

# Analyzing the Effect of Global Steel Price Fluctuation on Iran's Steel-Maker Stock Prices: A System Dynamics Approach

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## **Abstract**

*Steel making is an energy intensive industry and for this reason, energy prices, especially oil and natural gas prices, have an important effect on this industry. In 2008, the sharp rise of crude oil as well as iron ore price caused the sharp rise of steel price because of the rise in prices of key production factors. But Iran's producers experienced almost no rise in their production factor prices especially key factors of energy and iron ore prices. As a matter of fact, inexpensive energy and iron ore are competitive advantages of steel makers in Iran because the huge natural resources of the country let the government to provide inexpensive production factors for the industry. But these inexpensive factors have some side effects that one of them is on the stock price of steel makers in stock market.*

*In this paper we are to model the effects of fluctuations in world steel price on stock price of one of Iranian steel producers. In the end, we will offer some policies to mitigate the fluctuations of stock prices.*

## **1. Introduction**

Steel is a fundamental material for many industries, from automotive to household industries. With an exception of crude oil, no material is as central to economic growth processes and industrial development as steel.

As a consequence of globalization and the associated catching-up processes in emerging market economies, steel has experienced a worldwide boom. World crude steel

production has almost doubled during the last 15 years. World crude steel production reached more than 1,344 million tons in 2007, an increase of almost 7% over 2006. This increase is largely due to growth in China, whose production grew by 16% in 2007. This country experienced a growth of 19% in the year before namely 2006. Table 1 shows the world crude steel production from 1997 to 2007. [1]

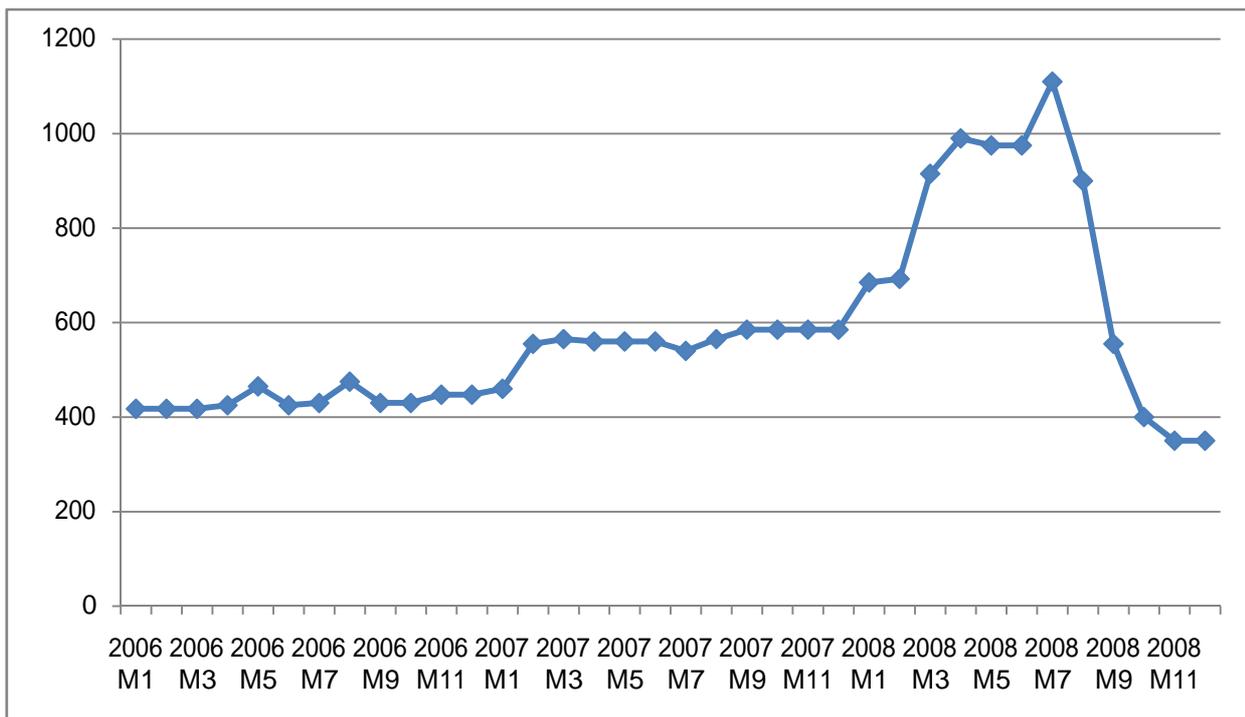
**Table 1: World crude steel production from 2002 to 2007 (Million Ton)**

| Year | World |
|------|-------|
| 2007 | 1,344 |
| 2006 | 1,250 |
| 2005 | 1,141 |
| 2004 | 1,057 |
| 2003 | 969   |
| 2002 | 903   |

Source: *International Iron and Steel Institute (IISI)*

The price of steel billet as an important intermediate product has risen in recent years. The Fig. 1 shows the monthly average price of billet from 2006 to the end of 2008. As it is shown in this figure, although the prices doubled in the first six months of 2008, in the middle of 2008 due to the financial crisis, the prices fell down sharply. Actually the year 2008 was the most turbulent year in the steel market; the price doubled in just 6 months and suddenly decreased by 70% just in 3 months. This sharp rise and drastic fall were the result of a similar rise and fall in the oil market.

**Fig. 1: The average monthly price of Billet (CFR Bandar-abbas) from 2006 to 2008 in USD**



Source: *Metal Bulletin*

In this paper, we develop a system dynamics model that analyzes the effects of the last year fluctuation in price of steel on the domestic steel market of Iran. Modeling this

subject is important, because of the unique nature of steel market in Iran. Before introducing the steel market of Iran, it is necessary to describe some technical aspects of different steel production methods.

### 1.1 Steelmaking Methods

Steelmaking is a process which needs huge amounts of energy. This is the most important element and the basic difference of various methods of steelmaking. Production processes can be divided into two categories:

- Coal (coke) based processes (Blast Furnace)
- Gas based processes (Direct Reduction)

In addition to energy consumption, these two methods differ from each other in some other aspects such as iron ore, semi-finished products, environmental and investment issues. Table 2 shows a brief comparison between the two processes. [2, 3]

**Table 2: Comparison of two methods of steel making**

|                        | Coke-based processes   | Gas-based processes                       |
|------------------------|--|---|
| Iron Ore Specification | In some cases, this method is able to process on wide range of iron ore types. So it is more flexible. | Just limited to Direct Reduced Iron (DRI) |
| Semi-Finished Products | Is called “Pig iron”   | Is called “Sponge iron”                   |
| Environmental Aspects  | More polluting than gas-based Process  | Less polluting                            |
| Investment costs       | No difference  | No difference                             |
| Operation costs        | Coal is important  | Natural Gas is important                  |

With this brief description of the steel market and different steel making methods, in the next section we will describe the conditions of Iran’s steel industry.

