig. 2. Wavelet coherence of exchange rate and oil price.

Source: Research finding.

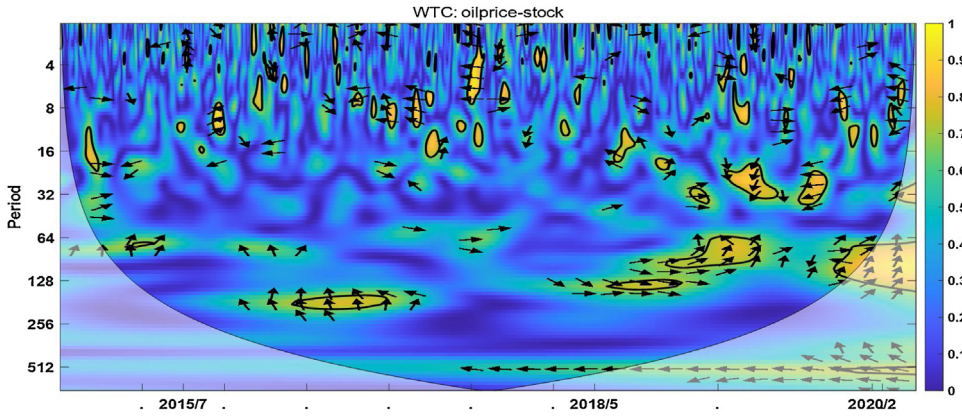


Fig. 3. Wavelet coherence of oil price and stock price.

Source: Research finding.

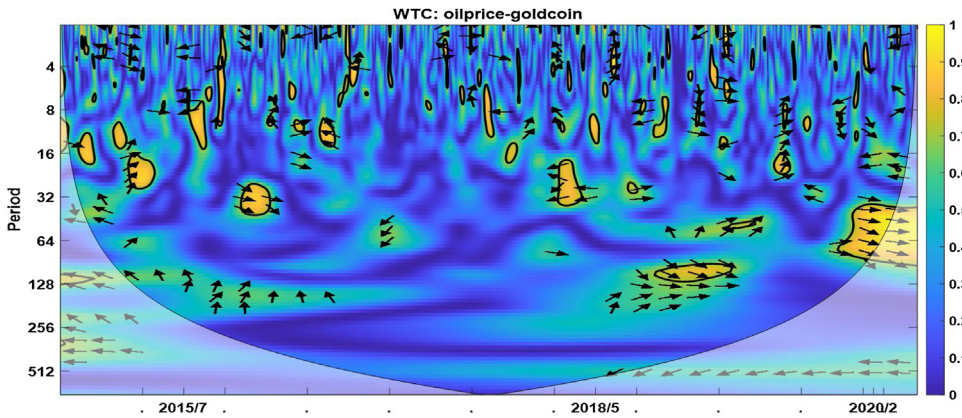


Fig. 4. Wavelet coherence of oil price and gold price.

Source: Research finding.

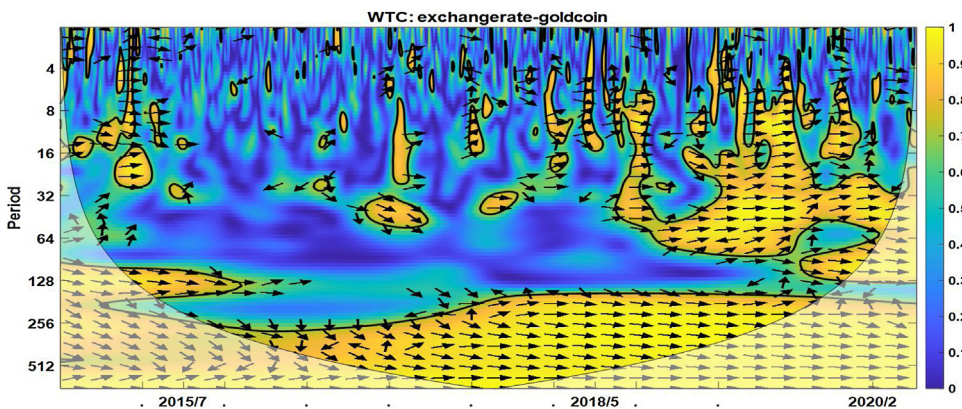


Fig. 5. Wavelet coherence of exchange rate and gold price.

Source: Research finding.

