Effect of Localization on the Car Market Under Intense Sanctions; A System Dynamics Approach

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***Abstract*—In recent years, Iran's economy has been under sever sanctions. The sanctions were increased by United Nations Security Council (UNSC) after 2012 which caused rapid changes in the price of all imported materials. As the result, price of the imported parts and materials of car manufacturing companies rapidly increased. After this sudden jump in the prices, the government decided to import technology and adjust it with regards to the economic, social, and political conditions of the country which is termed as technology localization. In this paper, we first propose a model describing effect of sanctions on Iran's energy market and relate these sanctions to the market of car manufacturing companies. Then we model the effect of technology localization in stabilizing the car prices in long term.**

I. INTRODUCTION

In the long history of the relationship among governments of different countries, there have been always countries with opposing ideas. Sometimes in competitions and interactions among countries, front runner countries unified with their alliances to force the other one or group to change their political behavior, taken actions could be diplomatic bans [1], military interventions [2] or economic sanctions [3]. For clarifying the subject, North Korea is the country which has been experienced international sanctions since Korean War in 1950s [4], or the economic sanctions against Cuba, Sudan and several other countries are the famous historic examples [5].

After creation of the United Nations in 1945, which got together the countries from all over the world, unanimous sanctions are imposed more reasonably and more organized [6]. With leading of United Nations, main intention of sanctions is to force the hostile country to cooperate with rest of the world to prevent the probable wars [7]. In most of the cases, the only substitute for entering direct military interventions is to impose economic sanctions to provoke and force the countries for getting along with international rules. Besides the sanction imposed by UN, there are examples of sanctions imposed unilaterally or multilaterally. As an example, During past decades United States has imposed some unilateral economic sanctions on a variety of countries. All these sanctions whether or not forced by UN are called "International Sanctions" along the lines of this paper.

One of the most powerful sanctions among the over mentioned different types is economic sanction, which forces limitations on the trade stream and international economic activities of the target countries. As an example of this type of sanction, the limitations imposed to Myanmar since 1993 [8] or the bans imposed to India at 1998 [9] or the economic sanction of Zimbabwe in 2001 [10] could be mentioned. One of the strictest of this type of sanctions was the recent economic sanction on Iran and more specifically on energy sector [11]. As a result of this sanctions, Iran encountered with difficulties in its oil export which was the main revenue source of the country, value of Rial, Iranian currency, dropped massively to one third [12] of its value and inflation rate went over 40% during a period of 6 months [13]. These sanctions caused immense fluctuations and uprisings in the price of common merchandise [14]. One of the boldest uprisings was in the price of manufacturing material and equipment for car industries which was doubled in less than 6 months and caused a stagnancy in the market [15].

Despite all the damages to the economy of Iran during the period of sanctions, recent agreement of Iranian government that is called Joint Comprehensive Plan of Action (JCPOA) [16] with P5+1 countries, including United States, United Kingdom, France, China, Russia and Germany has brought the hopes back to the market of Iran with over 80 Million ready-to-buy consumer. Based on these agreement all the economic sanctions imposed against Iran after 2006 were lifted, international interactions and activities of country will become normal, banking system got connected to Society for Worldwide Interbank Financial Telecommunication(SWIFT) again and oil export limitation was removed. It is worth to mention that still a part of unilateral sanctions of United States against Iran is in place but these sanctions are mostly following persons and not whole economy of country [17].

Historically Iran used to import main parts and equipment from foreign partners for its car industries but during the sanctions period, Iranian government tried to encourage local companies to spend more on R&D researches and produce most of the requisites of industry domestically, this policy and actions of country is referred with the term of "Localization" in this paper. Although, localization had almost no effect on stabilizing of market and controlling the prices in short term but in the mid-term and long term it can strongly reduce the dependency of Iranian car industry to abroad and as a result this could prevent future price fluctuation in the market [18].

