Speculative Dynamics of Exchange Rates in Turkey: A System Dynamics Approach

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Abstract

A country's economy may undergo a period of volatility due to domestic politics and challenging external environments. Foreign exchange rate is one of the factors that may affect and be affected by the economy of a nation significantly. Motivated by the volatile US Dollar exchange rate issue in Turkey, the impacts of speculation and manipulation on the dynamics of foreign exchange rate in developing markets are examined in this paper. The study focuses on the structures generating the unstable US Dollar exchange rate against Turkish Lira by using system dynamics approach, based on relationships among inflation, interest rate, exchange rate and monetary market. System dynamics is a convenient approach for this problem because of the nonlinear, dynamic and complex structure of this problem. First, a stable-market model is formulated by excluding any speculative and external disturbances, in the base model. Then, the effects of speculation among people, the existence of manipulative investors and interest rate adjustment intervention by Central Bank are included by extending the base model in each scenario. Simulation results reveal that coping with an economic crisis does not only depend on monetary policies but also on the perception and behavior of people. Policies that focus on preventing speculation/panic among individuals are therefore particularly important to avoid unstable fluctuations in exchange rates in developing markets.

1   Introduction

Exchange rate is considered to be an important determinant of a country's relative level of economic health. The movements in the exchange rate directly influence the overall competitiveness of a country and have the potential to directly improve the overall trade performance of the majority of the firms and the balance of payments in developing countries. In the recent history, developing and emerging-market economies in all the major regions have had to cope with financial crises due to surges in inflation, incorrect interest rate policies, huge losses in real income, rising debt burdens and inadequate measure of people's panic behavior due to the expectation of an imminent currency movement. However, a strategy of avoiding those financial crises and exchange rate instability has not been successfully implemented in the past and an applicable strategy is still not clear. An exchange rate is simply defined as the price of a nation's currency in terms of another currency and determined by the market

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forces of supply and demand. For instance, if the demand for US dollars by Turkish people increases, the supply-demand relationship will cause an increase in the price of the US dollars (USD) in relation to Turkish Lira (TRY). There are many factors affecting the value of a nation's currency; in this study in addition to the regular supply-demand dynamics, speculative and manipulative buy-sell decisions, interest rate for the national currency, and inflation are considered as factors.

1.1 Speculation in Foreign Exchange Markets

It is believed that speculative or manipulative behavior of some players in the foreign exchange market is one of the reasons of sharp increases in foreign exchange rates in developing countries. Speculation is a foreign exchange risk with a profit anticipation (Salvatore, 2007). "Destabilizing speculation refers to the purchase of a foreign currency when the exchange rate is rising or is high, in the expectation that it will rise even higher in the future. Thus, destabilizing speculation magnifies exchange rate fluctuations over time and can prove very disruptive to the international flow of trade and investments" (Salvatore, 2007, p. 420).

1.2 Interest Rate and Inflation

National interest rates influence exchange rates because they directly affect the supply and demand of a nation's currency. Higher interest rates provide higher return for national currency relative to other alternatives; higher returns attract individuals, investors and foreign capital, which increases demand and the value of the national currency and consequently causes the exchange rate to decrease. The opposite is true for decreasing national interest rates, which normally increases the exchange rates.

By monetary policy, national central banks control the rate of lending by banks by adjusting their base interest rate and available banking money reserves within their economies.

Inflation designates the value of national money, and widely thought of as the pace at which prices increase in a given economy. (European Central Bank, n.d.).

A relatively higher inflation rate in Turkey tends to reduce the value of its currency because high inflation means that the Turkish goods' price increase is quicker than the other nations' goods. Therefore, Turkish consumers will find it more attractive to buy, for instance, dollar imports and they will supply TRY to be able to buy dollars or dollar imports. Therefore, in the long run, changes in relative inflation rates will cause a change in exchange rates through affecting people's buying/selling preferences (Pettinger, 2012).

1.3 Turkish situation

Turkey is a developing country and it is dependent on outside financial sources in terms of resources, energy, technology etc. Therefore, when the exchange rate increases, money spending (TRY equivalence) for debts increases automatically. Increasing exchange rate will lead to an unhealthy economy due to decrease in new investments, decrease in economic growth, and increase in unemployment rate. Therefore, there is no doubt that unstable dollar exchange rate in Turkey has a negative impact on not only the governmental accounting but also every individual's standard of living. Dollar exchange rate against Turkish Lira has shown an increasing trend since the early 2000s. A representative data graph between 2006-2016 is given in Figure (1).

Figure (1a) shows that there is an increasing trend in USD/TRY exchange rate between 2006 and 2016. It can be observed that besides minor yet frequent oscillations, once every two or three years there are sudden/major peak points, which may indicate a crisis in the Turkish economy. Crises make it harder to analyze the regular cycles of the data. So, two relatively stable data sections are selected to analyze in order to set a reference mode for our model. April 23, 2009-July 2, 2011 period is selected to see the cycles in a relatively stable period of Turkish economy (Figure (1b)). April 7, 2014-August
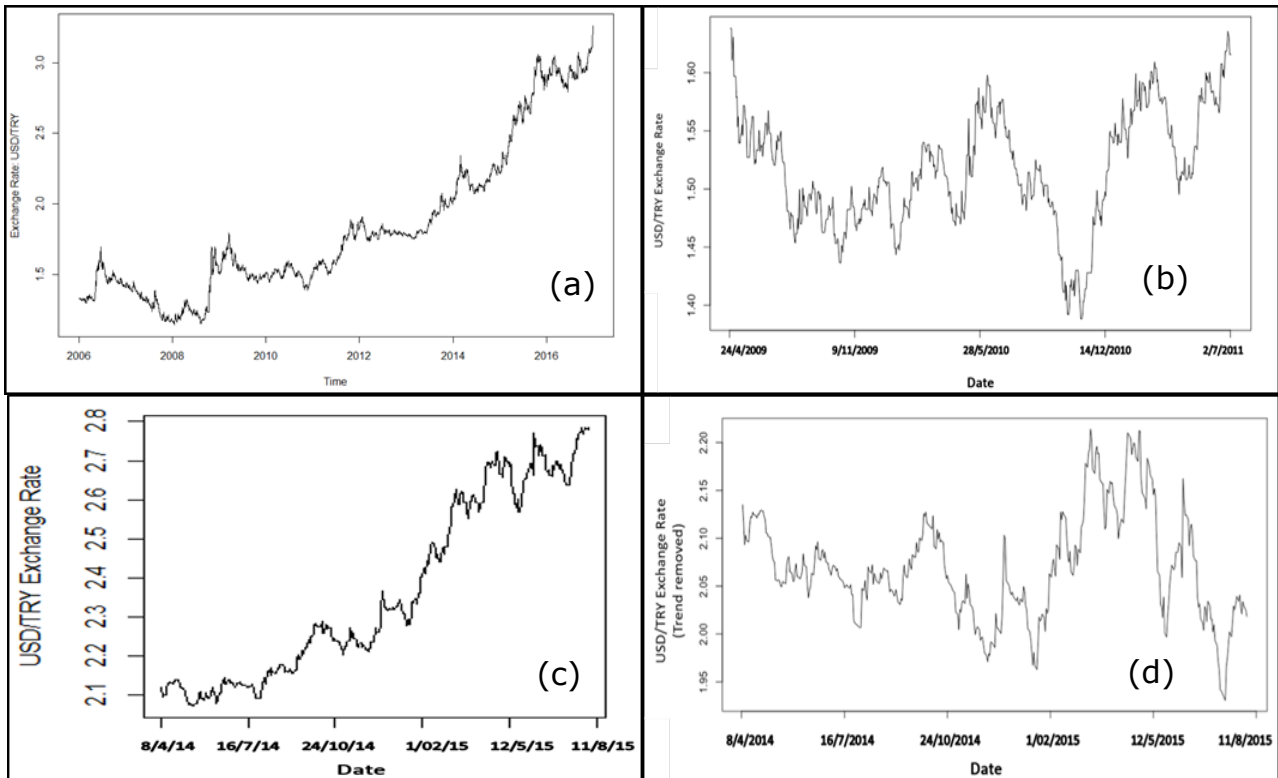
Figure 1: USD/TRY Exchange Rate (Data: TCMB-Central Bank of Republic of Turkey)

10, 2015 period is selected to see the cycles when there is an increasing trend in foreign exchange rate (Figure (1d)). There is an exponential trend in 2014-2015 data, so first the trend is removed from the data, then the cycles are examined.