### 1.2 Iran's Steel Industry

The foundation of the first steel-making company in Iran was laid after signing a contract with the USSR in 1965 to finance and erect a steel plant in Isfahan. The company, called Zob-e-Ahan, was based on coal process and blast furnace. However, after a few years of operation, Zob-e-ahan was facing some problems such as shortage of scrap and quality coking coal. These problems, the huge available resources of natural gas, and the required raw materials forced the government to convert its steelmaking technology to direct reduction technology. [4]

Since 1990s, the expansion of steel industry in Iran has changed the technology route to make the best use of locally available iron ore and natural gas. This change caused Iran to become the third country in the world that produces steel with DRI<sup>1</sup> technology after Mexico and Venezuela. [5]

These inexpensive natural resources are the roots of a problem that this paper is aimed to model. Table 3 shows Iran's Production, Export and Import of crude steel. According to this table, it’s obvious that there is a surplus of demand in the steel market which forces the importation of steel.

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<sup>1</sup> Direct Reduced Iron

**Table 3: Iran's Production, Export and Import of crude steel**

| Crude Steel |            |        |        |
|-------------|------------|--------|--------|
| Year        | Production | Export | Import |
| 1999-2000   | 6,304      | 890    | 49     |
| 2000-2001   | 6,614      | 817    | 397    |
| 2001-2002   | 6,927      | 700    | 469    |
| 2002-2003   | 7,477      | 678    | 1,469  |
| 2003-2004   | 7,959      | 762    | 1,716  |
| 2004-2005   | 8,986      | 1,252  | 2,391  |
| 2005-2006   | 9,574      | 968    | 1,925  |
| 2006-2007   | 9,928      | 531    | 2,789  |
| 2007-2008   | 10,217     | 417    | 4,177  |

Source: *IMIDRO*

## **2. Problem Definition**

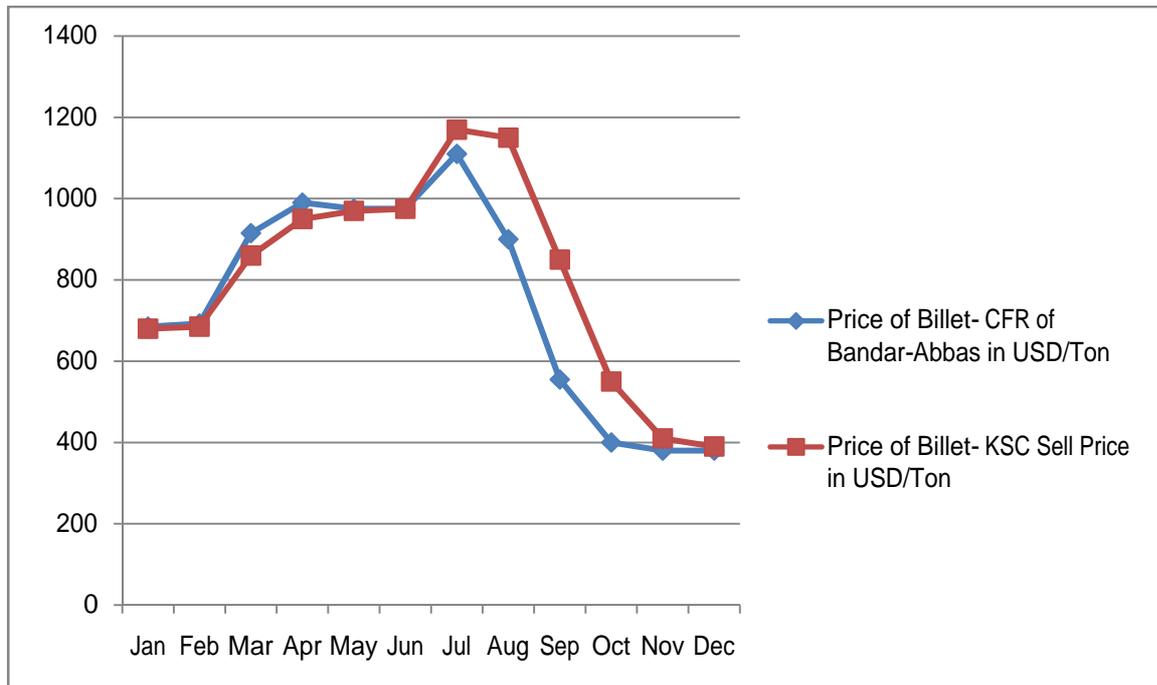
Iran is among the countries rich in natural resources especially crude oil and natural gas. Iran has the third largest oil reserves and also has the second largest natural gas reserves in the world after Russia. These rich natural resources have brought both advantages and disadvantages for Iran. The most important advantages are easy billion dollar income from selling oil and other natural resources, developing energy consuming industries with high profit margin due to availability of inexpensive production factors, and even political power in the region and the world.

On the other hand, the easy income reduced the innovation and other intellectual productions of the country. Actually the oil revenue was about 80% of the total revenue of Iran's government in 2008. That easy billion dollar income has also created lots of local party conflicts over the control and consumption of it. And finally, the most important disadvantage of these natural resources is the inefficient and energy consuming industries that are not able to compete with their global competitors even with subsidized energy. For example, in electricity production sector, most of the electricity is produced in steam boilers, using inefficient combined-cycle gas-turbine technology. [6]

As described earlier in the steel industry section, most of Iran's steel making plants are based on gas technology or DRI technology that uses huge amount of natural gas and electricity as energy factors. To support domestic industries, government decided to give steel plants subsidized production factors that three key subsidized factors are natural gas, electricity and iron ore. Until two years ago, all steel plants were government-owned so the steel making companies had no control over pricing their final product. Hence, the steel price in Iran was sometimes less than half of its world price.

Government intervention in pricing caused many problems and created a black market. For example in some cases the black market price was twice the government price, which resulted in corruption in the market. [7] Therefore, the government decided to change its policy and liberated steel price. From three years ago, steel is made with subsidized production factors, but it is sold in *Iranian Metal Exchange* with free market mechanism in which the price follows the world price of steel plus tariff and other costs. Fig. 2 shows the monthly average price of billet sold by one of Iranian steel makers, Khoozestal Steel Company (KSC), with the CFR price of Billet in Bandar-abbas port in south of Iran.