Besides this, oil price is always one of the most important drivers of market in Iran [19]. Before sanctions 80% of country's revenue was made up by oil and oil product exportation [20]. During past several years, due to international economic sanctions and pressures on oil and gas industry of Iran and also because of global oil price crisis [21], revenue

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of country has dropped and at the same time, share of oil revenues on annual budget changed. This policy change put the main pressure on people and industries for increasing and improving taxing system. State-controlled car industry is part of this regulative alteration. The massive 80 million market of Iran and government support from domestic car industries has made the car market as one of the most attractive businesses in Iran.

In this paper, following our previous works [22]–[32], we have used Systems Dynamics [33]–[35] to model Iran's car market and its dependency to the oil price to catch the fluctuation in the market. Besides, we have modeled the effect of the localization on this market to see and predict its mid and long term impacts in car market as an example of important industrial sector in Iran.

II. MODEL AND CAUSAL LOOPS

In this part, we will describe the overall model with the casual loops inside the model. Briefly, our model consists of three different sub models that are connected with each other to make the main model. First sub model is the oil market model that has the main supply and demand loops. Second sub model is the car market model which consists of three model namely demand, supply and sanctions. The final sub model is the sub model of the localization which consists of policy making, cost reduction and technology complexity loops. In the following, each sub model and its relation to other sub models will be described in details.

A. Model of the Oil Market

In our model, the oil market briefly consists of one main model and two sub model. Main model describes the balance between supply and demand and the sub models describe the effective parameters of the oil demand and supply that are described in detail in the following.

1) Main Model: Like any other commodity in the free market, oil market is strongly affected by supply and demand. The increased price will motivate oil producing countries to increase their supply and will decease the demand of oil in the market. In our model, the pure value of the supply and demand does not directly affect the oil price while they affect it by Demand to Supply Ratio(DSR). A ratio smaller than one represents the saturated market where there is more oil in the market than the demand which will decrease the price, while a ratio greater than one represents great demand and shortage of supply in the market which will lead to price increase.

It is obvious that demand and supply are not independent parameters and are affected by external factors. The effective factors on supply and demand that will be described in the next sections are briefly shown as effective factors on oil demand and supply. Figure 1 represents the over mentioned relation among the parameters.

We have used linear regression ($Oil\,Price = Slope * DSR + Intercept$) to find the relation between DSR and oil price. We have used the historical quarterly data between first quarter of 2013 till forth quarter of 2015 [36].

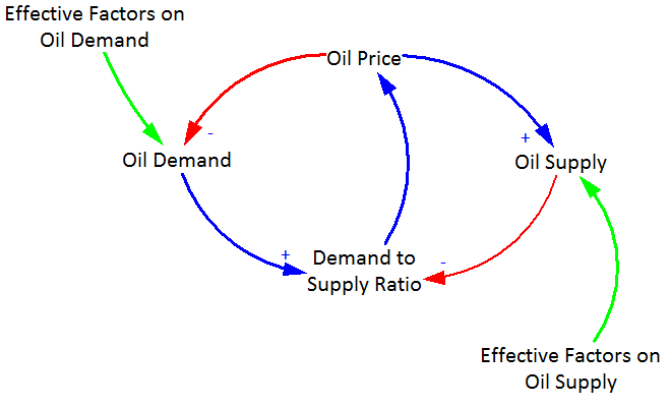

Fig. 1: Main Model of the Oil Market

Due to the existence of sudden and short-term changes in the oil price which is temporary and not the real trend of the market, we have used least absolute deviation regression [37]instead of the ordinary least square which is robust to the outliers. Table I represents the result of our regression analysis.

2) Supply Sub Model: In our model, as shown in Figure 2 we have divided the oil producing countries into four different categories; OPEC members, Russia, US and other countries. This division is due to their production policy. OPEC members try to set their policies with each other and they supply oil to the market as OPEC oil basket. We have considered Iran separately in the model since its production share changes rapidly in the market due to the different sanctions imposed to its supply.

Russia is considered separately since they usually have their independent policy of production. On the other hand, the international sanctions on the economy of Russia as the third greatest oil producing county due to Ukraine crisis [38], caused to model its production individually to catch its supply accurately.