Figure (1b) & (1d) show that oscillations exist in regular exchange rate dynamics with or without the trend. This result will be the reference mode for our model calibration and validation.

Based on financial theories, it is widely accepted that an increase in interest rates of domestic currency, will appreciate this currency against other foreign currencies. Thus, the necessity of implementing an interest rate policy in parallel with a sharp increase in the foreign exchange rate is considered as a critical intervention in most economies. In Figure (1a), we can see that dollar exchange rate has a sharp increase at the end of December 2013 and in the beginning of January 2014. It can also be observed that exchange rate decreases sharply back in less than a month. This immediate decrease arises from government intervention on interest rate on 28 January 2014.

Likewise, USD/TRY exchange rate had shown a rapid increase in Turkey recently, however Central Bank of Republic of Turkey (TCMB) opted for not implementing an interest rate policy for a while. Later, it was decided to increase the interest rate on 24 January 2017, which has followed by a considerable decline in the exchange rate. Consequential exchange rate and interest rate fluctuations can be seen in Figure (2).

This study aims to model and understand the dynamics of unstable/increasing dollar exchange rate in Turkey by observing speculative dynamics and evaluate potential strategies and policies to keep the exchange rate at a stable level. The dynamic structure of the problem (change over time), the existence of non-linear relations and feedback structure between variables (i.e. interest rate and exchange rate) shows that system dynamics is the convenient methodology to study this problem.
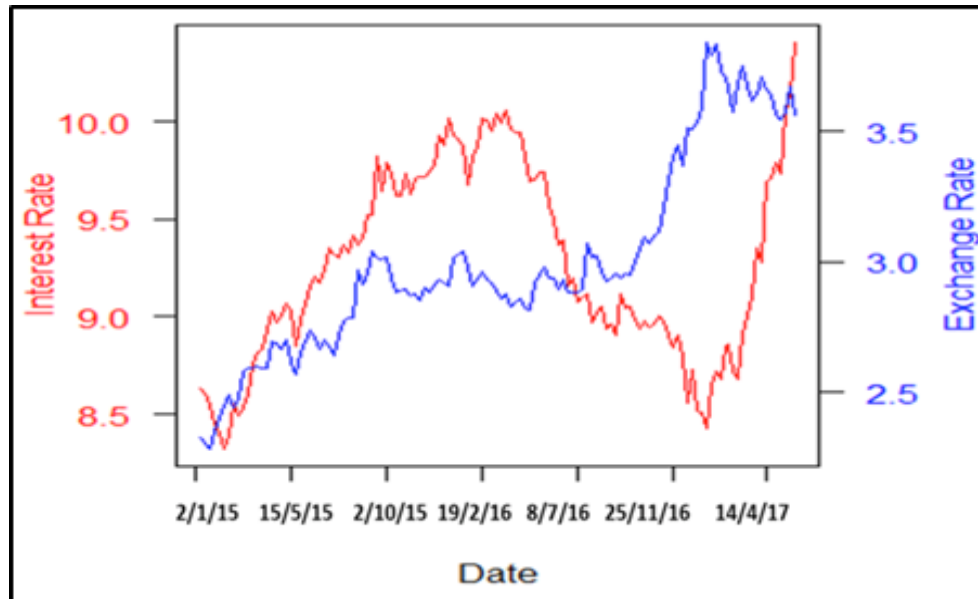
Figure 2: Interest Rate vs. Exchange Rate Data in Turkey (Data: TCMB)

2 Literature Review

2.1 Exchange Rate Dynamics

Furman *et al.* (1998) have examined the effect of an increase in interest rate, inflation, and many non-monetary factors on exchange rate for nine developing countries during 1992-98. They found that the high interest rate was associated with a subsequent depreciation of nominal exchange rate but the effect was more pronounced in low inflation country than in high inflation country.

Klitgaard and Weir (2004) tried to explain exchange rate changes in the short run by observing the net position of speculators. They claimed that interest rate, GDP and prices can be useful to predict exchange rate in the long run, however in the short run (daily basis) the behavior of speculators must be observed.

2.2 Speculative Behavior Modeling in System Dynamics

Sterman (2000) mentioned from speculative bubbles in Business Dynamics as positive feedback loops that are created by "the locally rational behavior of individual entrepreneurs?. Mill (1848) explained behavior of speculators in Principles of Political Economy (1848). According to Mill, speculators stock goods despite of high prices with the expectation of a further price increase and they cause more price increase (1848). Dwenger and Pavlov (2008) worked on the feedback analysis of speculation in foreign exchange market. They examined chartists and fundamentalist movements on foreign exchange market with feedback loops. Benmaran and Saeedi (2014), studied on identification of speculative bubbles in Tehran stock-exchange market with system dynamics approach. In that study, the economy was assumed as a closed-economy to focus on internal dynamics. Mohammadi *et al.* (2010) mentioned speculative demand in land market and its effect on house market. They used a system dynamics approach to model the market and pointed the land price and rate of change of the land price as the reasons behind the speculative demand.

3 Methodology

System dynamics methodology is an attempt to address the complex dynamic problems of the contemporary world and try to gain insight on long-term policies to applicable these problems (Barlas, 2002). System dynamics methodology is founded on nonlinear differential equations and feedback structures ((Sterman, 2000); (Barlas, 2002)). Finding an analytical solution to high order and nonlinear differential equations is typically not possible, therefore system dynamics simulation becomes a convenient methodology for this kind of problems. Another benefit of using a simulation method is to conduct policy analysis which are costly and may take too long in real life. It is hard to try different policies on a country's economy without causing damage, besides the fact that results of these policies can be observed after a long-time period. This study aims to model exchange rate dynamics and understand how different players in the market affect the overall dynamics. Understanding theses dynamics may help decision makers to prevent future crisis in an economy.

Causal interactions of variables determine the behavior of the whole system. Causal loop diagrams are used to represent these causal relations and overall structure of the system. Direction of causality is shown by an arrow. When the value of one variable increases (decreases) if it causes the value of other variable to increase (decrease), it is called positive causality and indicated by a (+) sign on the arrowhead. When the value of one variable increases (decreases), if it causes the value of another variable to decrease (increase), it is called negative causality and indicated by a (-) sign on the arrow-head (See for example Figure 7, below). The overall sign of a loop is obtained by multiplying the sign of each arrow in a loop. Negative loops are self-balancing, positive loops are self-reinforcing (Sterman, 2000). An isolated self-balancing loop means the system will reach a balance and equilibrium eventually. An isolated self-reinforcing loop means the system may explode or collapse.