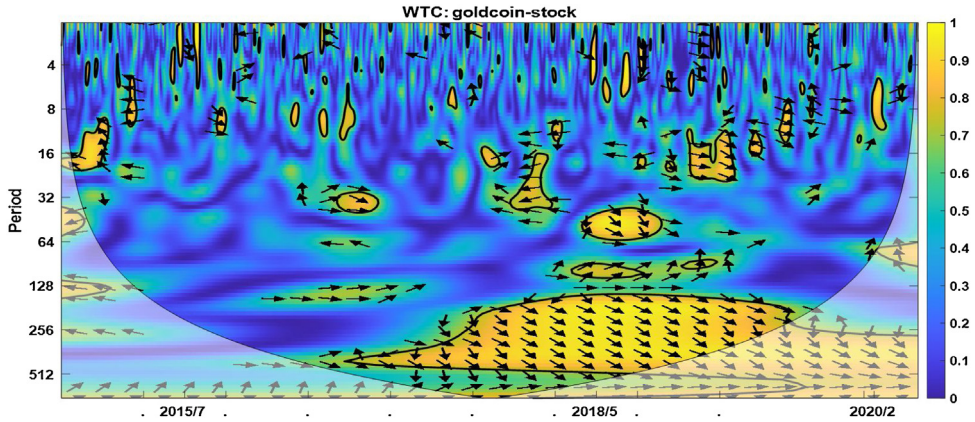


Fig. 6. Wavelet coherence of gold price and stock price. Source: Research finding.

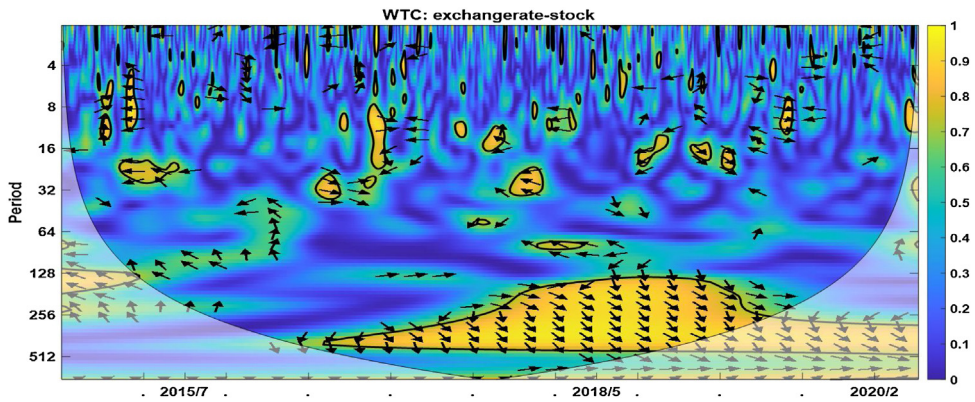


Fig. 7. Wavelet coherence of exchange rate and stock price. Source: Research finding.

Based on the results (Fig. 2), it can be stated that there was almost no significant co-movement between the oil prices and exchange rates. This result is similar to what was reported by Baig et al. (2013) in Pakistan and could be explained by the fact that during the pre-JCPOA period and after the US withdrawal from the JCPOA and the re-imposition of sanctions, Iran’s oil revenues were severely limited and the country was run almost without oil revenues. At a time when the sanctions were easing and the oil revenues increased, the central bank controlled the foreign exchange market in a way that it was not affected by global events. During the outbreak of the Covid-19 pandemic, because the Iranian economy was under sanctions, the sharp fluctuations in oil prices did not affect the foreign exchange rate.

Unlike the foreign exchange market, the stock market prices fluctuated in some cases with the volatility in oil prices, a result which is consistent with those reported by Huang et al. (2018) and Gourène and Mendy (2018). This co-movement between the stock market and oil market could be supported by the point that many companies listed on the Tehran Stock Exchange are export-oriented and their income is affected by the price of oil and petroleum products as well as the exchange rate.

Nonetheless, as Fig. 3 shows, the co-movements between oil prices and stock prices were sporadic and occurred over short periods of time. In fact, in Iran, the stock market is completely under the control of the government and is almost detached from the real sectors of the economy and unaffected by the global markets. For example, despite the relative stagnation in global stock markets and a recession in Iran during the period under study, small and large enterprises on the Tehran Stock Exchange were not affected significantly. During the same period, the stock market was very active and the total market index increased from 80,000 to about 2,000,000 units. Therefore, the price of oil cannot serve as a reliable guide for domestic investors who want to invest in the stock market.