US oil production is considered separately too, due to its independent production policy and Shale oil production which increased US oil supply greatly [39]. The other producing countries usually have stable production policy and we have considered their production as one parameter.

3) Demand Loop: As it is shown in Figure 3, like the supply sub model, we have divided the oil consuming countries according to their policies. Countries with the same economic policy are considered as one parameter. On 1960, a group of countries signed an agreement to create an organization to coordinate their policies. This group of countries are called OECD (Organisation for Economic Co-operation and Development) [40].

Regression Analysis	Intercept	Slope
Least Absolute Deviation(LAD)	-179.0	179.5
Ordinary Least Square	-296.4	295.1

TABLE I: Regression Analysis for DSR and Oil Price

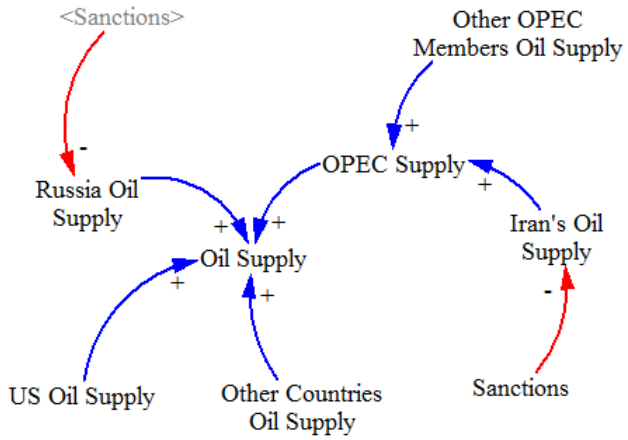

Fig. 2: Supply Sub Model of the Oil Market

On May of 2008, Brazil, Russia, India and China, as the major emerging economies, came to an agreement to help each other economically and follow a coordinated economic policies. After 2010, South Africa was added to this group and now member of this group are called BRICS (Brazil, Russia,India, China and South Africa) [41]. In our model we have considered their demand as "BRICS countries oil demand". The remaining countries that are not member of OECD or BRICS are grouped together and modeled as "Other Countries Oil Demand".

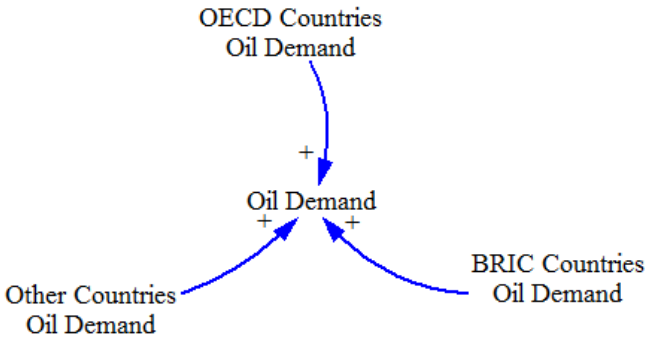

Fig. 3: Demand Sub Model of the Oil Market

B. Model of the Car Market

In this section we will describe the model of the car market in details. The car market has a main balancing loop describing effect of supply and demand in determining price of the car. The other effective parameters in the market like sanctions, oil price and working capital to debit ratio are parametrized in a sub model that are described in the following.

1) Main Model : Like any other commodity in the free market, car is affected by demand and supply. Car market specially in a closed economy like Iran is affected directly from demand and supply. In our model, increasing the demand for a fixed value of supply will increase the price and the increased supply for a fixed value of demand will decrease the price. This relation is shown in Fig. 4 in detail.