**Fig. 2: Billet price: CFR of Bandar-Abbas as Importation Price and KSC Sell Price**



Source: AGAHAN Company Investment Department

When the companies were government-owned, it was considered that this profit will return to the government treasury. In addition, it would support domestic industries by providing subsidized production factors. But another policy was executed two years ago; "Mass privatization of Government-Owned Companies". With the entrance of steel companies to the Iranian National Stock Market, everything changed. These companies used subsidized inputs but sold their products in free market and their profit directly was divided among private share holders.

Another source of problem of subsidized production factors in Iran is the fixed price policy over a year. Although it is obvious in many countries that when the global price of a product rises, the domestic prices of that product and related products will rise too, in Iran the price of many important factors like oil, gasoline, electricity and iron ore are set for one year and nothing can change those prices during that year, even if the global prices doubled or tripled!

The mentioned policies in natural gas, electricity and iron ore (main production factors of steel making) are shown Fig. 3, Fig.4 and Fig. 5.

With this description of steel market in Iran, we consider the effects of price fluctuations in world steel market in the last year on Khuzestan Steel Company (KSC) stock price which is a domestic producer of crude steel in Iran. We selected that company for three main reasons:

1- It is one of companies that were privatized two years ago as a step in mass privatization program in Iran. So its stock price and its financial statements are publicly available.

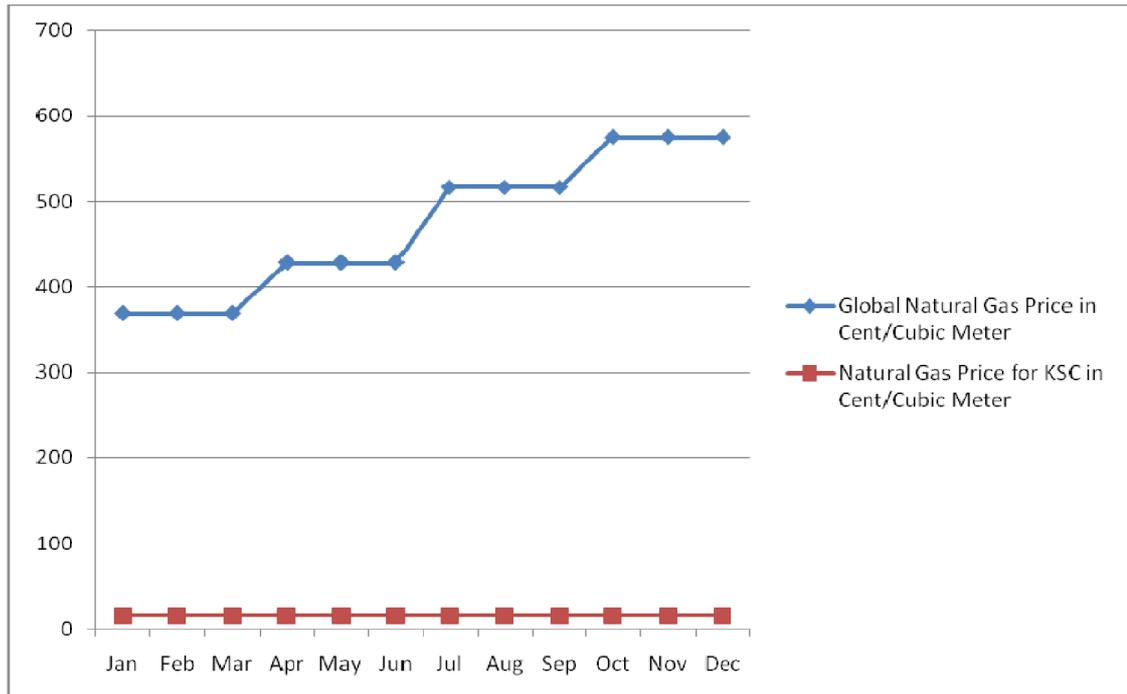
2- Its production factors are entirely subsidized although the company is privatized and sells its products in free market with global price.

3- The main products of the company are billet, bloom and slab, namely crude steel that is suitable for our purpose because these products are to some extent standard products. Hence, we can track the world price easily. Other steel making companies in Iran produce

some finished products that they are not standard and they do not have a trusted source to find their global price.

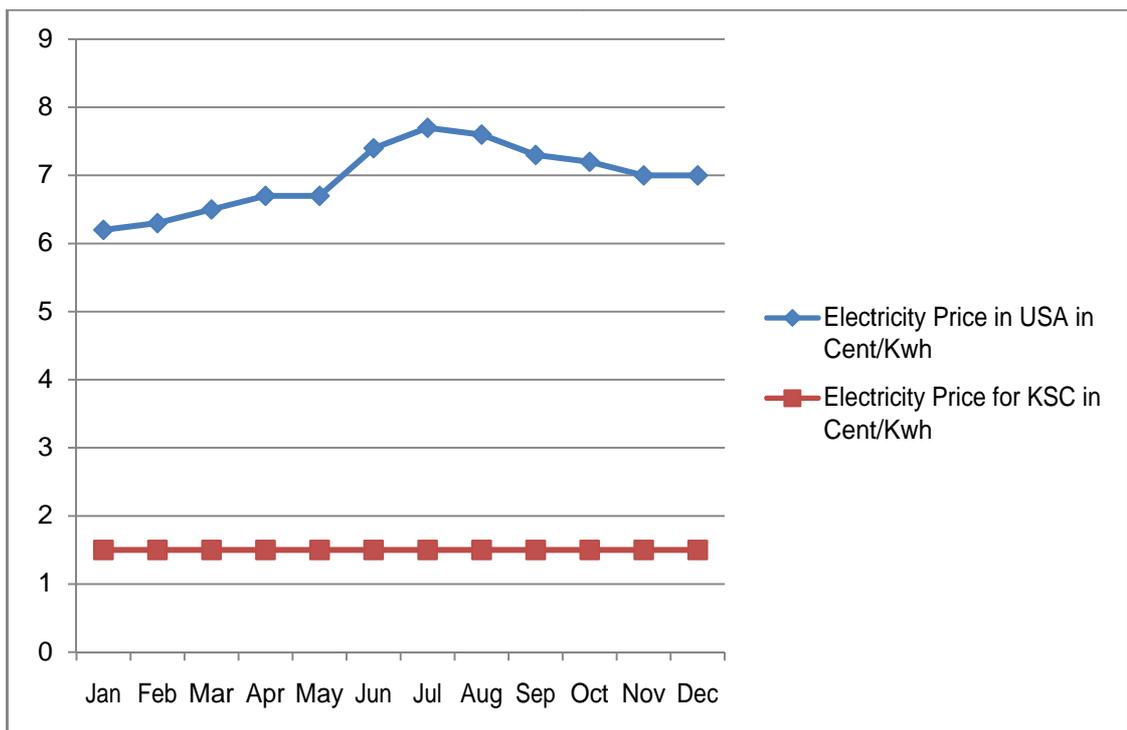
Fig. 6 shows monthly average of the stock price in Iranian stock Market.