In System Dynamics methodology, differential equations are represented by variables named as stocks, flows and converters (Barlas, 2002). Stocks are the state variables, flows define the rate of change of stock variables and converters are auxiliary variables. Stocks are represented with rectangle shapes, flows are represented with valves on arrows into or out from stocks, converters are represented by circles which can be seen in Figure 11. Dollars in the market is a stock, buying and selling of individuals are flows and effect of speculation is a converter in that figure.

In real life, systems do not respond to an effect immediately, but after a time delay. By system dynamics methodology it is easy and possible to model these delay structures.

4 Model Structure

4.1 Research Objectives

The research objectives can be stated as follows:

- Understanding the stable and speculative dynamics of dollar exchange rate in Turkey

- Understanding some of the consequences of and public reactions to changes in the exchange rate

- Analyzing the Central Bank's interest rate policy effects on the exchange rate dynamics

- Analyzing potential policy scenarios for keeping dollar exchange rate at a stable level

4.2 Model Overview

Our purpose is to model the regular and speculative dynamics under various scenarios and understand the factors that control the main dynamics in the market. Causal relations in the model are based on

well-known economic theories. Turkish economy is the case study for this paper, thus the parameter values are taken from Turkish economy and related dynamics are considered during modeling. Besides the fact that this study focuses on Turkish economy, four different types of economic settings are also approximated and analyzed in this study.

The model comprises the allocation of US dollars among the individuals, big investors and the exchange market. Individuals and big investors can buy/sell US dollars from/to market thus their actions determine the price of US dollars based on the well-known supply-demand theory. Individuals are simply the players in the market who are concerned only with their own profitability and buy/sell US dollars accordingly. Their individual actions do not affect the market significantly since they play with small amount when compared to the total amount of US dollars in the market. However, the cumulative buy/sell decisions of individuals have a significant impact on the behavior of the market. Big investors are the manipulative players who buy/sell huge amounts of US dollars not only to have large amount of profits but also to influence the fluctuations in the exchange market ? and the price, for their expediency. They can manipulate the market with their buy/sell decisions.

In the first economic setting, there are no players who try to manipulate the market by huge levels of US Dollar buying/selling and the individuals do not tend to increase their buying under speculation. Individuals and big investors are assumed to be sensible. This is the base run for this study. It represents stable supply-demand oscillations in the economy without any disturbances.

In the second economy, individuals are speculative while big investors are sensible. Even though there are no manipulative players in the market, the individuals tend to buy more US Dollars when the exchange rate goes up too quickly, since they do not trust the economic structure of the country - basically they do speculative buying.

In the third economy, big investors are included in the model to manipulate the market. However, the individuals do not panic or speculate and do not buy US Dollars if the exchange rate is higher than their reference values. In other words, there is no speculation in the market; individuals are sensible.

In the fourth economy, there are both manipulative players in the market and individuals cause speculation when the rate of change of exchange rate is higher than their reference values and they buy more money even though the exchange rate is too high. The reason behind their speculative buying is that individuals expect that the price cannot be controlled in the future and the exchange rate will rise even more. The fourth model is the total crises scenario for an economy, which may lead to collapse of the entire economic system in a country. The players who can change the dynamics of the market by buying/selling large amounts of US Dollars are named as "Big Investors" in this study.

Investor Behaviors ⟍ Individual Behaviors	**Sensible Big Investors** Players do not disturb the market to obtain more profit.	**Manipulative Big Investors** There are players who disturb the market to obtain more profit.
Sensible Individuals Since people don't see risk in the market they don't buy speculatively.	1	3
Speculative Individuals Rapid changes in the exch. rate lead individuals to buy more US Dollars.	2	4

Table 1: Features of Economic behaviors modeled in the study

Furthermore, an interest rate control mechanism is modeled to control the crises in the speculative

market. The central bank (TCMB for Turkey) controls the interest due to the rate of change of exchange rate. It is assumed that central bank is aware of the threshold for people to start speculations. The main objective of the central bank to pull the rate of change of exchange rate to this threshold value to prevent crisis by changing the interest rate accordingly.

4.2.1 Causal Loop Diagrams

The most important loops that govern four different economic behaviors of Table (1) are shown in Figures (4a - 4d).
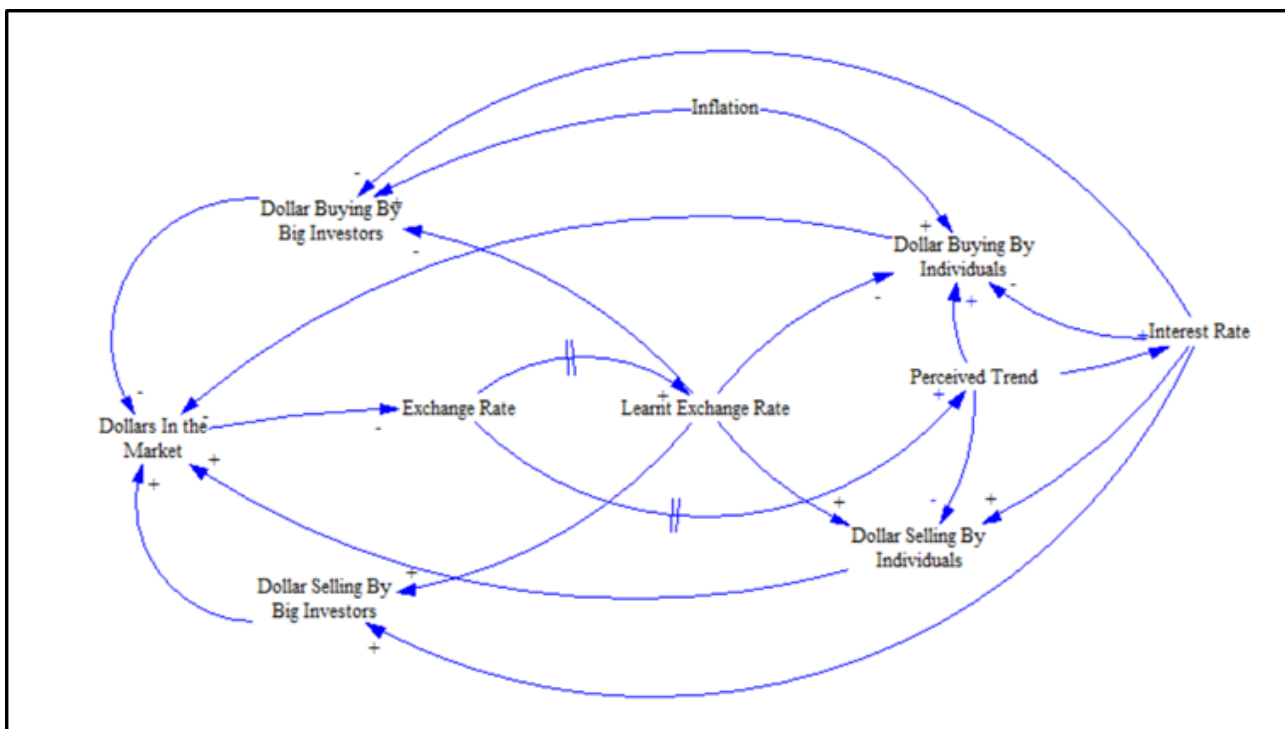
Figure 3: Speculative Market Model

4.2.2 Stock-Flow Diagram

A simplified version of stock flow diagram is shown below in Figure (5). The main stocks and their relations are presented to provide a comprehensive perspective on the model. The complete stock-flow model can be found in appendix Figure 21.