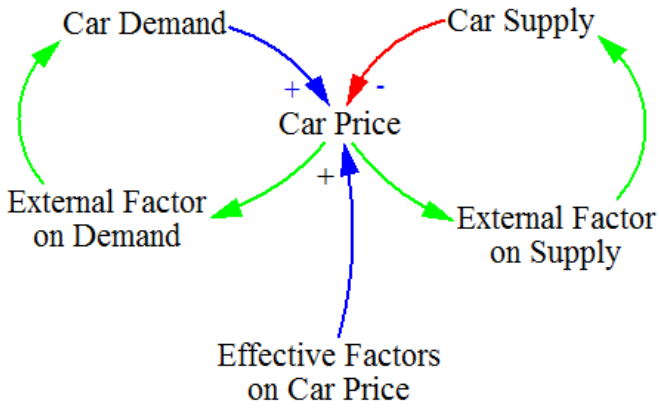

Fig. 4: Main Loop of Car Price

2) Sub Model: Most of the manufacturing companies in the world import some of their needed parts from external sources and rarely a company produces all of its needed parts inside one manufacturing site. For example, Airbus has sites all around the world including France, Germany, Spain, China, US, Japan and India that work closely together to have a high quality final products [42]. The same thing applies for Iran's car companies. This causes a dependency to the foreign currency specially US dollar which is the main currency used in the international trades [43].

Iran's economy and subsequently its manufacturing companies are strongly related to the exported oil since it is the main source for foreign currency. As the result, oil market will have a great effect on the exchange dollar rate(relative value of a currency unit against US dollar). In our model, we have modeled this dependency through the oil price and supply. Oil supply is an important factor since it could be greatly reduced by international sanctions which will reduce the total foreign currency gained by oil dependent countries for a fixed value of oil price. In a country with high inflation like Iran, it is normal for the prices to change through time [44] but this changing rate could be reduced by different factors. One of these factors is manufacturing productivity [45]. Productivity by definition is the effectiveness of a company in changing resources into goods [46]. Efficient manufacturing systems can reduce the changing rate of a merchandise price [47]–[49]. So we have modeled the effect of productivity on this change rate.

The other important factors in price changing rate are working capital and the debt of the manufacturing company. Having high debt forces the manger of the companies to slightly start increasing the price to pay their debts while having high working capital shows the right policy [50] of the company and sometimes this even could lead to decrease the changing rate in order to attract more customers. In another

words, in this situation, companies focus to increase their revenue by increasing their selling instead of increasing their price. We have modeled this trade-off between working capital and the debt by working capital to debt ratio. The higher this ratio, the lower price change rate.

In a high inflation country like Iran that its economy is highly dependent to oil production and has been under sever economic sanctions, one of the most important factors in balancing the price will be the localization factor. When a country is under sanctions and has a lot of problems in gaining foreign currency and importing needed parts for its industry, they start to localize their industry by producing all of their needed materials inside the county. This option is completely effective (in long-term) for Iran due to its different mines and natural resources.

After Iran's sever sanction in recent years, the prices start increasing rapidly and meanwhile the government started investing on the industry localization. This is the main reason for price balancing after 2 years of sanctions while almost all other factors are the same.

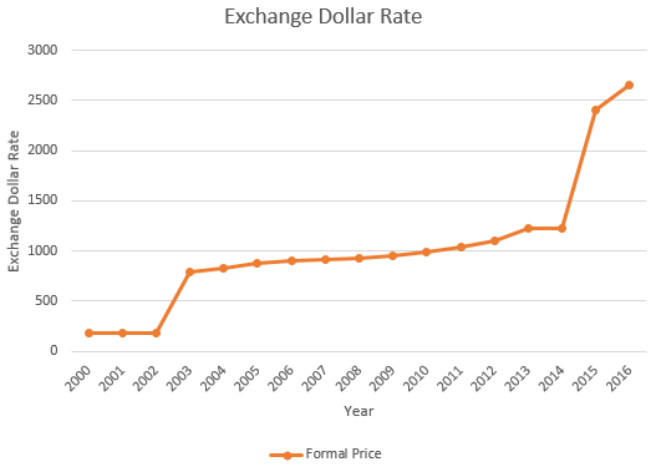

Fig. 6: Iran's Exchange Dollar Rate increase, Formal Rate Vs. Free Market Rate

C. Model of the Localization

Nowadays, most companies are strongly related to each other and cooperate with each other improve their economy and the quality for the final product. On the other hand, some technologies are more stable in one company in a special country that industries prefer to have its related part to be produced in that company. However, in some countries like Iran, due to the sanctions, cooperating is not easy for companies so they prefer to produce their needed parts inside the country which is called as localization. Localization can make the country more stable for further sanctions.