**Fig. 3: Comparison of global natural Gas price with Iran's natural gas price**



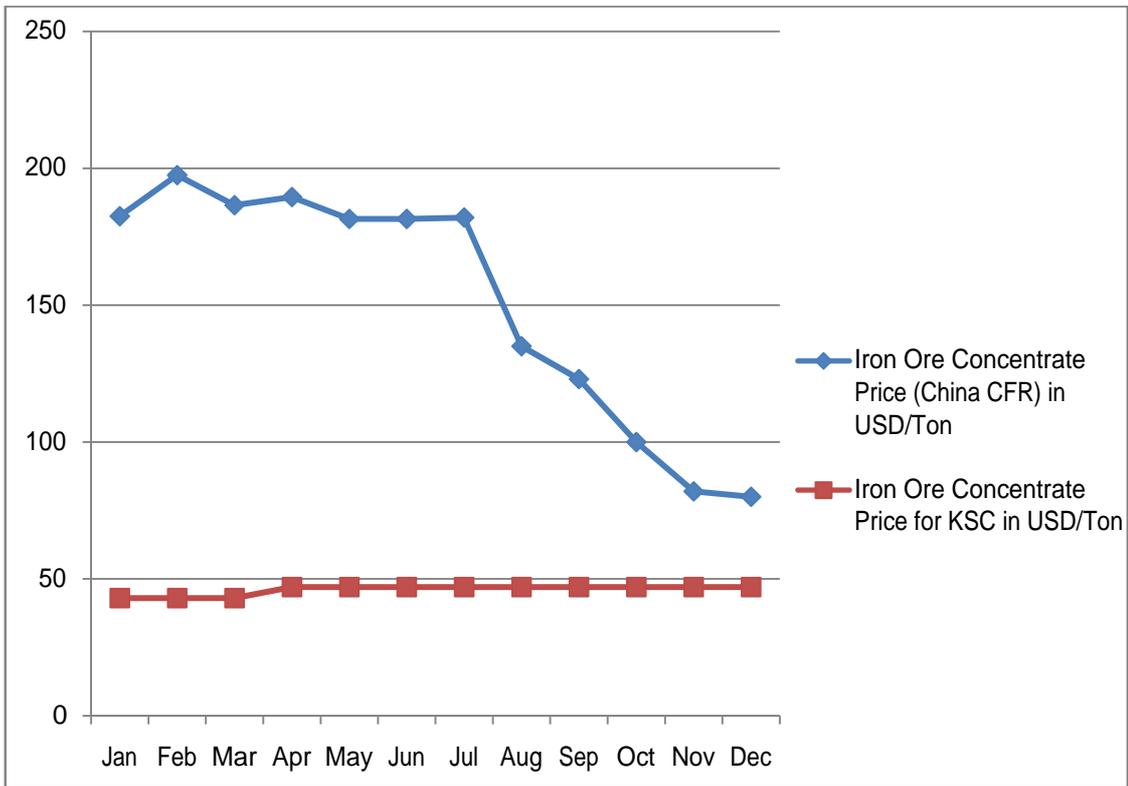
Source: *International Monetary Fund (IMF) & AGAHAN Company Investment Department*

**Fig. 4: Electricity Price in USA and Iran**



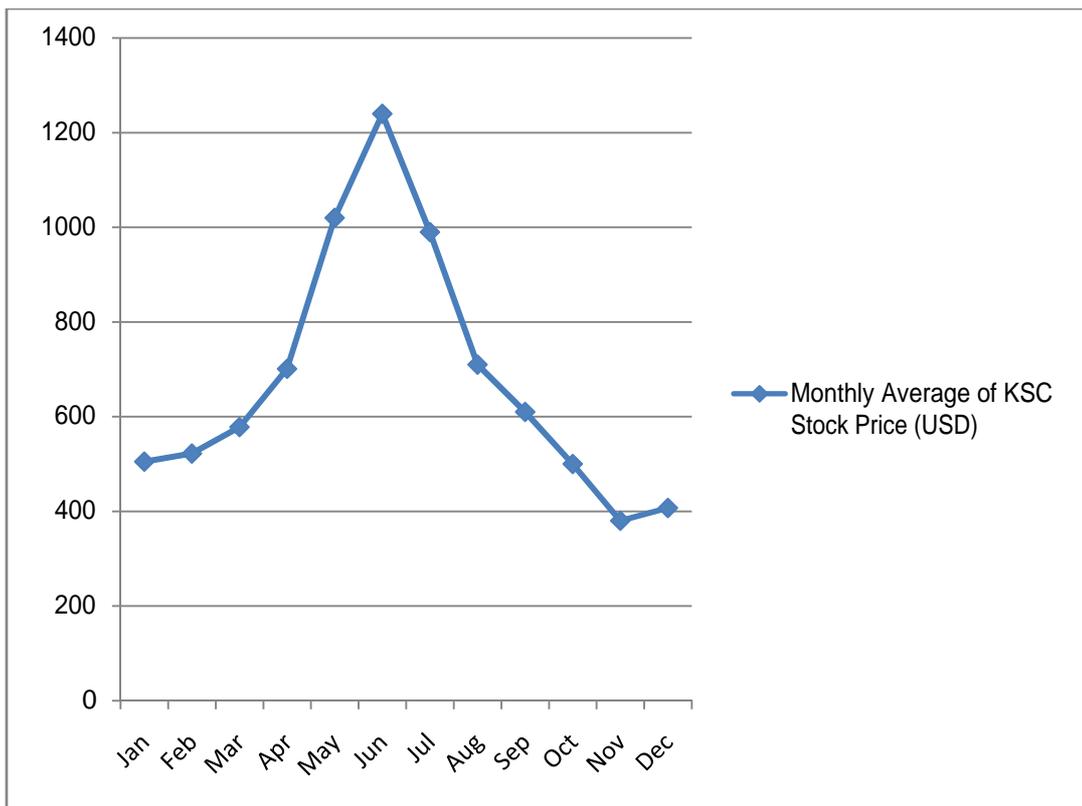
Source: *Energy Information Administration (EIA)*

**Fig. 5: Iron ore concentrate price in Iran and CFR China**



Source: Metal Bulletin and Chadormaloo Company (Iron ore supplier of KSC)

