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A dynamic financial stability analysis of the foreign exchange market

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ABSTRACT

Economic stability is considered one of the fundamental prerequisites for sustainable economic growth, and exchange rate fluctuations, being one of the most significant macroeconomic variables, play a decisive role in either strengthening or undermining this stability. The main objective of this study is to evaluate the financial stability of Iran's economy by focusing on a dynamic analysis of the foreign exchange market over the past two decades. Using a system dynamics approach and Vensim software, the model is developed based on two decades of empirical data and simulated for the next 20 years. Causal and feedback relationships between the exchange rate and key macroeconomic variables are modeled to capture the dynamic interactions within the system. Simulation results indicate that sharp exchange rate fluctuations during periods of crisis have significantly undermined investor confidence, banking indicators, and financial balances, thereby intensifying financial instability. The findings reveal that fixed exchange rate policies or abrupt rate hikes are among the least effective approaches, while gradual and economically-aligned increases have comparatively lower negative impacts on macroeconomic indicators. In fact, a managed floating exchange rate regime is identified as a key factor in promoting financial stability. The study underscores the necessity of structural reforms in Iran's monetary and exchange rate systems to mitigate currency shocks and enhance long-term economic resilience.

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1. Introduction

The foreign exchange market plays a vital role in shaping economic equilibrium as one of the most important components of a country's financial system. This market not only facilitates international transactions and foreign trade but also serves as a key indicator of investor confidence and macroeconomic stability. In the case of Iran, which faces challenges such as international sanctions, dependence on oil revenues, and severe exchange rate volatility, the performance of the currency market has a direct impact on inflation, economic growth, and social welfare. Therefore, a thorough analysis of this market is essential for understanding future trends and formulating effective monetary and fiscal policies.

Exchange rate fluctuations can act as a double-edged sword. On the one hand, managed changes can improve export competitiveness and help balance the current account; on the other hand, sharp and unpredictable fluctuations can exacerbate economic instability. In Iran, currency shocks have often resulted in heightened uncertainty, capital flight, depreciation of the national currency, and inflationary pressure — all of which pose serious threats to financial stability. Consequently, assessing the dynamics of the foreign exchange market and identifying the root causes of volatility are critical steps toward formulating sustainable strategies to reduce Iran’s economic vulnerability.

Severe currency market volatility can have detrimental effects on economic stability, including higher inflation, currency devaluation, increased economic uncertainty, and disruption of long-term planning for firms and households. Studies have shown that currency shocks in developing economies like Iran often lead to increased import costs, reduced purchasing power, and instability in financial markets (Dornbusch, 2001; Krugman, 1979). Moreover, uncontrolled exchange rate fluctuations can place additional stress on the banking system and increase the risk of default, thereby weakening financial stability (Mishkin, 1996). Given the current context of sanctions on Iran and its oil dependency, managing such volatility is crucial to prevent the deepening of economic crises in the country.

Given the importance of the exchange rate in ensuring economic stability and the significant impact of its fluctuations on key macroeconomic variables such as exports, imports, and economic growth, the present study aims to examine the effects of exchange rate volatility on economic stability. In other words, the core objective of this research is to evaluate how fluctuations in the exchange rate influence the sustainability of economic stability indicators.

The paper proceeds by first presenting a review of the literature and theoretical foundations. The research adopts a system dynamics approach, beginning with the development of causal loop diagrams and followed by the construction of stock and flow diagrams for model implementation and scenario simulation. The article concludes with model analysis and policy implications.

2. Literature Review

Amarati et al. (2022) examined the impact of exchange rate fluctuations—considered a key indicator of economic stability—on the sustainability of asset values. Their findings indicate that exchange rate volatility had a statistically significant inverse effect (at the 95% confidence level) on the book value of assets, as the first index of asset value stability. Similarly, the effect on the second index, market value of assets, was also significant. Furthermore, exchange rate volatility negatively and significantly affected the present value of assets. Based on these findings, the authors suggest

reducing reliance on imported inputs and promoting the use of domestic resources as a strategy to mitigate the adverse effects of exchange rate fluctuations.

Sadeghi (2012) designed an optimal monetary policy to respond to corporate debt levels and maintain financial stability. The study also assessed how exchange rate volatility influences corporate debt and ultimately contributes to financial instability in an open economy. Using a DSGE (Dynamic Stochastic General Equilibrium) model, the research demonstrated that in situations where accumulated corporate debt disrupts financial stability, the central bank should respond by increasing interest rates according to a predefined policy rule derived from the model.

Ahmadian et al. (2021), in "Sanctions on Financial Stability in Iran: A Dynamic Macroeconomic Analysis," investigated the impact of U.S. sanctions on Iran's financial stability using VAR models and panel data analysis. The results reveal that banking and oil sanctions significantly reduced foreign reserves, increased exchange rate volatility, and destabilized financial markets. Additionally, limitations on access to international payment systems (such as SWIFT) negatively affected the Iranian banking system. The study suggests diversifying revenue sources and strengthening regional financial cooperation to reduce financial vulnerability.

Karimi and Gholami (2020) analyzed the financial soundness of Iranian banks following intensified sanctions. Using indicators such as Capital Adequacy Ratio (CAR) and Non-Performing Loans (NPL), they found that Iran's banking crisis resulted from a combination of sanctions, poor risk management, and expansionary monetary policies. The authors recommend banking sector reforms and stronger regulatory oversight to ensure long-term financial stability.

Esfandiar and Rahmani (2022) investigated the impact of exchange rate volatility on financial stability in Iran using a GARCH model. Their findings show that exchange rate shocks increased uncertainty in financial markets, reduced the value of the national currency, and placed pressure on banks' balance sheets. The study proposes implementing policies to mitigate exchange rate volatility, such as establishing a foreign exchange stability fund, to manage financial risks more effectively.