In the following part, we introduce several variables that affect the rate and amount of localization in a developing country. Then we model the relationships between these parameters and their quantitative effects on technology localization. The model consists of one main model and a sub model that are connected to each other to model the localization and the way it stabilize the industry.

1) Main Model of Localization : The main model in localization consists of dependency on foreign country, need to import new technology, financial support for R&D, R&D infrastructure, capacity of technology development, R&D activity, independently developed technology, rate of technology localization and technology localization. Country that is dependent to foreign country needs to import more new technologies. Import more technology, will reduce the financial support for R&D. On the other hand, having for support for R&D will increase the R&D infrastructure that will lead to more capacity of technology development and R&D activity respectively. On the other hand, increasing the R&D activities will increase the technology developed by country independently that will increase the expertise on technical knowledge. This increase in the expertise will increase technology localization that will decease dependency to foreign country. Figure 8 shows the over mentioned relations.

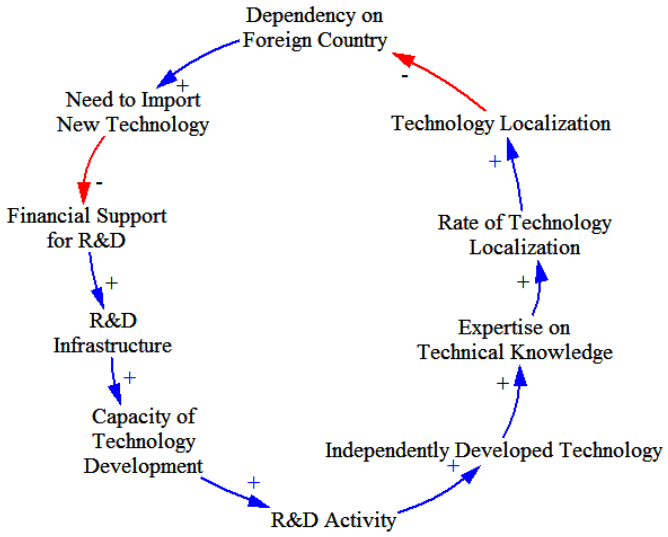