**Fig. 6: Monthly average of KSC Stock price in 2008 in USD**



Source: Iranian Stock Market

### 3. Dynamic Model Description

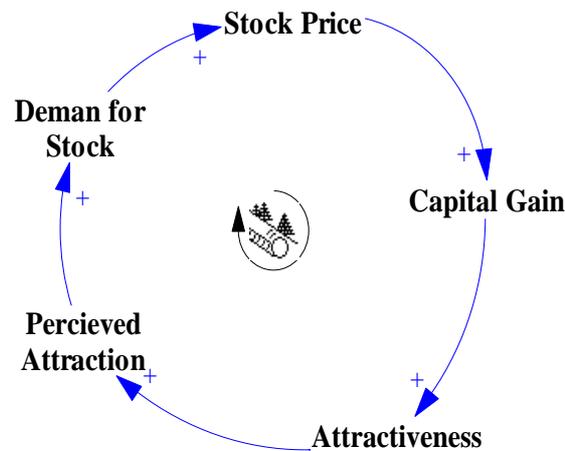
The model is established in two main sectors, stock market sector and steel pricing sector. These two sectors by interaction with each other create the behavior of the stock price as a focus of attention in this paper. Based on the literature review mentioned in the previous parts, dynamics which run these two sectors are discussed here.

#### **3.1. Stock market sector**

Dynamics of stock market is well described in the literature. In this sector, two main loops in a tight relation result in response of stock market. [8, 9] The first loop, demonstrates the change of attractiveness of investment in the stock market and so its demand due to the stock price. This loop is shown in Fig. 7. In the figure, higher stock price leads to higher capital gain and total return on stock. Increasing of capital gain makes the stock market more attractive for investment so the total attractiveness of the stock market will increase. After a while this attractiveness become known by people so perceived attraction will increase.

This “perceived attraction” comes from the delay between the rise in capital gain and people awareness of this rise. It means that perceived attraction does not change as soon as capital gain increased. It needs some time for people to know the attractiveness of the market to invest in. Higher “perceived attraction” result in increasing of demand for stock and higher demand leads to higher stock price. Therefore the loop which is a reinforcing one is formed.

**Fig. 7: Stock Market Attractiveness loop**

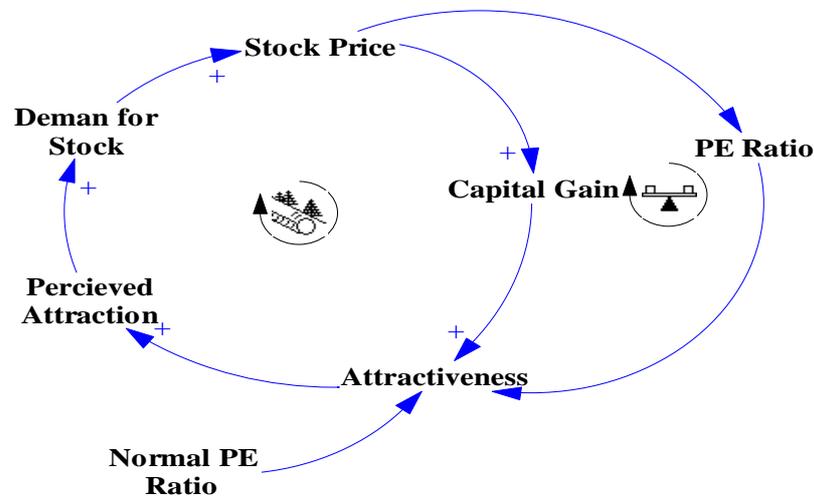


There is another loop which limits the rise of stock price as a balancing loop. This balancing loop comes from a very important factor which is P/E ratio (Profit/Earning ratio). This indicator is very significant to investors, which shows a combination of profit as well as the risks behind their investment. Another important factor in this loop is the number of shares which influence the earning.

In the model, “Earning” is the point of relation between two sectors. In this loop rising of stock price will increase the P/E ratio. By going far from the normal P/E ratio, attractiveness of the stock market will be affected and will decrease. Decreasing of attractiveness will decrease the perceived attraction and demand for stock as well. Therefore the balancing loop is shaped.

Fig. 8 shows both loops. As shown in the figure, the dynamics of stock market contains two major loops which interact with each other to balance the stock price.

Fig. 8: Stock market loop



### 3.2. Steel pricing sector

In this sector the dynamics of pricing the steel in the country according to the domestic costs and world price and its effect on the earning are modeled. Domestic steel price rates (increasing rate and decreasing rate) are both strongly affected by the world price. In this sector “Pricing strategy” of the domestic steel is one of the most important points to change the behavior of the model as well as the policies which are going to be discussed further.

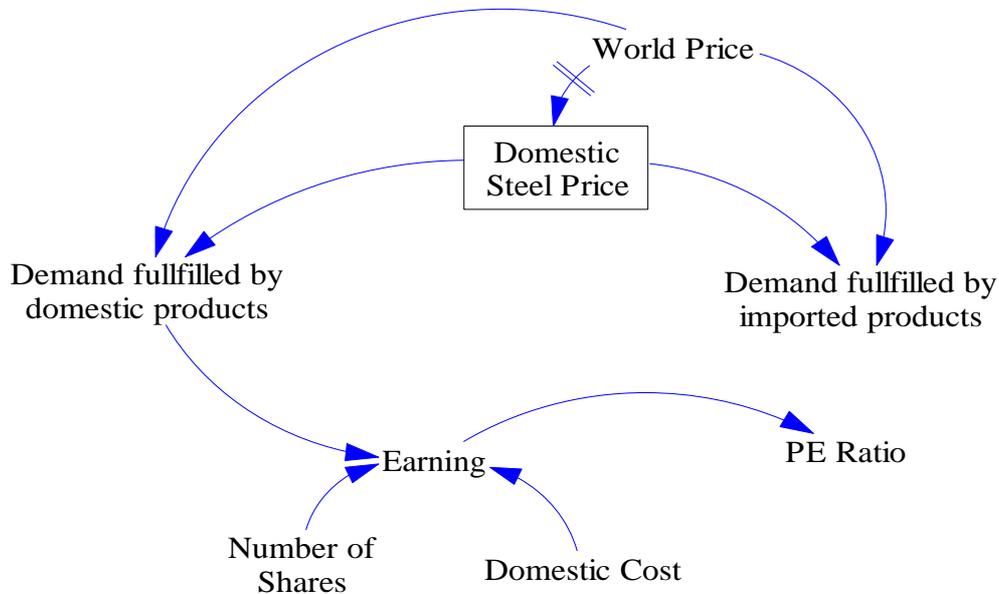
Pricing strategy is based on the adjustment of the domestic steel price with the world’s steel price. If the current domestic steel price is lower than world price, then the domestic price will increase to adjust itself with the world price so the increasing rate of the domestic price will change according to the discrepancy between them. On the other hand, if the domestic price is higher, the decreasing rate will work to adjust the domestic price with the world price.