Hosseini and Tavakoli (2019) used a DSGE model to examine the effects of expansionary monetary policies on financial stability. Their results demonstrate that increased liquidity and interest rates contributed to inflation, depreciation of the national currency, and heightened systemic risk in the financial system. The study recommends that central banks should treat financial stability as a primary policy objective, rather than focusing solely on inflation targeting.

Moradi and Zare (2023), employing a NARDL model, analyzed the nonlinear relationship between the stock market and financial stability. Their findings reveal that booms and busts in the capital market had asymmetric effects on financial stability. Specifically, negative shocks in the stock market could trigger capital flight and undermine investor confidence. The authors suggest that effective capital market regulation can help prevent the formation of financial bubbles.

Taghavi and Alizadeh (2021), using an SVAR model, found that declining oil revenues led to budget deficits, increasing public debt and putting pressure on the banking system. Their results highlight that fiscal dependence on oil revenues transmitted oil shocks quickly into the financial sector. The study proposes the establishment of a financial stability fund to cushion the effects of oil-related shocks.

Ansari and Shahbazi (2022) explored the impact of financial technologies (such as cryptocurrencies and digital banking) on financial stability in Iran. The findings suggest that while FinTech can promote financial inclusion, the absence of regulatory frameworks may introduce new risks, such as money laundering and cryptocurrency market volatility. The study recommends that the Central Bank

of Iran develop a comprehensive regulatory framework for financial technologies to ensure stability and mitigate emerging threats.

Khalili and Mohebbi (2020) investigated the effects of the COVID-19 crisis on various financial sectors, including banks, the stock market, and the foreign exchange market. Their findings show that the decline in economic growth and the rise in public debt significantly increased systemic risk. Furthermore, government support measures—such as emergency loans—placed additional pressure on the banking system. The authors highlight the need for more resilient financial structures in times of global crises.

Jafari et al. (2023) demonstrated that the U.S. Federal Reserve's interest rate hikes led to capital outflows from Iran and exerted pressure on the foreign exchange market. Additionally, reduced access to international financial resources has increased the cost of external borrowing for Iran. The study suggests that Iran should pursue alternative financing channels, such as partnerships with Asian banks, to reduce vulnerability to external financial shocks.

Naderi and Khodaparast (2024) analyzed the effects of exchange rate policies—fixed and managed floating—on financial stability. The results indicate that Iran’s dual exchange rate system has contributed to exchange rate distortions, rent-seeking behavior, and instability in financial markets. The authors recommend a transition toward a genuine floating exchange rate regime under central bank supervision as a viable strategy for enhancing financial stability.

3. Research Methodology

In analyzing various economic phenomena, relationships between components are sometimes examined in a simplified manner by assuming other variables to be constant. However, in many real-world cases, system components are interrelated and interact dynamically. Under such conditions, traditional static methods may yield inaccurate results. For analyzing such complex systems, System Dynamics (SD) offers a more suitable approach compared to conventional methods. This methodology allows for systemic simulation of the problem, enabling validation of both the modeler's mental assumptions and the designed model structure.

System dynamics is a methodology for analyzing and simulating complex systems. It was first developed by Jay Forrester at MIT in the 1960s and is especially useful for studying problems involving feedback loops, time delays, and nonlinear interactions. In this approach, systems are modeled using causal loop diagrams (CLDs) and stock and flow diagrams, which help in better understanding the structure and behavior of dynamic systems.

The advantages of using system dynamics include:

1. Its analytical and critical modeling process provides a deeper understanding of the internal structure of the system.

2. It allows for the simultaneous inclusion of both qualitative and quantitative variables in the system.

System dynamics focuses on examining the internal and reciprocal relationships of system components over time. It is inherently structured and can integrate concepts from perceptual and social psychology, economics, and other social sciences. This flexibility makes SD a powerful tool for analyzing the behavior of social and economic phenomena.

Modeling in system dynamics assists policymakers and managers in focusing on long-term patterns and core dynamics rather than short-term details. The modeling process is iterative and recursive, meaning it is shaped by real-world behavior and, in turn, influences actions in the external

environment. This feedback loop between the model and the real system is central to continuous model refinement and learning. The standard stages of system dynamics modeling are illustrated in Figure 1.

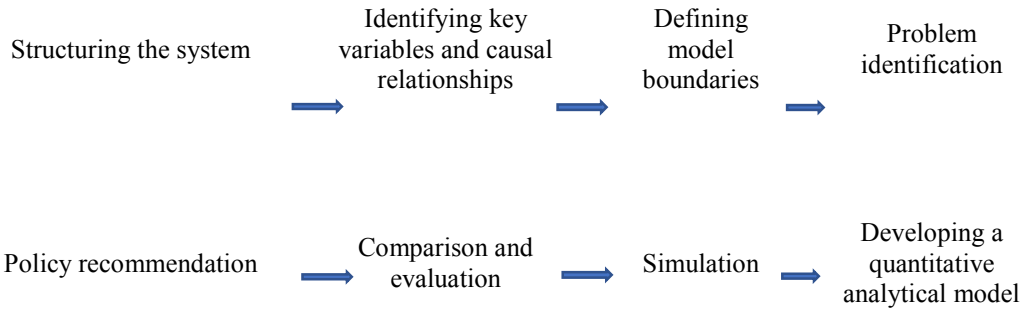


Figure 1. Stages of system dynamics modeling process

Model Implementation. Financial stability is a state or condition, rather than a single measurable variable. Therefore, various studies have employed different proxy indicators to quantify this state. A critical consideration in selecting these proxies is that they must align with the structural and data realities of the country's financial system. In this research, exchange rate policy and budget deficit are selected as key proxies representing the financial stability condition in Iran.