Fig. 8: Main Loop of Localization

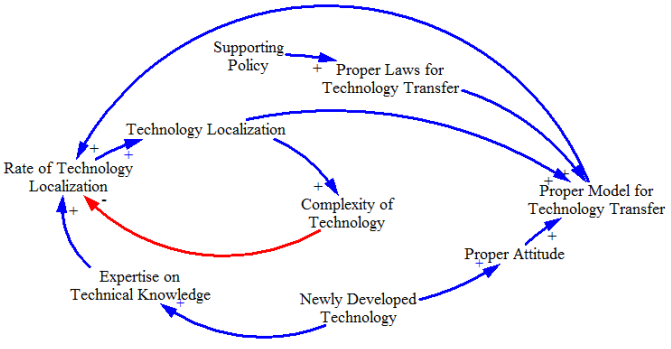

Fig. 9: Main Loop of Localization

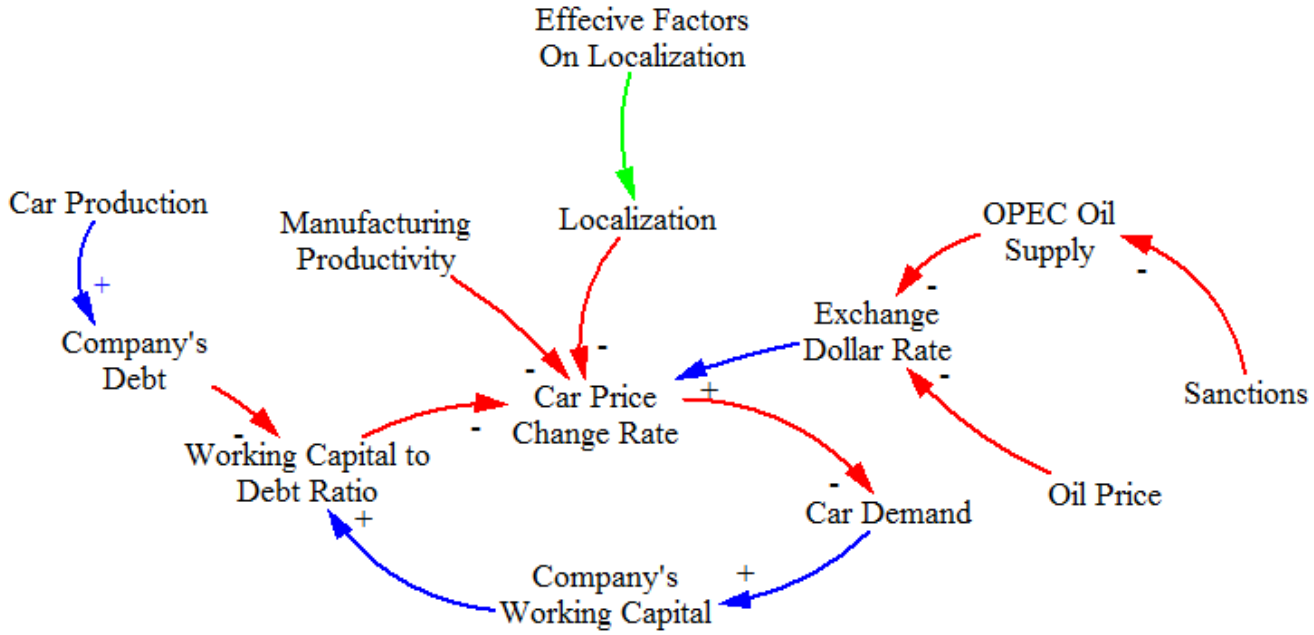

Fig. 5: Main Loop of Car Price

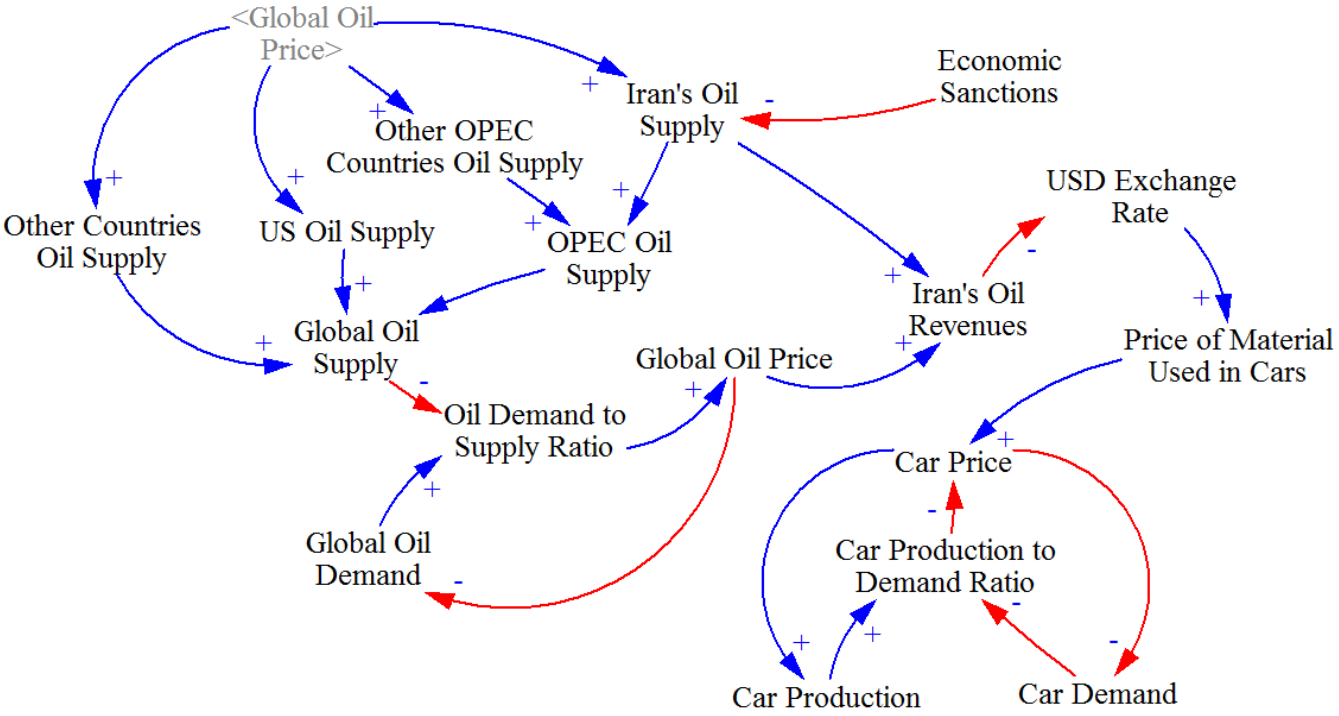

Fig. 7: Car Price Change

2) Sub Model: The sub model in localization consists of supporting policy, proper laws for technology transfer, proper model for technology localization, proper attitude, newly developed technology, expertise on technical knowledge and complexity of technology which is shown in Fig. 9.

The complexity of technology will decrease the rate for localization. On the other hand, supporting policy and proper attitude to for localization will improve the model for technology transfer.

III. SIMULATION RESULTS

For evaluating the model, we have simulated the price in Vensim PLE [51] for the car "Pride" produced by "Saipa" auto manufacturing which is the second largest auto manufacturing company in Iran. The real data for the price changes is between 2001 and 2015 [52]. Figure 7 briefly shows the overall connecting model. In the real data, after initialization of the sanctions on the oil market, the car price starts to climb to nearly triple its initial price, which was nearly flat before sanctions. Moreover, the damped oil price fluctuations are propagated with some delay to the car price. By the way, after a sudden jump in price, the government started to