4.2.3 Main Variables and Main Effect Formulations

Price of Dollars   Price of Dollars is a function of dollars in the market divided by reference dollars in the market, which is formulated according to supply-demand theory. This reference indicates the average dollar quantity in the market. As quantity (US dollars in the market) increases, price of the dollar decreases and vice versa. The reference value and range of ratio (x-axis) are determined by research on the market. Sensitivity analysis is conducted around these values to obtain the closest dynamics to real ones.

(a) Stable Behavior of Individuals

(b) Stable Behavior of Big Investors

(c) Individuals' Behavior under Speculation

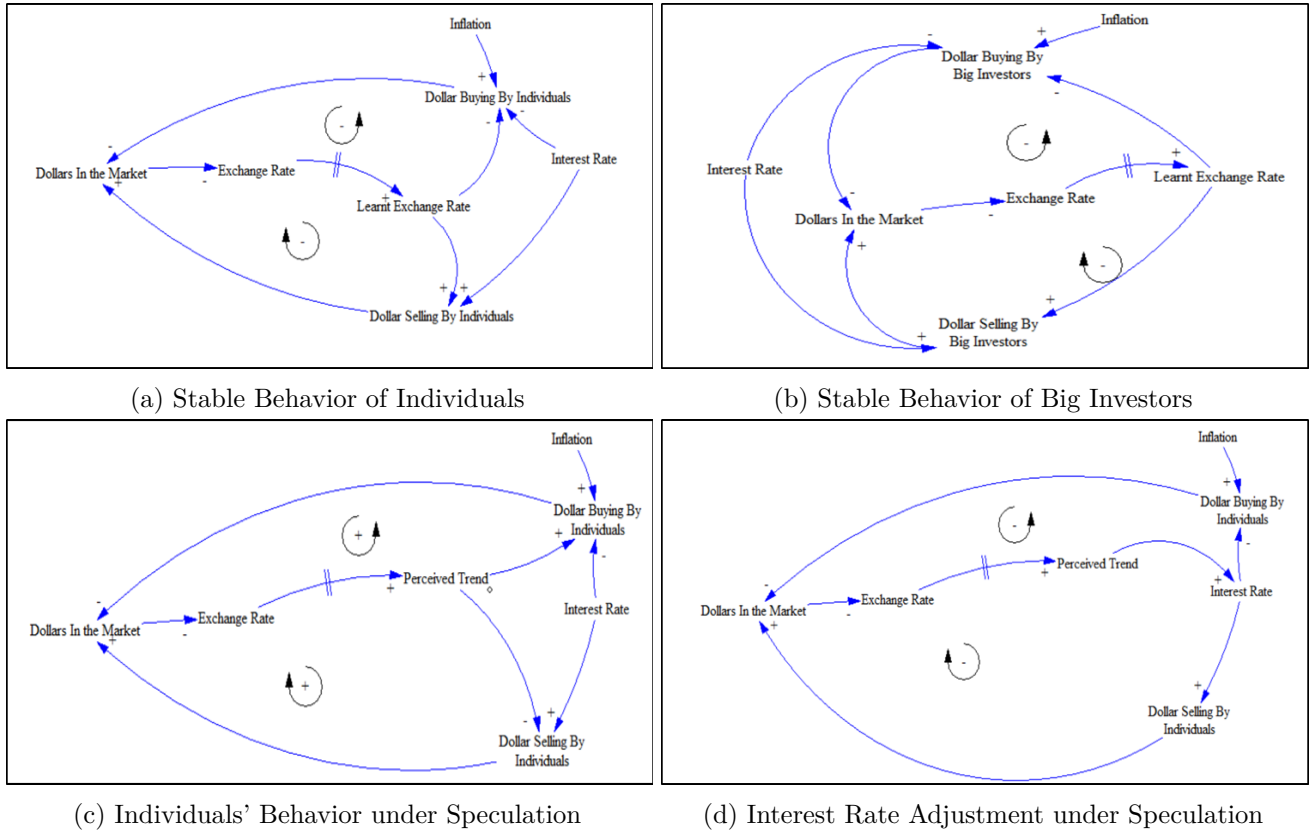(d) Interest Rate Adjustment under Speculation

Figure 4: Main Loops

Effect of Speculation   Effect of speculation is a function, which affects the buying and selling rates of individuals. Individuals determine the speculation level due to rate of change of exchange rate. To calculate rate of change, thirty days delayed value of exchange rate is subtracted from the current value of exchange rate, then this value is divided by thirty-day period. This calculation provides the slope of exchange rate. If the slope is higher than the reference of individuals, they start to speculate and show buying or not selling behavior due to panic. The reference value is determined by the average of absolute value of non-speculative environment rate of change. Sensitivity tests are conducted around this value to reach real life dynamics.

Buying Function of Big Investors   Two different functions are used as buying function of big investors to create two variants of economic structure. The first buying function is same as the buying function of individuals. In this economy, the big investors are not in a manipulative behavior. In the second version of the function when the exchange rate falls below the buying reference value of big investors, the function becomes steeper and they can increase their buying to ten times with respect to their base buying.

Interest Rate Adjustment Formulation   Central bank adjusts the interest rate with the feedback loops. Since the reason behind the speculation is the increasing rate of change of exchange rate, the central bank determines its target as decreasing the slope of exchange rate function. It is assumed that central bank knows the threshold value of individuals to begin speculation and tries to bring the rate of change of exchange rate to this value by increasing interest rate. A multiplicative formulation is used. The ratio of slope of exchange rate to threshold rate determines a coefficient, which is multiplied

with the reference (base) interest rate.