Fig. 4 shows that although the price of gold in Iran was affected by the world price of gold and the foreign exchange rate, the world price of gold itself was affected by the world price of oil. However, there was a very limited co-movement between the price of gold and the price of oil in Iran. This result is consistent with those of Amiri and Falahi (2015). In general, the movement of oil prices in the Iranian economy cannot be used as a good indicator to determine the optimal investment portfolio. Nevertheless, due to its weak co-movement with the other three domestic markets, the stock market is the best offer for a risk-averse investor among the other three markets examined in this study.

The results of WCA for the pair of exchange rates and gold prices are shown in Fig. 5. It was observed that during stable economic conditions (post-JCPOA), due to the stability of the gold and foreign exchange markets, there was a positive correlation between these two variables only in the long term. However, in times of economic uncertainty (e.g., during the sanctions and the outbreak of the Covid-19 pandemic), there was a positive correlation between these two variables in the short, medium, and long term. The leading variable was found to be the exchange rate. This result is consistent with that of Nademi and Khochiany (2017), who also found a strong co-movement between the foreign exchange rate and gold prices from 2012 to 2013 (during the sanctions period), in which the exchange rate was the leading variable. To invest in these two markets, i.e. the foreign exchange and the gold markets, the investor must first evaluate the prevailing market conditions. Under normal circumstances, short- and medium-term investments can be made in both markets without having to worry about co-movements between the two variables. Nevertheless, in times of economic instability, investing in both markets at the same time expose investors' to great risk in the short, medium, and long term.

Due to the strong co-movement between the exchange rate and gold prices in the Iranian economy, as shown in Figs. 6 and 7, a similar coherence was observed between these two variables and the stock prices. In the pre- and post-JCPOA periods, the stock market was affected by the price of gold and foreign exchange rate in the short term, but this co-movement became stronger by the increase in the instability of the Iranian economy (return of sanctions).

There was a strong positive co-movement between the gold prices and foreign exchange rates, on the one hand, and the stock prices, on the other hand, in which the foreign exchange rate was the leading variable. This result is in agreement with what was reported by Gilmore et al. (2009). It is noteworthy that the degree of co-movement between these three variables also decreased sharply after a while. The government intervention in the foreign exchange and gold markets have inflicted significant losses on investors from time to time, but its support for the stock market and the steady increase in the total market index have attracted a large number of people, even those with little savings, to this market. Thus, when the stock market was negatively affected by the fluctuations in the foreign exchange and gold markets, the government started to support the stock market. Even after the outbreak of Covid-19, there was no significant co-movement between the foreign exchange and gold markets, on the one hand, and the stock market, on the

other hand. Therefore, it can be stated that the analysis of the co-movement of exchange rates and gold prices in the early stages of a crisis (after a period of stability) can provide the stock market investors with a sound basis for making investment decisions. However, as the crisis continues, the stock market will move away from the other two markets; and a co-movement analysis will not be helpful to investors interested in investing in the stock market.

A summary of the conclusions that can be drawn from Figs. 2–7 is given in Table 3. In general, it can be said that in the pre-JCPOA period (from September 2014 to July 2015), due to the formation of optimistic expectations about the potential positive outcomes of the JCPOA, the markets experienced a period of relative economic stability. During this period, in most cases, there was no co-movement or there were only short- and medium-term co-movements, which were inconsistent. In the post-JCPOA period, the volatility in one market did not spill over into another market rapidly.

However, with the re-imposition of sanctions and the outbreak of Covid-19, the negative changes in the investor sentiment quickly spread from one market to other markets. What is noteworthy is that the behavior of the stock market, unlike in the other three sub-periods (pre-JCPOA, post-JCPOA, and the withdrawal of the US from the JCPOA), was completely independent of the foreign exchange and gold markets in the fourth sub-period, i.e. after the outbreak of Covid-19.

5.3. Segmented regression results

After analyzing the co-movement of financial markets, in order to investigate the impact of significant events, such as economic sanctions and the outbreak of Covid-19, Eq. (3) was estimated by the OLS method. The coefficients β_0 to β_5 for all the time series (sub-periods) related to the co-movement of each pair of variables were estimated and are reported in Table 4.

The second column of Table 4 shows that the average co-movement of oil prices and exchange rates at the beginning of the period under study (September 2014) was equal to 0.18, which then increased by 0.002. With the start of the sanctions (May 2018), there was no significant correlation between these two variables, nor were there any significant changes in them.