The model is executed by simulating various exchange rate policy scenarios. Among these scenarios, the policy that leads to greater economic stability is identified and recommended. In the case of the budget deficit, the model first evaluates the effects of multiple factors on the deficit, followed by an analysis of how fluctuations in the budget deficit impact other macroeconomic variables.

To comprehensively assess financial stability, the model is implemented in two separate subsystems:

1. A model focuses on exchange rate stability, where the causal factors and their dynamic interactions with currency volatility are analyzed.
2. A model centers on fiscal stability, where the drivers of the budget deficit and its feedback effects on macroeconomic indicators are studied.

The integration of these two subsystems enables a more holistic understanding of financial stability dynamics in the context of Iran’s economy, particularly under conditions of external shocks, sanctions, and policy shifts.

3. Data Analysis

Model Implementation**.** Financial stability is not a single measurable variable, but rather a state or condition that must be quantified through appropriate proxies. Numerous studies have proposed different indicators as proxies for financial stability. However, it is essential that the selected indicators be aligned with the institutional and data structures of the country in question. In this study, four main proxies are selected based on their relevance to Iran’s financial system:

1. The ratio of currency in circulation and demand deposits to total liquidity: This indicator reflects liquidity preference among the public and acts as a proxy for deposit-taking institution risk. A higher ratio indicates increased liquidity preference, reducing the banking system's ability to meet withdrawal demands, thereby increasing financial instability.

2. The ratio of the Central Bank's assets to GDP: This indicator is a proxy for macroeconomic risk. Greater dispersion in this ratio (measured by variance from the mean) reflects higher systemic instability.

3. Exchange rate level and growth: This serves as a measure of external sector risk. Higher levels or accelerated growth in exchange rates are typically associated with greater financial instability.

4. Government financial health (budget deficit): This represents institutional risk. A larger budget deficit undermines the independence and rule-based function of the central bank, increases government debt, and amplifies fiscal vulnerability, leading to systemic instability.

The model is implemented in two sub-models:

- The Exchange Rate Stability Model, which simulates the effects of various exchange rate policy scenarios (fixed, managed float, and sudden devaluation). The model identifies the policy that results in the most stable macroeconomic behavior.
- The Fiscal Stability Model, which evaluates both the causes of the budget deficit and its macroeconomic implications. It investigates how different variables (such as oil revenue volatility or interest rates) affect the deficit, and how, in turn, the deficit impacts inflation, money supply, and financial system resilience.

Each model is developed using system dynamics modeling, employing causal loop diagrams and stock-flow structures. The ultimate goal is to identify policy options that enhance financial stability in the context of Iran’s externally constrained and oil-dependent economy.

Proposed Model Structure. The proposed model begins with the development of causal loop diagrams (CLDs) to visualize the key relationships and feedback loops among system components. These diagrams form the foundation for the subsequent construction of stock and flow diagrams, which are used to simulate the behavior of the foreign exchange market under different policy scenarios.

The results of the model simulation are analyzed across various macroeconomic variables, including exports, imports, trade balance, and gross domestic product (GDP), under different exchange rate scenarios. This allows for a dynamic assessment of how exchange rate policies influence broader economic stability.

The overall structure of the exchange rate model consists of two interlinked sub-models:

1. Real Exchange Rate Sub-Model:

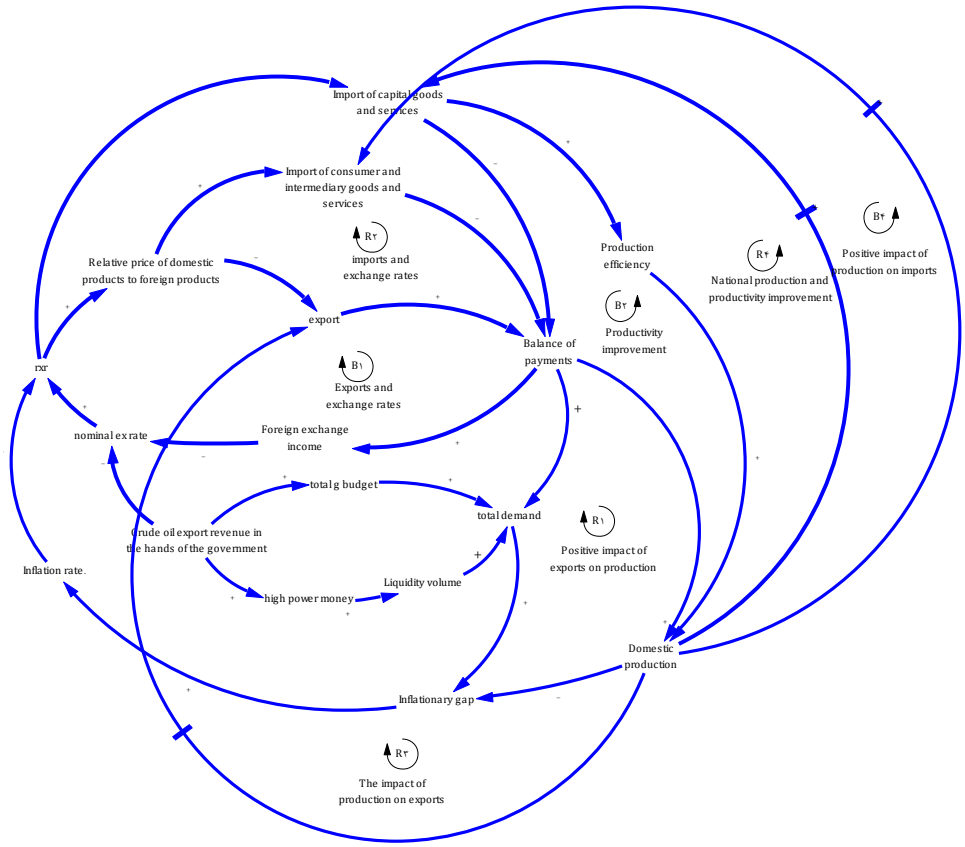
This sub-model simulates the dynamics of the real exchange rate by incorporating key influencing variables such as inflation differentials, monetary policy, foreign exchange reserves, and external shocks. It captures how shifts in policy or external conditions affect the real value of the national currency over time.