Reference Update   Individuals and big investors have initial references to buy or sell dollars to the market. However, since the economy may have a trend they must update these reference values. In this study, individuals and big investors update their reference with 45-day periods.
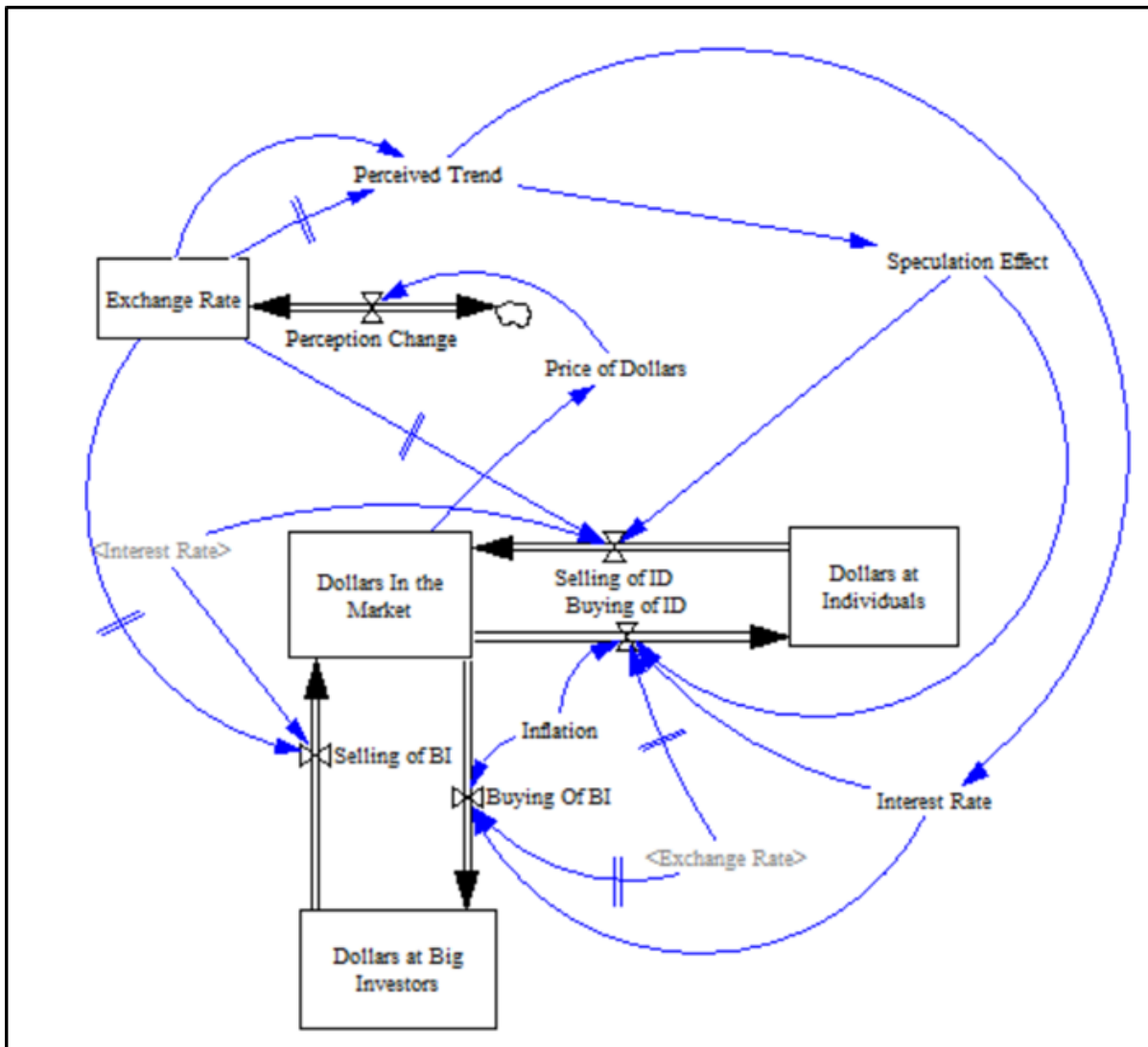

Figure 5: Simplified Stock-Flow Diagram of the Model

4.3   Assumptions and Determination of Initial Values

When the TCMB (Central Bank of the Republic of Turkey) statistics and other statistical channels are investigated, it is not likely to find exact values for initial money stocks. The data is either not available for these measures or out-of-date. The values are determined with approximation and intuition according to news site and newspaper articles related to that topic. Since the project has started in December 2016, initial values are determined according to December 2016-January 2017 data available for Turkish economy.

4.3.1   Assumptions

- **Closed economy**: Model boundary is limited with Turkey. In this model, the number of dollars in Turkey is constant. It means there is not any international money inflow or outflow. It is crucial to assume a closed economy model to investigate the effects of internal factors on foreign exchange market rather than the external factors.

- It is assumed that in this economy there are only US dollars and Turkish lira as investment tools. (Gold, stock market and other foreign currencies are neglected.)

4.3.2   Initial Values

- Dollars At Individuals: According to an article on Bloomberg HT (Yıldırım, December 12th, 2016) the amount of dollar deposit account of domestic individuals is $ 88.718 billion. By assuming there may be dollar reserves of individuals out of recorded economy, the initial value is taken as $ 100 billion (Captital.com, August 1st, 2001).

- Dollars At Big Investors: There are different news articles about how much dollar have the big investors at bank. According to a financial news site, (Finansgündem.com, December 3rd, 2016) it is approximately $ 389 billion. According to Bloomberg HT it is approximately $55.631 billion (Yıldırım, December 12th, 2016). With respect to these values, $200 billion is taken as the initial stock of big investors.

- Dollars In the Market: This value is determined according to some point in between dollars at individuals and dollars at big investors. It is $ 135 billion.

- Dollar Exchange Rate: It is taken as 3.5 USD/TRY (December 20th, 2016 value).

- Central Bank Dollar Reserve: It is taken as $ 120 billion (Bloomberg HT, October 20th, 2016).

- Reference value of money flows: The reference daily selling amount of both individuals and big investors taken as the twice of their daily buying amount. The reference value represents the normal daily transactions to sustain the life. In addition to that, the currency in Turkey is Turkish Lira. So, it is assumed that people tend to use more Turkish lira than US dollars in daily life and they exchange their US dollars to Turkish lira more than they exchange their Turkish Lira to US dollars. The total reference flow of individual's and big investor's money stock is 6% of the initial value of each stock. This assumption is based on "foreign currency transaction volume of the banks" statistics of TCMB. According to January 2016 table, the daily average transaction is $ 16.502 billion (TCMB Foreign Currency Transaction Volume, 2016). Stocks have inertia, however flows change suddenly, so January 2016 is selected as reference date since it was the pre-crisis period for Turkey. In this model, it is assumed as $18 billion.

- At the day of model construction, the value of inflation was 8.5% (at the end of year it rose to 8.8%) according to TCMB data; the reference inflation is taken as expected inflation for 2015, which is 5% (TCMB Inflation Expectation, 2015).

- The current overnight interest rate value is 7.25%, which is taken from TCMB data (TCMB Interest Rates, 2016); the reference interest rate value is taken as 8.33%, which is expected overnight interest value from the survey (TCMB Expectation Survey, December 15th, 2016).

5 Model Validation

5.1 Direct Structure Validation

The model is constructed in three phases: Regular behavior, speculative behavior and the speculative behavior with central bank intervention. For direct structure testing, at each stage, the relationship between variables and parameters are checked by blocking some parts of the system. For example, for goal-seeking market model, the big investor flow is blocked at the beginning and observed only the behavior of the individuals in a regular economic environment. Then the big investors are included into the model. After then, the speculation effect is added. At the end, the adjustment on interest rate by Central Bank is added.

Unit consistency test and coefficients' real meaning test are also done for all equations. Except price of dollars, all effect formulations are designed as multiplicative. So, the effect functions give unitless coefficients. Units of money stocks are US dollars and their flows are in US dollars/day. Units of exchange rate stocks are US Dollars/Turkish Lira and their flows are US Dollars/Turkish Lira-day.

5.2 Indirect Structure Validation

For indirect structure validation, extreme condition tests are performed and the system behaviors under extreme conditions seems to be valid. Each effect function is bounded for extreme values. These upper bounds are determined by the change in real data. Effect formulations saturates at certain values.

During effect formulation, non-linear behaviors of the system are taken into account and non-linear behaviors in real life are modeled with effect formulations that are drawn with graphical function in non-linear manner. Desired and actual values of variable are distinguished.

Various sensitivity tests are done by different initial values greater than, equal to and less than reference values of individuals and big investors. Different ranges are applied to effect formulations and the system behavior is observed due to changes. The behaviors of the models remain logical in each case.

6 Output Behavior Analysis

In simulation experiments, time horizon is taken as 1250 days, which is approximately 3.4 years. Time period is one day. For these experiments, in first one year or two years model adjust itself due to its initial values, then shows steady-state behavior. However, it is not likely for an economy to last for three years in such crisis. Some political change will eventually occur during such catastrophic crisis.

First part of the output behavior analysis is deterministic. The reference buying and selling values of individuals and big investors are constant. In the second part, experiments have a stochastic behavior. Buying/selling references and price of dollars have normal distribution with mean is equal to reference values and standard deviation is equal to 30% of the mean value.