localize the industry which showed its effect in stabilizing the market in long term. Figure 10 compares the simulations results with real data. As it is seen form the figure, the model represents the trend of the market. The effect of localization is also clear in stabilizing the market which is reflected in the simulation.

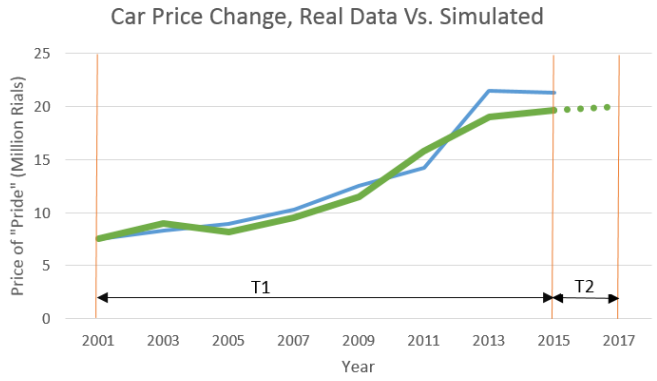

Fig. 10: Car Price Change

IV. CONCLUSION

This paper focus on modeling effect of sanctions on Iran's economy whose revenues is heavily dependent on the exports of the sanctioned product. Our main focus was on the Iranian car industry and we showed that due to the sanctions, there was a shortage in the foreign currency which led to an increase in the price of materials in the supply chain of the car industry and as the result, there was a great jump in the price at the beginning of the sanctions. However, in long term, due to investment of government on industry localization, the prices become more stable. In the paper, after developing a model for the oil market which was the main sanctioned product for Iran, we develop a model for the car market and relate it to the sanctions of the oil market. To describe the stability of the market in long term, we propose a model to explain effect of localization on the market. Our model explains and follows the historical trend of the market.

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