Furthermore, there is a time delay for this adjustment during increasing time as well as decreasing time. Regarding the experts in steel field, the time delay for increasing rate is less than that of decreasing rate. It means that by an increase in the world price, the domestic price will increase sooner but by a decrease in world price, domestic price will decrease with a considerable delay. Therefore the parameter “Delay1” is one third of “Delay 2”. Another point in this part is that the domestic price will never become less than the domestic cost. It means that the minimum domestic price will be equal to the domestic cost regardless of the world price because government uses tarrifs to support the domestic producers.

Second concept in this sector is the effect of the domestic price on the demands fulfilled by imported products and on the other hand by domestic products. Total domestic demand for steel is assumed to be constant. Division of the demand between these two groups is assumed to be proportional to the world price and domestic price. Besides, it is assumed that all the domestic production is used, even if it is more expensive than the world one because of the surplus demand of Iran's market and also the delay of providing the import steel.

“Demand fulfilled by the domestic products” and “Number of shares” then form the earning which is a critical factor in PE ratio. Therefore, “Earning” is the parameter which join two sectors. The pricing sector causal relation is shown in Fig. 9.

**Fig. 9: Causal Relation of Pricing Sector**



#### **4. Simulation Model**

The model based on the two causal loops mentioned in the previous part is shown in Fig. 10. There are two sectors and the sectors are joined by the “Earning” parameter. There are some points about the stock and flow model which is mentioned here.

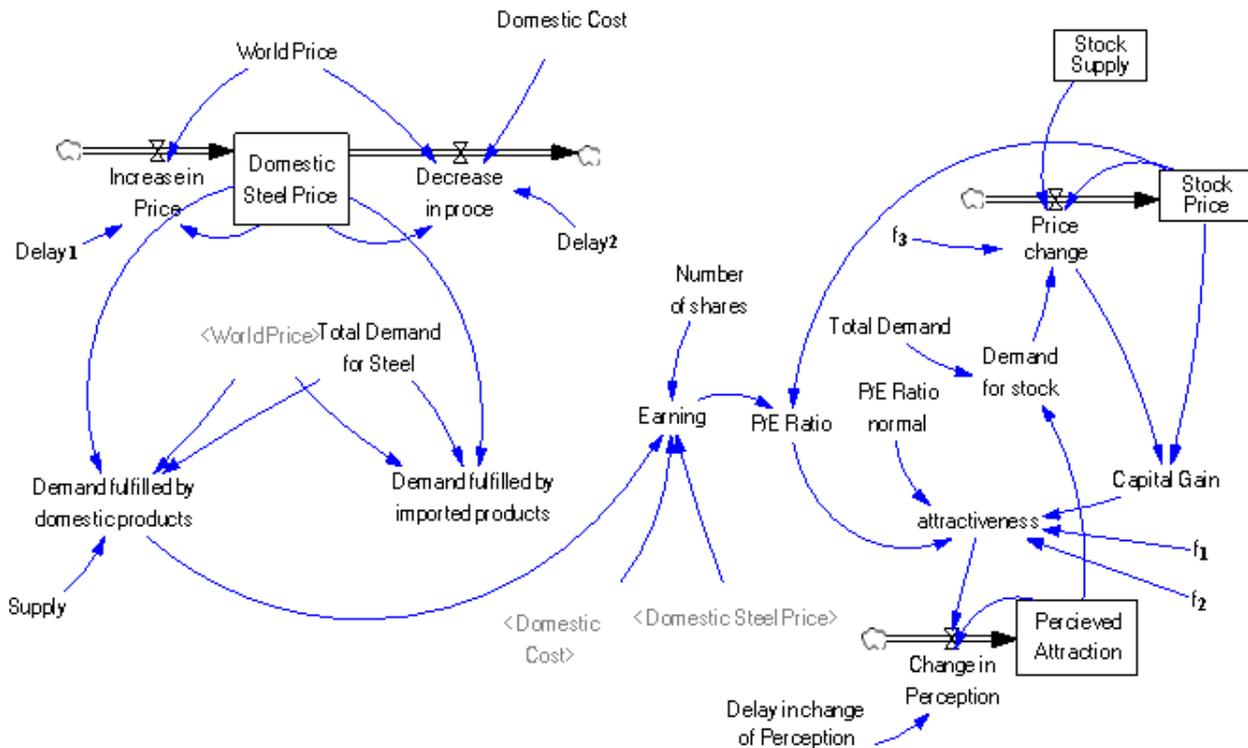
Stock price market which shows the dynamic of the stock market is based on the two positive and negative loops. In constructing the model there are some assumptions worthy of notice. “Stock supply” and “total demand for stock” in this section have constant values over time. There are two functions acting on the “Attractiveness”. F1 shows the “Attractiveness” as a function of “Capital Gain”. This function is an increasing function which shows that “Attractiveness” is positively influenced by the changes in “Capital Gain” and will change in the same direction. F2 describes “Attractiveness” as a function of “P/E ratio” to “Normal P/E ratio”. This function starts from a maximum value which is for the P/E ratio equal to zero and then decline by increasing the proportional P/E ratio. When this proportional value approach a maximum value the “Attractiveness” will be zero.

Another function in this sector is F3 which describes the “Stock price change” as a function of proportional value of “Stock supply” to “Demand for stock”. As this proportion approaches one the function will be zero which means that there will be no rate change. As this proportion go below zero the price will increase by a negative rate. Therefore, the stock price will change in accordance with the demand for it and the constant supply of the stock in the stock market.

Pricing sector can be seen in the left part of the model. It models the pricing strategy which leads to the demands fulfilled by domestic products as well as the demands fulfilled by imported products. These demands then form the earning. Parameter “Earning” is gained by the “Demand fulfilled by the domestic products”, “Number of shares” and “Domestic cost”. In this sector, “Domestic cost” and “Number of shares” are assumed to be constant.

As mentioned above two Time delays affecting the rates of “Domestic steel price” are different due to the perception of people in increasing or decreasing the steel price. It is modeled as the time delay in decreasing rate is three times more than the delay time in increasing rate and this happens because of hope that the decline in current domestic steel price will not last for a long time.

**Figure 10: Complete simulation model**



## 5. Simulation and Results

As described, this model consists of two sectors. The first sector is the stock market and the second sector is a description of how producers price their products.

The main concern here is that the world price of the steel fluctuates based on the price of production factors such as gas and iron ore, but the price of these inputs are under the control of government through some subsidizing programs during these years in Iran, which results in the constant production cost during these years.