When first scenario analyses were done, there were significant transient behaviors at the beginning of each run. To avoid this, the initial values of money stocks (Dollars at Individuals, Dollars in the Market, Dollars at Big Investors) are set at some point near their equilibrium values for base run.

6.1 Scenario Analysis of Deterministic Models

In this part five different scenario analyses are conducted. The first scenario can be considered as the base run of the model. In the first two experiments, there are not any manipulators in the market. The second three experiments involve manipulators in the market. For both cases (manipulators

do not exist and do exist), first market behavior is regular (non-speculative), then it is speculative. Finally an interest adjustment policy is applied to speculative and manipulative market condition. In goal-seeking case, big investors and individuals have the same buying function. In manipulative case, big investors have a steeper buying function with respect to exchange rate changes. They can buy up to ten times of their reference buying value.

6.1.1   Sensible Individuals and Sensible Big Investors

In this case, manipulation and speculation behaviors are excluded, as it is the base run of the model. Market behavior is assumed to be regular. Individuals and big investors buy US dollars when the price is low, and sell when the price is high. There is borderline equilibrium in the market. As it is shown in Figure (6), there are only minor oscillations in the market, which is consistent with real life.
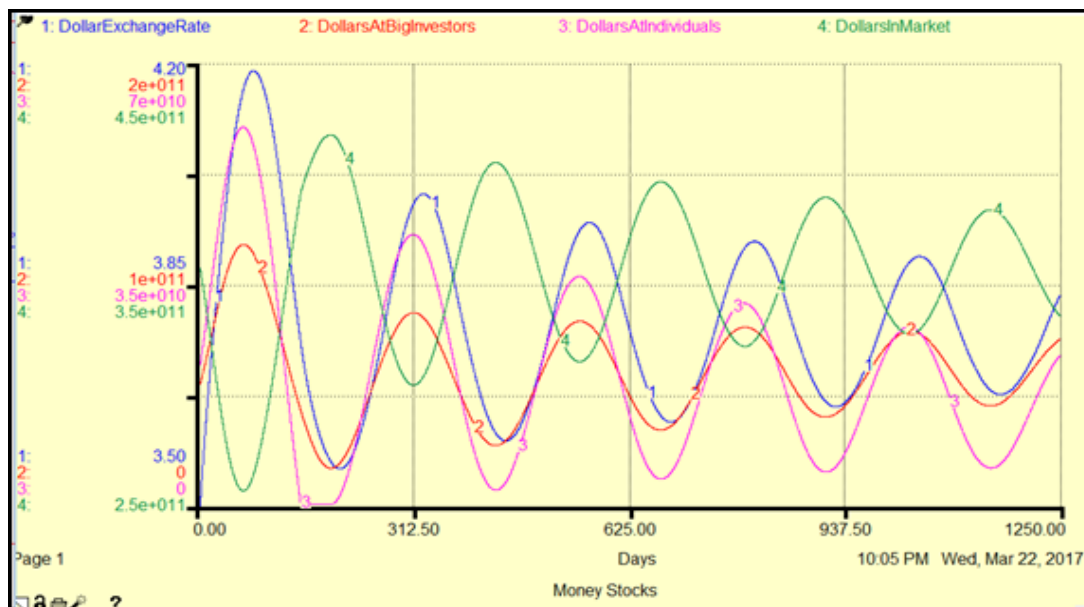
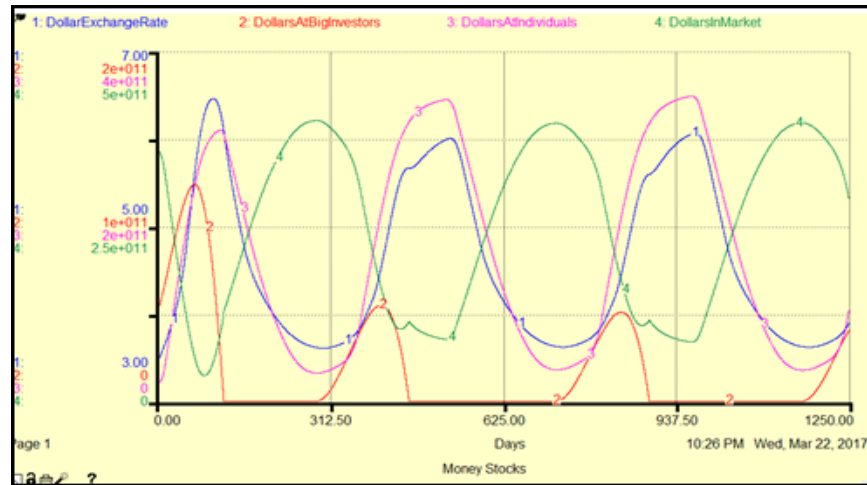Figure 6: Model Dynamics with Sensible Individuals and Sensible Big Investors

6.1.2   Speculative Individuals and Sensible Big Investors

Even though, there are any not manipulators in the market, individuals speculate when the rate of change of exchange rate is high, then they start to buy more dollars from the market and with reinforcing loop, the exchange rate increases even more. Individuals continue to buy despite the increasing exchange rate as they anticipate that price of a dollar will rise even more in the future. On the other hand, big investors are not assumed to show manipulative behavior here ? they buy only when the exchange rate is low.

In Figure (7a), it seems that an economic crisis occurs during the first half-year and speculative cycles are observed to continue in the following years. However, after an economic crisis in such magnitude, the economy of a country might collapse and all the dynamics might change in real life. In Figure (7b) shows crisis dynamics in more detail.

6.1.3   Sensible Individuals and Manipulative Big Investors

In this setting, even though big investors buy US Dollars in large quantities, since individuals are assumed to be sensible, crisis does not occur in this market. Individuals respond big investors move

(a)
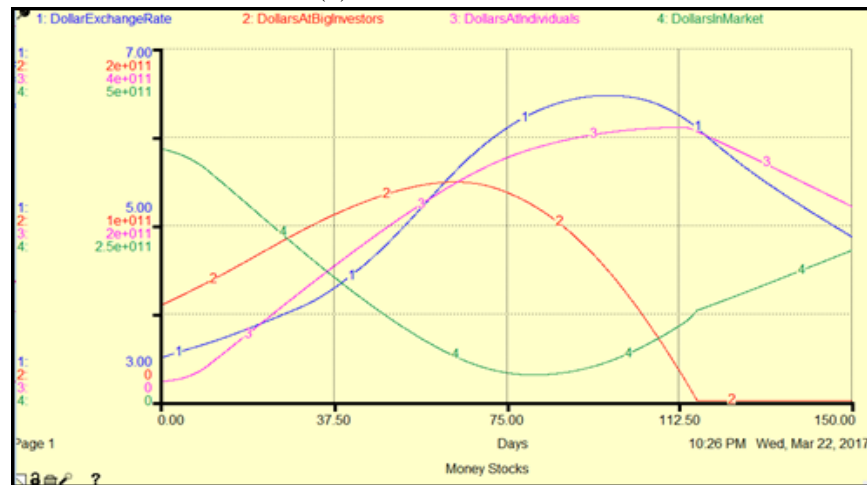
(b)

Figure 7: Model Dynamics with Speculative Individuals and Sensible Big Investors with different time horizons

by buying less dollars.

6.1.4 Speculative Individuals and Manipulative Big Investors

In this case, both speculation and manipulation effects are included to the model. Big investors manipulate the market by playing with huge number of US Dollars with intention of making profit, meanwhile individuals panic and respond to market by keeping US Dollars even tough price of a dollar is high. This run reflects the real life economic market dynamics of crisis situations.