2. Financial Instability Impact Sub-Model:

This sub-model focuses on the macroeconomic consequences of financial (especially exchange rate) instability. It explores how fluctuations in the exchange rate influence capital flows, inflation expectations, investment levels, and overall financial stability.

Together, these two sub-models provide a comprehensive dynamic framework for evaluating the short- and long-term effects of currency market volatility on Iran’s economic performance.

Sub-model real exchange rate



Graph 1. Real exchange rate (financial stability)

Due to exchange rate stabilization policies combined with continuously rising inflation, the real exchange rate declines. This decrease in the real exchange rate, resulting from the relative increase in the prices of domestic products, leads to reduced competitiveness in international markets. Consequently, exports decline while imports of goods and services, including capital, consumer, and intermediate goods, increase.

The increase in capital goods imports directly enhances production by improving productivity (loop B2). However, on the other hand, the decline in exports reduces the demand for domestic products, thereby damaging local production (loop R1). The reduction in domestic production leads to a decreased need for importing capital and consumer goods (loops R4 & B4) (Sepanlou et al., 2010; Tofighi et al., 2002).

If, due to the decline in the real exchange rate, total imports exceed exports, two distinct effects emerge. On the one hand, foreign exchange reserves decrease, which leads to an increase in the nominal exchange rate (loops B1 & R2). On the other hand, since a significant portion of government revenue originates from oil exports, the process of converting oil revenues into rials by the Central Bank leads to an increase in the monetary base and liquidity. As a result, aggregate demand in the economy continually rises, driven by government spending and liquidity growth resulting from the conversion of oil revenues.

The rise in the ratio of aggregate demand to total output widens the inflationary gap, ultimately leading to higher inflation. According to official statistics from the Central Bank of Iran, the country is among the few economies that have experienced double-digit inflation over the past four decades. This persistent inflation, coupled with exchange rate stabilization policies, has caused a continuous

decline in the real exchange rate. Although periods of relative exchange rate stability have occasionally been followed by sharp surges in the nominal rate, such sudden increases have had severely damaging effects on financial stability and macroeconomic indicators, including total production.

Sub-Model. Outcomes of financial instability

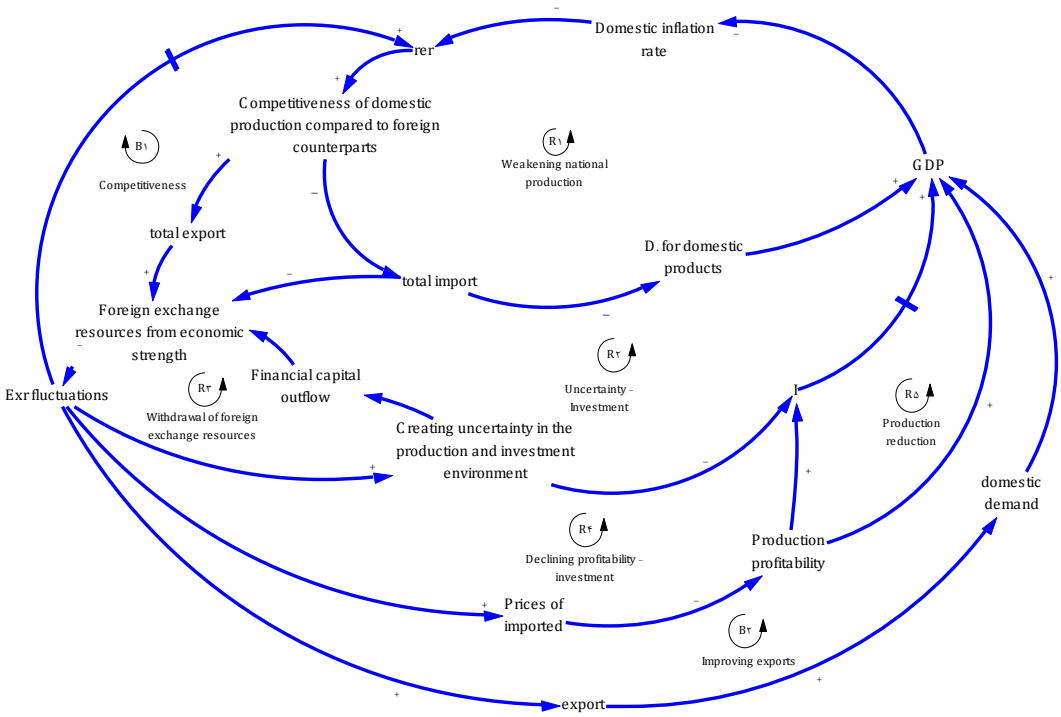


Figure 2. Currency shock and decline in national production

Exchange rate stabilization policies, coupled with high domestic inflation, lead to a decrease in the real exchange rate. The decline in the real exchange rate reduces the competitiveness of domestic production compared to foreign goods, resulting in lower demand for domestic products (Reinforcing Loop R1). One consequence of reduced competitiveness is increased imports and decreased exports, which ultimately leads to a reduction in foreign exchange reserves.

Under conditions of sanctions or declining oil revenues, the Central Bank is no longer able to maintain exchange rate stability. Since oil income constitutes a significant portion of the national budget, and given the inflationary pressures and reduced oil revenues in recent years, the Central Bank is eventually compelled to devalue the currency following a period of stabilization. This sharp depreciation ultimately weakens national production and leads to higher unemployment.

In this context, the exchange rate surge increases macroeconomic uncertainty, which, in turn, causes a significant decline in fixed and variable investments (Reinforcing Loop R2). Capital flight and the further depletion of foreign exchange reserves are additional outcomes of this uncertainty (Reinforcing Loop R3).