The co-movement of the pair of oil and stock prices was similar to that of oil prices and exchange rates. However, the impact of sanctions on the co-movement of the pair of oil and gold prices was different. At the beginning of the period under study, the average co-movement of oil and gold prices was equal to 0.13. Then, this co-movement decreased over time and reached -0.17 at the beginning of the sanctions. The sanctions had a significant effect on the co-movement of these two variables.

At the beginning of the period under study, the average co-movement of the pair of gold and stock prices was equal to 0.12 and did not change significantly over time. The average co-movement of this pair of variables reached 0.18 at the beginning of the sanctions but did not change significantly thereafter.

At the beginning of the period under study, the pair of gold prices and exchange rates had the highest average co-movement (0.62). The average co-movement between these two variables progressively decreased over time until it reached 0 at the beginning of the sanctions, which indicated that there was no significant co-movement between the two variables. However, during the sanction period, the average co-movement of gold prices and exchange rates experienced significant and positive changes.

At the beginning of the period under study, the co-movement of the pair of exchange rates and stock prices averaged 0.06 and did not change significantly over time. The average co-movement of this pair of variables increased to 0.2 at the beginning of the sanctions but decreased over time.

Table 3
Results of Wavelet coherence analysis.

Sanction and Covid-19	The period of US withdrawal from JCPOA and the return of sanctions	The period of post-JCPOA	Before the joint comprehensive plan of action (JCPOA)	Events
2020/19/02–2020/04/06 No significant co-movement is observed. There is negative co-movement in the short term There is positive co-movement in the medium term No significant co-movement is observed.	2018/09/05–2020/18/02 No significant co-movement is observed. There is positive co-movement in the medium term There is positive co-movement in the medium term There is positive co-movement in the short and long term	2015/14/07–2018/08/05 No significant co-movement is observed. No significant co-movement is observed. No significant co-movement is observed. There is negative co-movement in the short and positive in the long term There is positive co-movement in the long term There is negative co-movement in the short and positive in the long term	2014/29/09–2015/13/07 No significant co-movement is observed. No significant co-movement is observed. There is positive co-movement in the short term There is negative co-movement in the short term There is positive co-movement in the short and medium term There is negative co-movement in the short term	Dates Co-movements of oil price and exchange rate Co-movements of oil price and stock price Co-movements of oil price and gold price Co-movements of gold price and stock price Co-movements of gold price and exchange rate Co-movements of exchange rate and stock price

Source: Research Finding.

Note: Short-term means a period of 32 days or less, medium-term, a period of 32–128 days, and long-term, a period of more than 128 days.

Table 4
Results of segmented regression.

Co-movement of exchange rate and stock price	Co-movement of gold price and exchange rate	Co-movement of gold price and stock price	Co-movement of oil price and gold price	Co-movement of oil price and stock price	Co-movement of oil price and exchange rate	Dependent variable → coefficients ↓
0.06 (0.00)	0.62 (0.00)	0.12 (0.00)	0.13 (0.00)	0.04 (0.00)	0.18 (0.00)	β_0
0.001 (0.10)	−0.002 (0.00)	0.0005 (0.53)	−0.001 (0.00)	0.002 (0.00)	0.002 (0.00)	β_1
0.20 (0.00)	−0.038 (0.67)	0.18 (0.01)	−0.17 (0.00)	0.09 (0.18)	−0.01 (0.83)	β_2
−0.003 (0.04)	0.004 (0.02)	−0.002 (0.16)	0.006 (0.00)	−0.002 (0.09)	−0.0003 (0.80)	β_3
0.19 (0.80)	0.45 (0.74)	1.2 (0.29)	0.28 (0.70)	0.36 (0.73)	−0.27 (0.73)	β_4
−0.001 (0.92)	−0.007 (0.76)	−0.02 (0.3)	0.008 (0.50)	−0.008 (0.66)	0.002 (0.87)	β_5
14.16 (0.00)	18.29 (0.00)	11.3 (0.00)	33.2 (0.00)	7.1 (0.00)	18.4 (0.00)	F-statistic

Source: Research finding.

Note: The numbers in parentheses indicate significant probability.

In short, it can be stated that, at the beginning of the period under study (September 2014), the re-imposition of sanctions had significant effects on the co-movement of oil and gold prices and that of stock prices and exchange rates. However, the co-movement of stock and gold prices was only significant at the beginning of the period under study. Moreover, the co-movement of gold prices and exchange rates was not constant during the period under study. The co-movement of oil and stock prices and that of oil prices and exchange rates were not affected by the sanctions either at the beginning or during the period under study.