6.1.5 Speculative Individuals and Manipulative Big Investors + Control of Interest Rate by Central Bank

An interest rate adjustment policy is added to the preceding model. There is an increasing exchange rate at the beginning, but interest rate adjustment prevents the crisis before it happens. As it can be seen in Figure 16.b in detail, there is a sharp increase in exchange rate, however interest rate adjustment policy brings exchange rate to equilibrium.
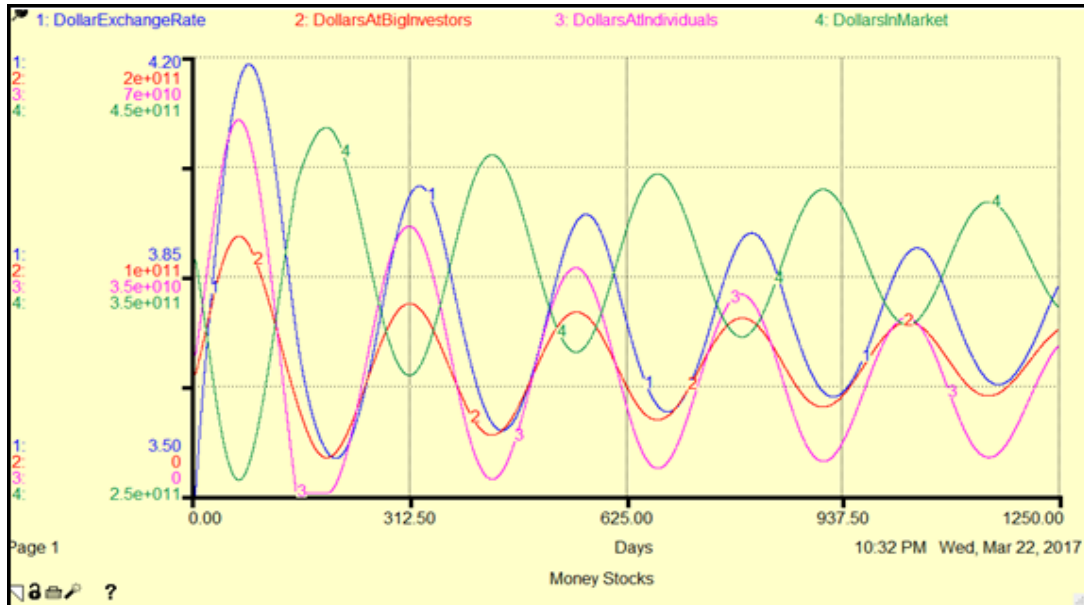
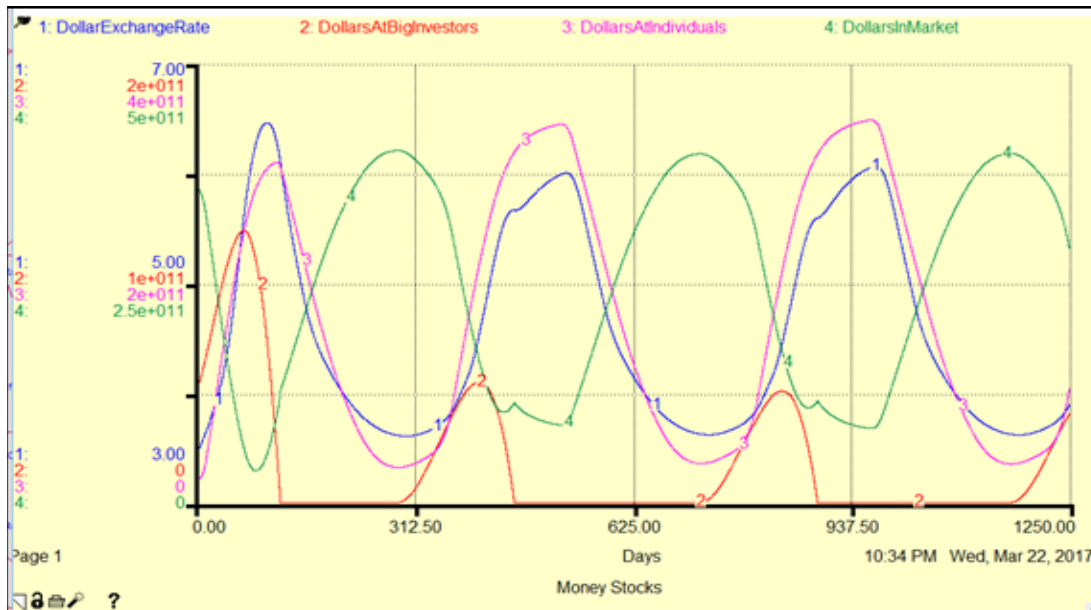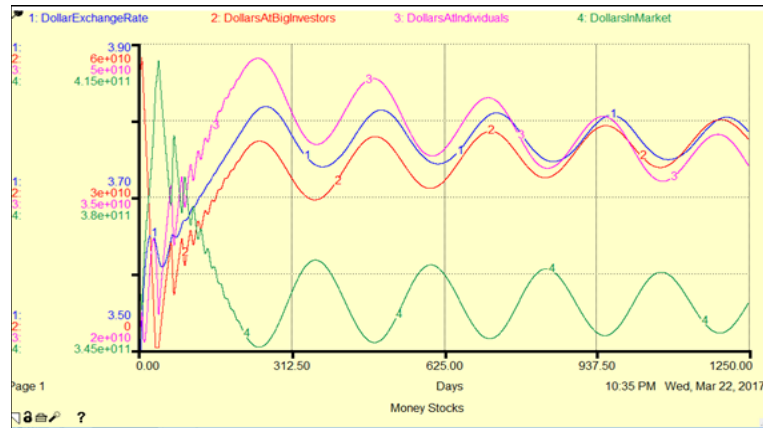Figure 8: Model Dynamics with Sensible Individuals and Manipulative Big Investors

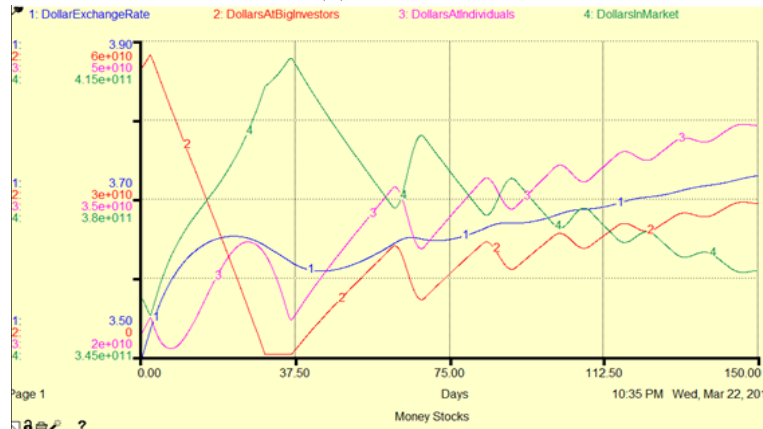Figure 9: Model Dynamics with Speculative Individuals and Manipulative Big Investors

As it is seen in Figures (10a), (10b) and (11), by adjusting interest rate in accordance with people's expectations, keeping the exchange rate at a low and stable level is possible.

6.2   Scenario Analysis of the Stochastic Versions of Models

In stochastic models, the buying/selling reference values of individuals and big investors and dollar price have normal distribution. These references represent if there is not any effect of exchange rate, inflation and interest rate on buying/selling behaviors. The players in the market will buy/sell these US dollar quantities in daily basis. In stochastic setting, noise is observed. Although the main pattern is conserved in the first two settings, noise affects model behavior considerably in the third setting.