Moreover, due to prolonged periods of a fixed exchange rate, the domestic economy has not developed sufficient capacity to produce essential inputs, intermediate goods, and capital goods, even in areas where such production would be feasible. As a result, despite the exchange rate shock, the country must continue importing these goods at higher costs. This increase in production costs both reduces investment (Reinforcing Loop R4) and, due to the shutdown of domestic firms, directly

reduces total national output (Reinforcing Loop R5).

The exchange rate shock also results in an increase in the real exchange rate (Balancing Loop B1), which can improve the competitiveness of domestic products in global markets and lead to higher exports. This rising demand for domestic goods can create a favorable environment for increased local production (Balancing Loop B2). However, findings from various studies suggest that the reinforcing loops associated with declining national production (R1-R5) outweigh the balancing loops (B1 and B2) intended to stimulate domestic output.

General flow model

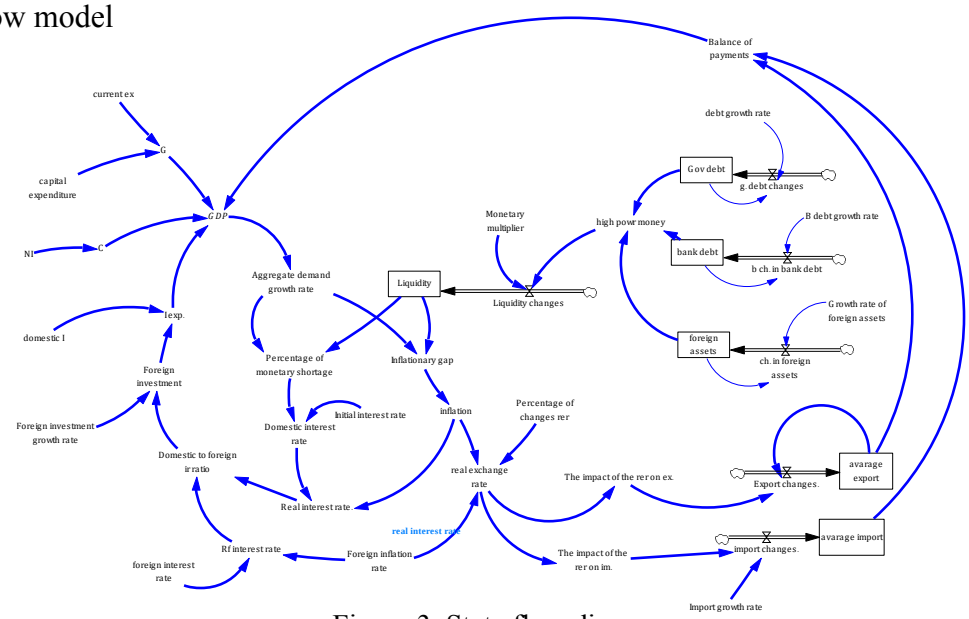


Figure 3. State flow diagram

Introducing the mathematical relationships of variables and functions of the currency section in the Vensim software:

1	**TD Cex+Gex+Iex.+Tca**	**B rial**
2	Cex= α (NI)+Ds	B rial
3	NI= INTEG(NI×IN r,NI(۰))	B rial
4	Gex= Gcu+G In	B rial
5	Iex=DI+FI	B rial
6	DI=(I(۰)×Ir)+ste	B rial
7	FI=Dfi	B rial
8	Ir= constant	%
9	s.e r= constant	%
10	ste= INTEG(s er(o) ×s. e. r,s er(o))	B rial
11	rTD= TD/(١+f.r.TD)	B rial
12	r.TDg= (r TDrTD(١))/rTD(1)	%

13	rTD(۱)=DELAY FIXED(r TD, ۱, r TD)	B rial
14	Ir= constant	%
15	s.e r= constant	%

According to the above relationships, TD is the total demand of the economy, Cex is consumption expenditure, Iex is capital expenditure, Gex is government expenditure, Tca is the balance of payments, Brial is billion rials, INr is the national income growth rate, IN(0) is the initial value of national income, NI is national income, rTD is the total real demand of the economy, r.TDg is the growth rate of total real demand of the economy, and rTD(1) is the real demand of the previous period. Iex, the total capital expenditure, consists of two components: DI (domestic investment) and FI (foreign investment). Domestic investment consists of two components: dI (fixed investment and ste (variable investment—changes in inventory and statistical errors). s.e r is the growth rate of changes in inventory and statistical errors, Ir is the growth rate of domestic investment, and Dfi is foreign direct investment. Also, rTD is the total real demand of the economy, r.TDg is the growth rate of total real demand of the economy, and rTD(1) is the real demand of the previous period. Furthermore, SMOOTH is an exponential smoothing function consisting of two parts: the first part is the name of the desired variable, and the second part is the number of smoothing periods.

The operation method of system dynamics models is such that by changing policy parameters, the target variables change, and in this way, the impact of different policies (parameters) on the target variables can be observed. In this model, the nominal exchange rate and the percentage change in the nominal exchange rate are policy parameters, and the national growth rate, national production, and balance of payments are considered target variables.

Implementation of the Financial (Foreign Exchange) Stability Model and Policy Analyses

Scenario 1: Exchange Rate Stabilization vs. Multiple Jumps

Using the mentioned system dynamics model, the impact of changes in the nominal exchange rate on financial (currency) stability and the effect of this stability on macroeconomic variables such as exports, imports, trade balance, and national production can be evaluated. The flow-state model is implemented using Vensim software based on the base year 2021/2022. Considering that the exchange rate in Iran, unlike currency markets in other industrial countries, is set administratively, the official exchange market is not considered a criterion for financial stability because the government constantly attempts to stabilize the exchange rate. For this reason, data from the unofficial exchange market is used. Subsequently, efforts are made to examine various policies and methods for determining the exchange rate, in order to select the most appropriate exchange rate policy that provides greater stability for macroeconomic variables.