Table 4 also shows that the outbreak of Covid-19 had no effect on the co-movement of any of the pair of the studied variables.

6. Policy impact

The most important concern of investors in any economy is to identify the most profitable market. This is especially important in an economy like that of Iran, which has been plagued by double-digit inflation for years, resulting in the sharp depreciation of the domestic currency. Financial markets in Iran include the stock market, gold market, foreign exchange (mainly US dollars) market, and the oil market. Due to the wide fluctuations in these markets, especially since the re-imposition of sanctions and the outbreak of the Covid-19 pandemic, investment in any of these markets will be fraught with risk.

The results of the analysis of co-movement between different markets can help investors to determine the optimal investment portfolio. In this study, we used WCA technique to analyze the co-movement between financial markets. WCA allowed us to not only examine how the markets were affected by each other in the short, medium, and long term but also determine which market was the leading market. By showing the beginning of the movement of a market, the results of such analyses can help investors predict which markets will co-move in different time periods and in what direction and whether their co-movement will have any impact on a third market.

This study focused on a period from September 2014 (before the JCPOA agreement) to June 2020 (the peak of the Covid-19 outbreak) in Iran. This period was divided into four sub-periods: The pre-JCPOA, the post-JCPOA, the re-imposition of sanctions, and the outbreak of Covid-19.

The results of this study showed that the movement of oil prices in the Iranian economy could not be used as a reliable indicator to identify the most lucrative market for investment. There was a weak co-movement between the oil market and the other three domestic markets in all the sub-periods and in both stable and unstable conditions. This is because in normal times, policy-makers rely heavily on oil revenues and use it to minimize the impact of oil prices on domestic markets. However, during the sanctions period, because access to oil revenues is severely limited, the behavior of domestic markets will not be dependent on oil prices.

The results of the segmented regression also revealed that the co-movement of oil and stock prices and that of oil prices and exchange rates were not affected by either the economic sanctions or the outbreak of Covid-19. For this reason, the oil market, compared to the other three markets, appears to be the best choice for a risk-averse investor. At the same time, during the sanctions period, the oil market can be used as a source of income by the government. This explains the recent move by the Iranian government to use this market to finance its budget deficit.

In the case of exchange rates and gold prices, WCA indicated that the leading variable was the exchange rate. Therefore, investors can predict the changes in the gold market by monitoring

the changes in the foreign exchange market. It should be noted that the behavior of these two variables in stable economic conditions was different from that in unstable economic conditions in Iran. Under normal circumstances, there was no significant co-movement between these two variables in the short and medium term. Thus, it can be inferred that investors can make short- and medium-term investments in both foreign exchange and gold markets without worrying about the interaction between these two markets. However, in unstable economic conditions, investors must exercise caution because the results of this study showed a significant co-movement between the above two markets in the short, medium, and long term.

The analysis of co-movement between the foreign exchange and gold markets, on the one hand, and the stock market, on the other hand, showed that, in the early stages of a crisis (after a period of economic stability), the foreign exchange rates and gold prices together could serve as a leading variable to the stock market. However, with the continuation of the crisis, the stock market was found to follow a different trend from that of the other two markets, suggesting that, in times of economic crisis, the study of co-movement between the stock market and other markets may not be helpful to the stock market investors. This was also supported by the results of the segmented regression, which showed a significant co-movement between the stock and gold prices and between the stock prices and exchange rates only at the beginning of the crisis. This is because with the continuing economic crisis, the stock market becomes particularly important to the government. By supporting the stock market and making sure that it is on track, the government can reduce liquidity and counterbalance any potential negative impacts of the stock market on other markets, including the gold and foreign exchange markets. Furthermore, by selling its capital assets on the stock market, the government can partially offset its severe budget deficit caused by diminished revenues and the economic costs of the Covid-19 pandemic.

The results of the segmented regression also showed that the re-imposition of sanctions had a significant effect on the co-movement between the gold prices and exchange rates. Therefore, it can be concluded that during the sanctions period, investing simultaneously in both gold and foreign exchange markets put investors' portfolios at great risk in the short, medium, and long term. This is also important from a policy-making perspective because it shows that the policy-makers can, especially in times of crisis, create relative stability in the gold market by controlling the foreign exchange market.

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