(a)

(b)

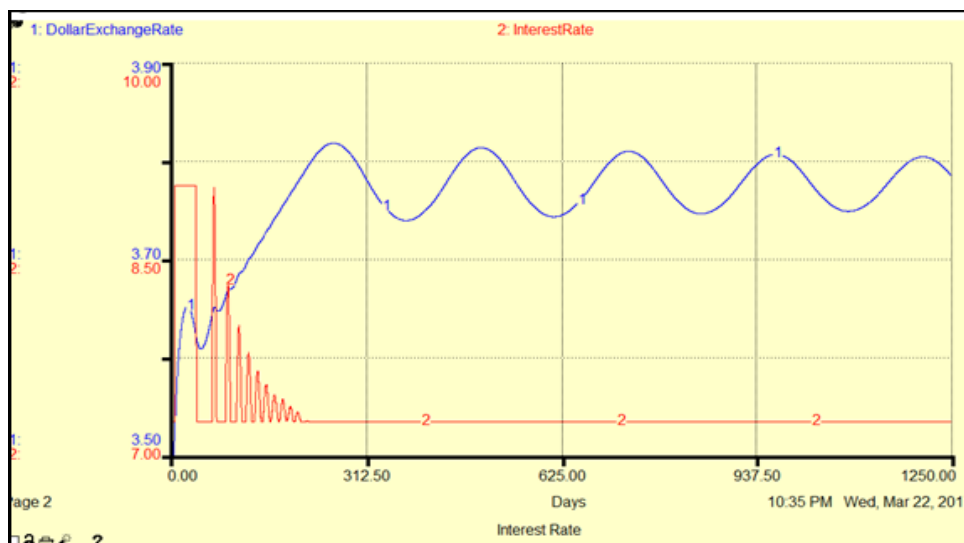Figure 10: Speculative Individuals and Manipulative Big Investors with Central Bank intervention (with different time horizons)
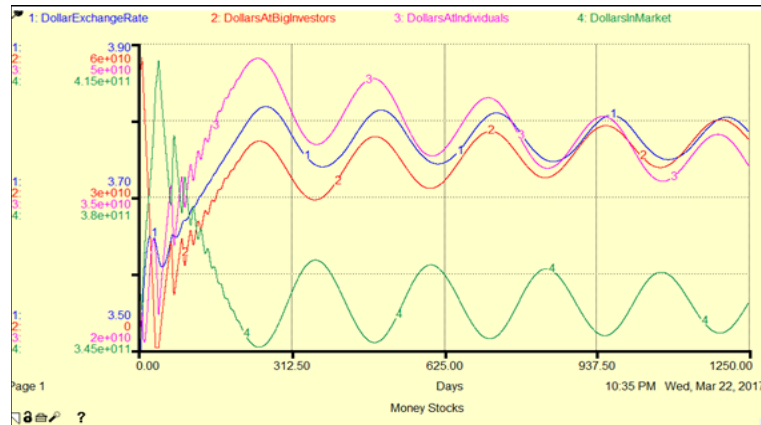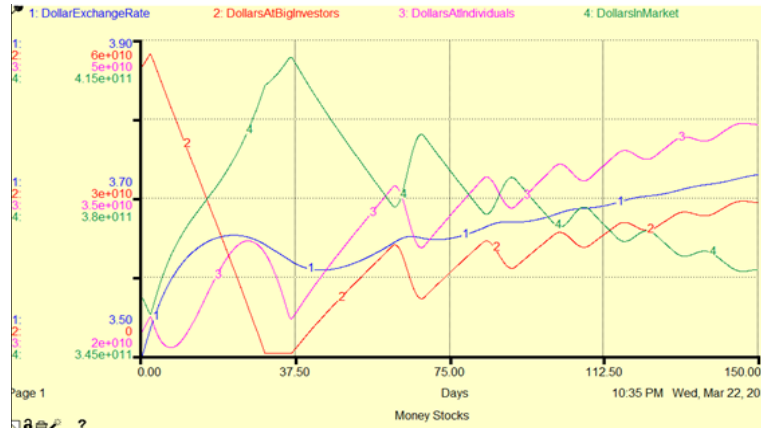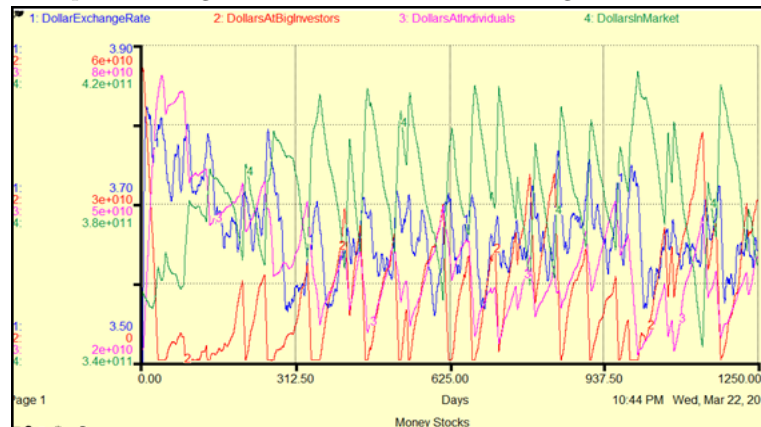

Figure 11: US Dollar Exchange Rate Dynamics depending on Interest Rate Adjustment

(a) Model dynamics with Sensible Individuals and Manipulative Big Investors in Stochastic Setting

(b) Model dynamics with Speculative Individuals and Manipulative Big Investors in Stochastic Setting

(c) Speculative Individuals and Manipulative Big Investors with Central Bank intervention in Stochastic Setting

Figure 12

7 Conclusion and Future Work

Motivated by the volatile US Dollar exchange rate issue in Turkey, the impact of speculation and manipulation on the dynamics of foreign exchange rate is examined in this paper. In this context,

this study attempts to analyze the relations among inflation, interest rate, exchange rate and the monetary market supply-demand by using system dynamics approach. This approach is adopted in order to better address the real-life feedback interactions, and causal mechanisms behind the unstable foreign exchange rate dynamics in Turkey.

A case study of Turkish exchange rate market is chosen; however the proposed model is applicable/adaptable to other developing country economies, once the relevant parameters are estimated.

As a base run, a goal-seeking market is modeled. The structural validity of the model is thoroughly tested. Then, the effects of speculation and panic behavior among people, the existence of manipulative investors and interest rate adjustment intervention by Central Bank are incorporated by extending the base model for each scenario.

The most important conclusion from simulations is that the existence of speculation/panic among individuals in the market is even more harmful than the existence of big manipulators in causing possible exchange rate crises. Economic institutions must be aware of this fact and lead the public perception and economic behaviors with this principle. A policy that focuses on preventing speculation among individuals is required in order to have a stable foreign exchange rate. As it is shown in the interest rate adjustment scenarios, once the people's expectations are satisfied, the exchange rate variables come to equilibrium eventually.

This study focuses on the interacting effects of foreign exchange rate, interest rate and inflation on the foreign exchange rate market, and circulation of foreign currency among the different players in an economy. Even though the exchange rate and interest rate are part of feedback loops, the inflation is not modeled as an endogenous model structure. In future research, the monetary policies of central bank and the interactions between these monetary policies and dollar market and inflation can be modeled endogenously and examined.

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