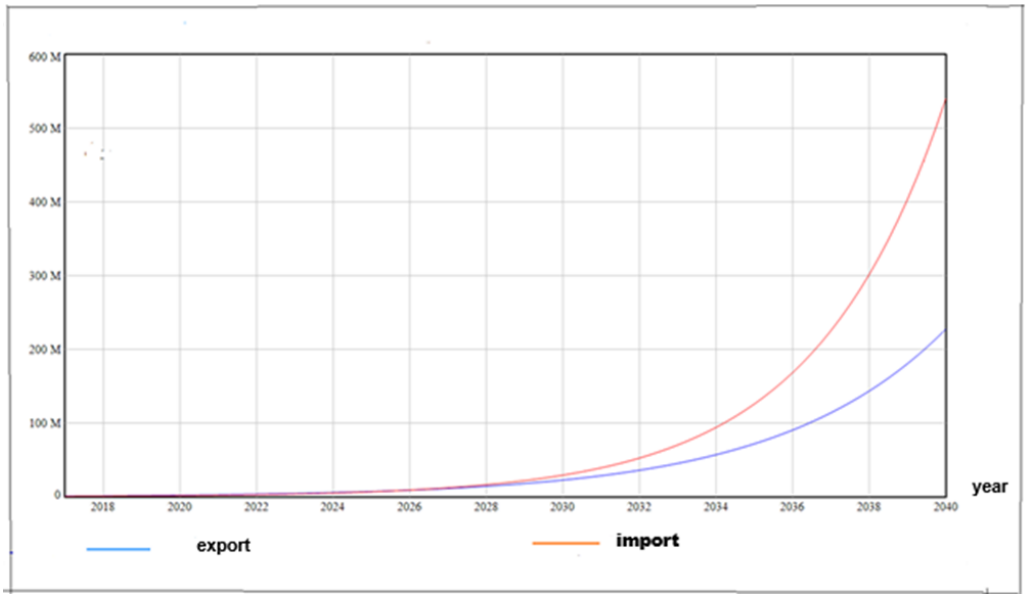


Diagram 1. Comparison of export and import trends assuming a stable nominal exchange rate

According to Diagram (1), in the case of exchange rate stabilization, imports are always higher than non-oil exports, and, as a result, the balance of payments remains negative throughout the period. According to Diagram (2), with a surge in the exchange rate, the balance of payments experiences a slight relative improvement. Previous studies have also indicated that severe exchange rate fluctuations have a negative impact on exports, such that the negative effects resulting from uncertainty and exchange rate volatility on the balance of payments partially offset the positive impact of an exchange rate increase, and the balance of payments remains negative in the long term.

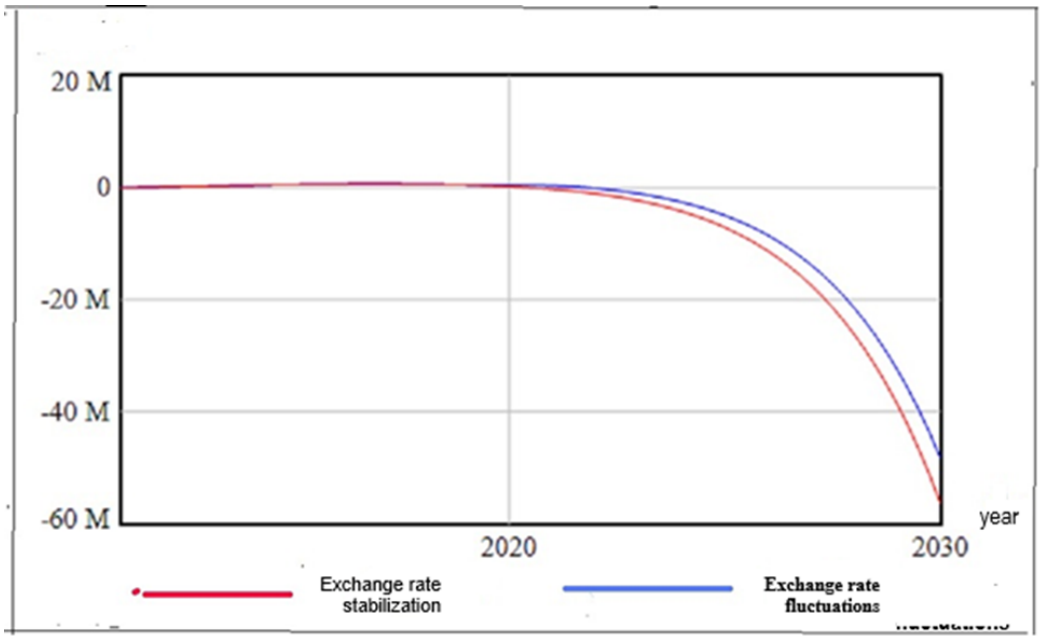


Diagram 2. Trade balance trend assuming exchange rate stability and multiple jumps

Scenario 2: 20% increase in exchange rate

The depreciation of the national currency causes an increase in the prices of imported goods and a relative decrease in the prices of domestic goods, compared to the period of exchange rate stabilization. This leads to an increase in the competitiveness of domestically produced goods

compared to their foreign counterparts; therefore, the export volume increases and imports decrease, resulting in an improvement in the balance of payments. The exchange rate is increased by 20%, and its impact on exports, imports, and the trade balance is examined in comparison with the conditions of exchange rate stability (Figure 3).