Regarding the constructed model, we want to examine the effects of such fluctuations on the stock price and its situation. We have three different scenarios:

- (1) There is no change in the steel world price.
- (2) There is an increase in the price of production factors which results in an increase in the world price of steel.
- (3) There is a fluctuation in the steel world price which generates an increase in the price of production factors and afterward a decrease in the factor prices.
- (4) In this scenario there is also a fluctuation in steel price, but the level of steel price reduction is to the extent which is lower than the domestic production cost.

In this section we will compare the results of these scenarios. In Fig. 11, the change in the world price under each of these circumstances is shown:

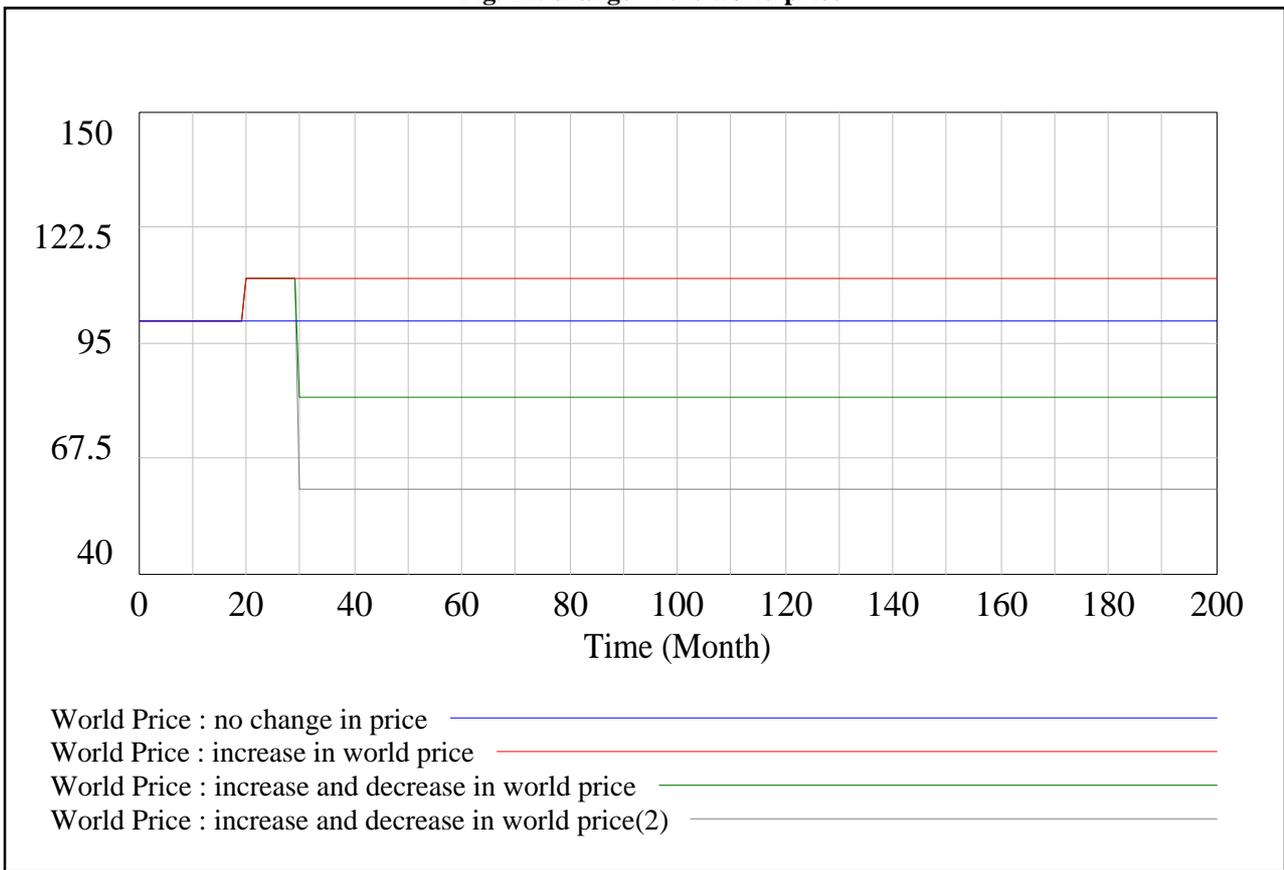
Based on our simulations for each of these scenarios, the results in Fig. 12 were obtained. As the blue diagram shows, we can observe the normal oscillation in the steel stock market, when the price of domestic steel price and world stock price are equal.

When there is a crisis in the market of production factors, and the steel price increases, the stock price oscillates as depicted in the red graph of Fig. 12. We can conclude that in this case, the oscillation takes place with the same frequency but the amplitude of the oscillation increases, which demonstrates the economical expansion in the stock market.

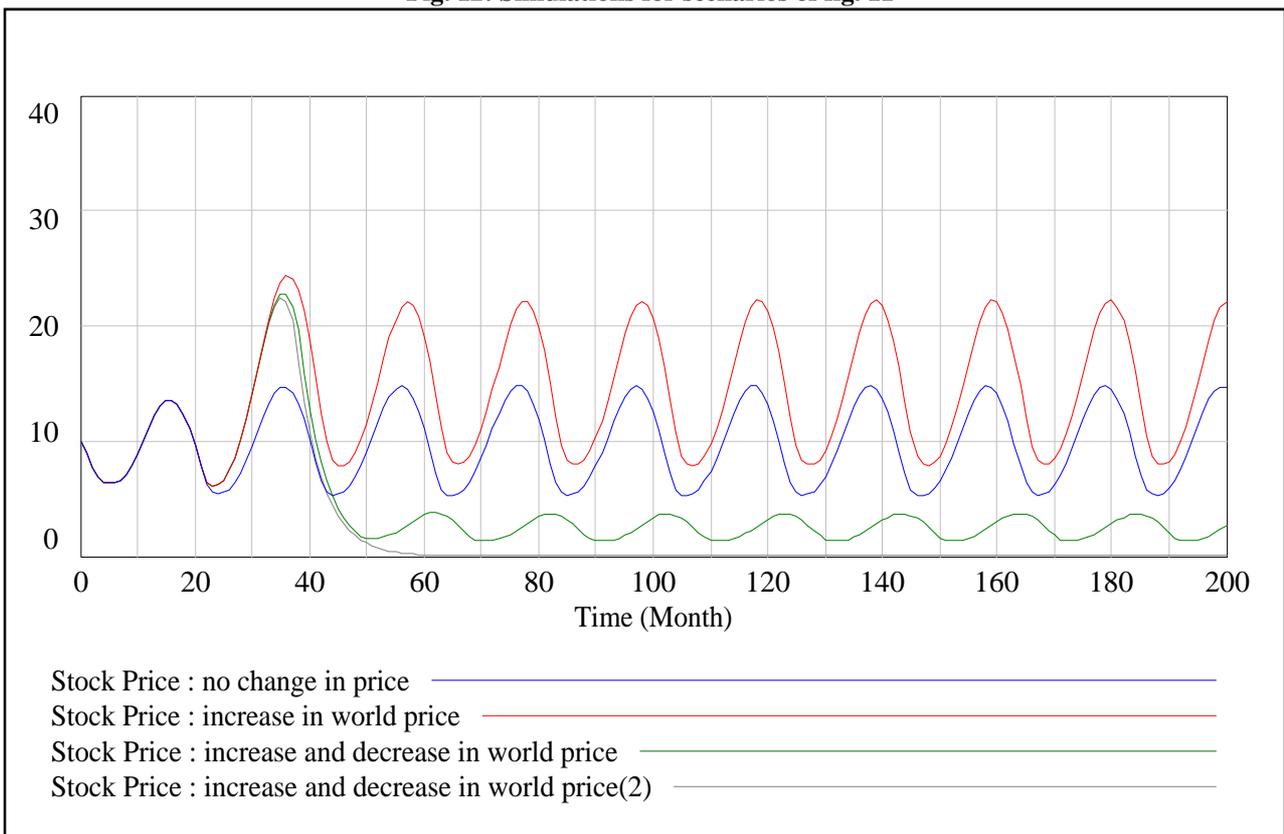
We should consider that always after an increase in the price of production factors, there will be a reduction in the price. This is the third scenario and the result is shown in