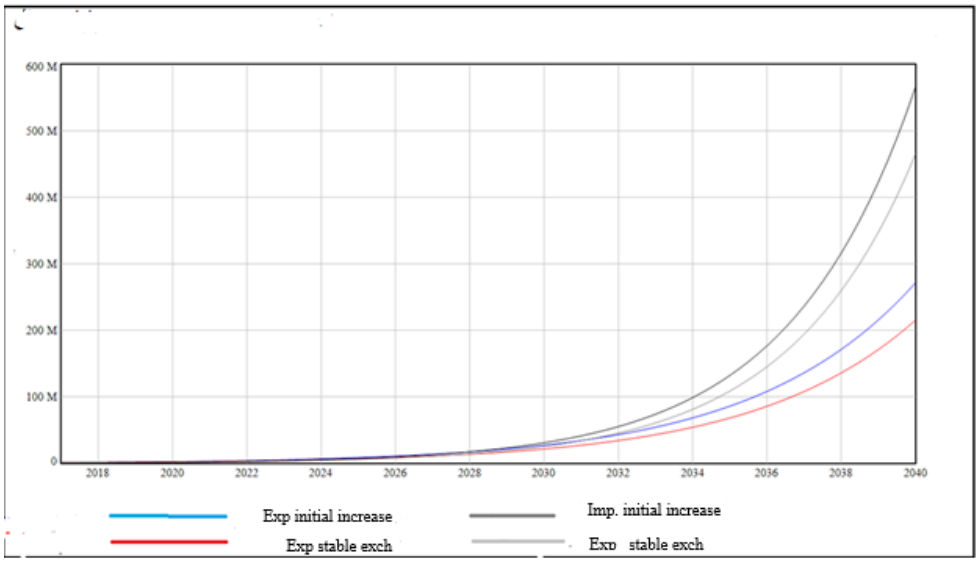


Diagram 3 - Comparison of export and import trends in two cases: stability and a 20 percent increase in the exchange rate

According to Figure (3), exports grow more during the period of exchange rate increase, compared to the period of exchange rate stabilization. The opposite is true for imports. This point is clearly illustrated in the balance of payments chart (Figure 4). This means that the depreciation of the national currency leads to an increase in the prices of imported goods and a decrease in the prices of domestic goods, compared to the period of exchange rate stabilization. As a result, the competitiveness of domestically produced goods relative to their foreign counterparts increases, leading to a rise in export volume and a reduction in imports. Therefore, it is expected that the depreciation of the national currency, compared to the time of exchange rate stabilization, will improve net exports and consequently increase the balance of payments (Diagram 3).

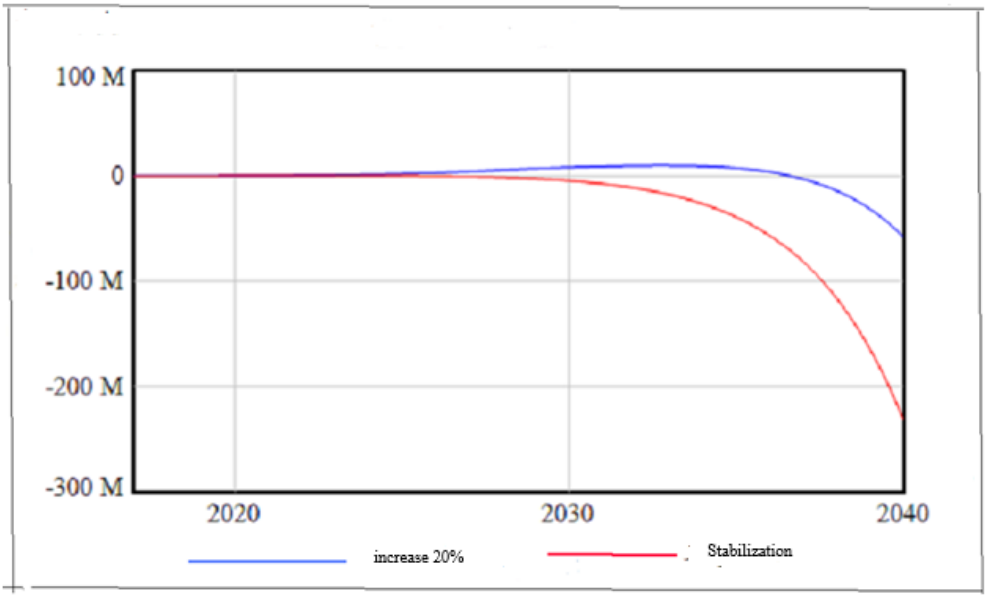


Diagram 4. Comparison of trade balance trends in two cases: a fixed exchange rate and a 20 percent increase in the exchange rate

Scenario 3: Continuous increase in the exchange rate

The exchange rate is continuously increased over several years, such that it rises by 5% in the first year and then by 10% each subsequent year. The volume of exports will be higher under this continuous increase in the exchange rate, compared to a one-time increase or exchange rate stabilization (under conditions of double-digit inflation). The opposite is true for imports, meaning that the volume of imports under exchange rate stabilization is higher than under a one-time or continuous increase. Considering the changes in exports and imports in response to the exchange rate increase, it is expected that the balance of payments will improve (Figure 4), such that, unlike the previous two cases, the balance of payments remains positive throughout the entire period. Given that increased trade relations with other countries lead to a relative improvement in the balance of payments, the improvement brings about an increase in national production (economic growth).