green curve. As you can see in the graph, in this case a recession will occur in the stock market, because of severe competition between domestic products and foreign ones.

**Fig. 11: change in the world price**



**Fig. 12: Simulations for scenarios of fig. 11**



Finally, if the level of reduction is lower than the domestic cost of products, there will be a dreadful situation for domestic producer. This phenomenon hasn't taken place yet, but it's possible due to the rapid change of technology and efforts in cost reduction worldwide. The effects of such a change in world price on the stock price can be seen in the gray graph. In this scenario domestic producers will move toward bankruptcy.

It seems that the change in steel world price due to the fluctuation in the price of production factors has a direct effect on the domestic stock price. The reason of such a direct effect is a result of the pricing strategy of domestic producers. In the next section, we will propose some policies for mitigating the effects of the world price of production factors on the stock market, mainly based on the non-subsidy factors for domestic producers.

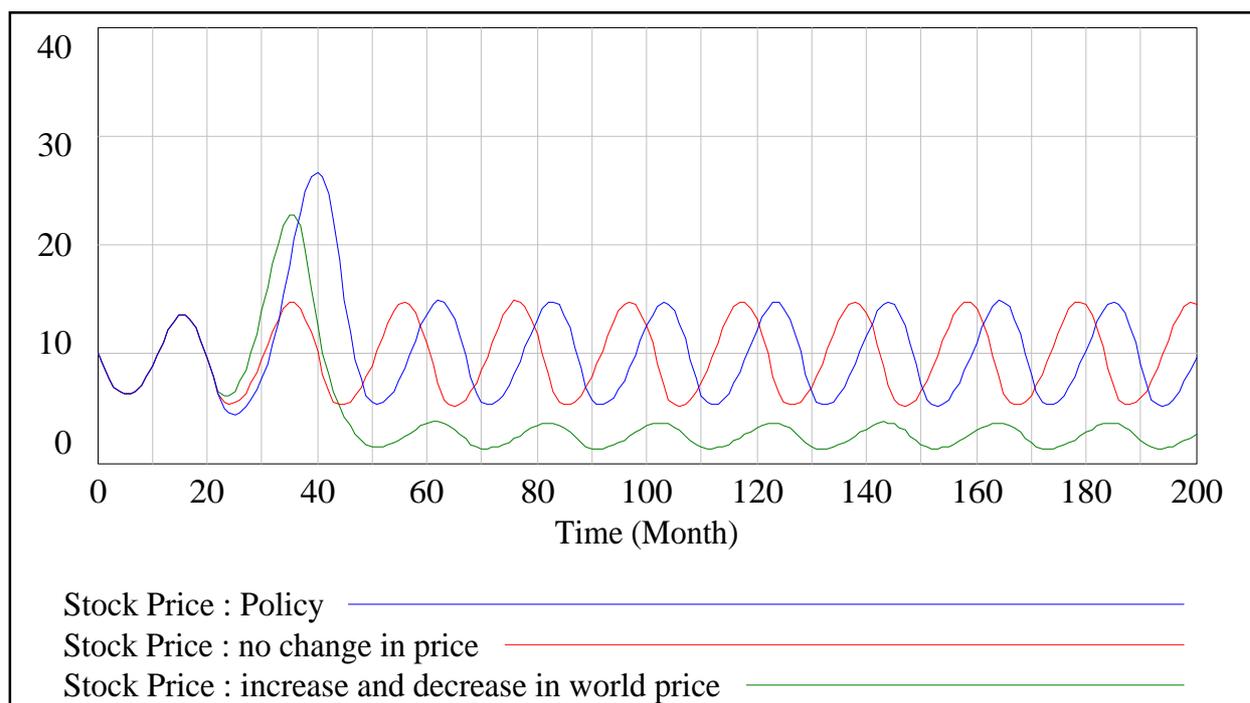
## 6. Policies

As mentioned, one of the main reasons that the change in production factor prices especially in the price of energy factor intensely influences the stock price is the subsidizing policies of government on the price of energy factors for domestic producers. It's a controversial issue in the guild of domestic steel producers about the effects of removing governmental subsidizing programs on the domestic steel stock market and domestic steel market.

In this section, we will examine the effect of the removing subsidy from production factors. We assume that the domestic cost of production will change according to the price change of production factors. It means that an increase or reduction of production factor prices will directly affect the price of domestic productions. The result of this policy compared to the other scenarios is shown in Fig. 13.

As demonstrated in this graph, this policy will make the amplitude of the stock market oscillation insensitive to the price change of production factors. It seems that this policy will be effective in mitigating the mentioned effect, but there is a concern of how this price liberation should be done so that the social and political side effects of such a change will remain at the minimum level.

Fig. 13: Simulation results of the policies



## 7. Conclusion

Price fluctuation of the world steel causes some effects on Iranian steel-maker stock price. When the global price rises, due to subsidized production factors, Iranian steel makers experience a sharp rise in their profit and consequently in their stock price. They experience a drastic fall, when the global price falls. In this paper we modeled the phenomenon and after that we tried to offer some policies to mitigate the global fluctuation effects on stock price of steel-makers in Iran.

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