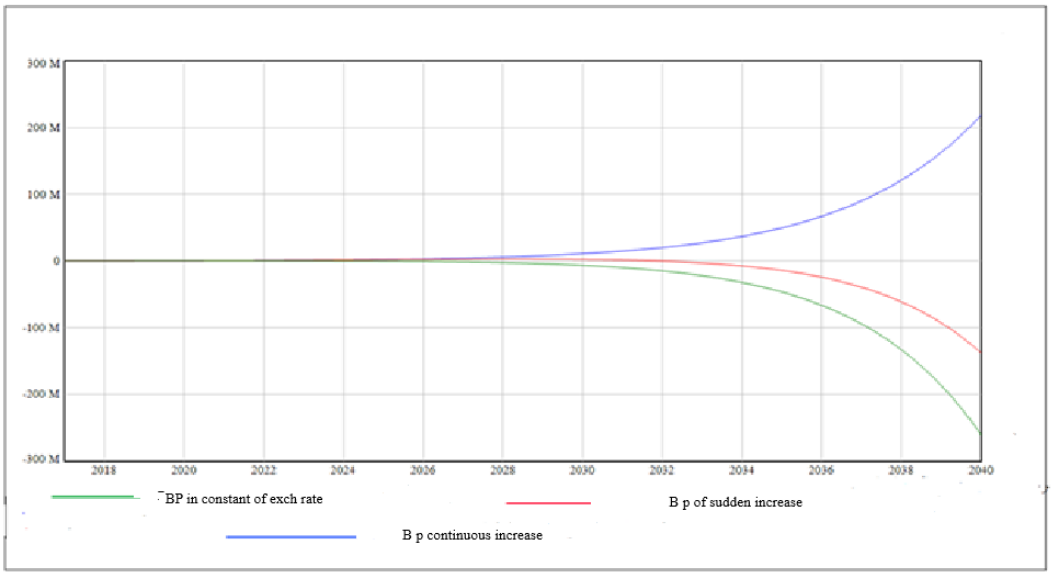


Diagram 5. Comparison of the balance of payments trend in three cases: stabilization, sudden increase, and successive increase in the exchange rate

Based on the above scenarios, the impact of financial stability on macroeconomic variables through different exchange rate policies, including national production, was examined under various conditions. The results of different exchange rate policies show that financial (currency) stability under a managed floating exchange rate system and its effect on macroeconomic variables is greater than other exchange rate policies (Diagram 6). Due to the negative role and impact of inflation on the foreign exchange market, it is recommended that policymakers focus their efforts and emphasis on controlling and stabilizing the general price level in the long term.

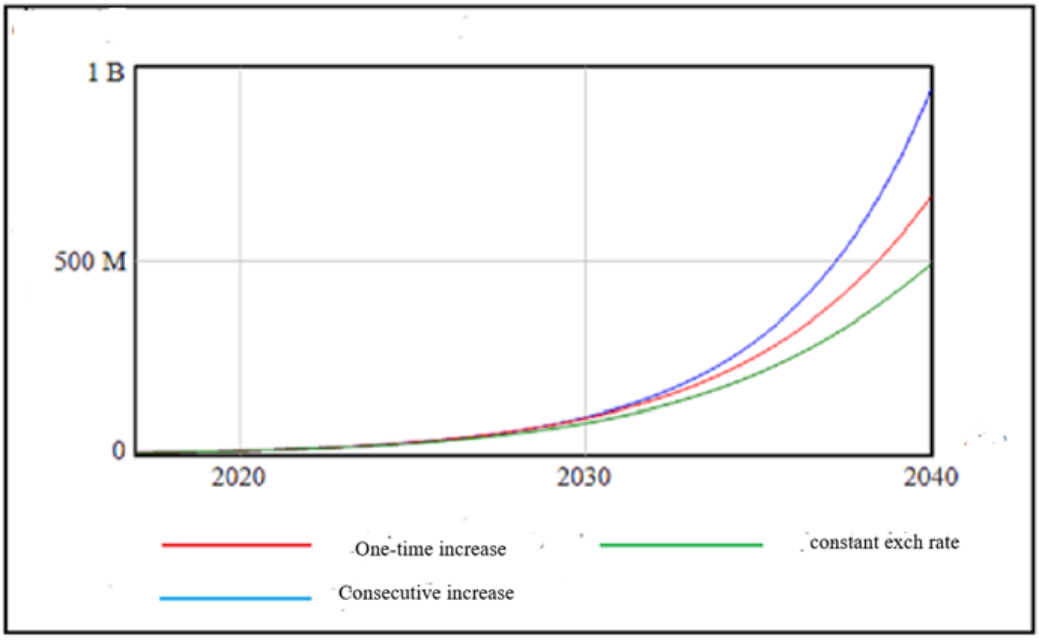


Diagram 6. National production trend in three cases: stabilization, sudden increase, and successive increase in the exchange rate

Model validation. Model validation in system dynamics is aimed at increasing confidence in the accuracy and correctness of a model. Since this method is used to address and resolve problems in various societal fields, the designed model is evaluated for its conformity with reality. The operational procedure and necessary validation steps begin from the early stages of modeling. During these stages, the model's structure and the real system structure are reviewed, attention is given to the dimensions of various equations and their consistency with each other and whether the developed model is suitable for achieving the intended goal is analyzed and assessed (Samadi et al., 2012: 84).

Validation in system dynamics models is divided into two types: structural validation and behavioral validation. Structural validation means that a model must accurately and sufficiently represent the relationships in the real world. Behavioral validation means that the behavior of a model sufficiently reflects the behavior of the phenomenon in the real world. Behavioral validation occurs when the model has appropriate structural validation (Homayounfar et al., 2018: 152). Many tests have been introduced for model validation, including boundary adequacy test, model structure evaluation, units of measurement, parameter consistency, boundary conditions, equation-by-equation verification, integral error test, behavior deviation test, unexpected behavior, sensitivity analysis, system improvement, and introducing shocks to variables (Yousefzi, 2019: 70; Bastan et al., 2018: 273).

Sensitivity analysis is carried out in three forms: numerical sensitivity, behavioral sensitivity, and policy sensitivity. There are various methods for validating system dynamics models. These methods are generally classified into three categories: model structure tests, model behavior tests, and policy theme tests. The nature of the subject determines the type of tests. In this article, considering the nature of macroeconomic models, the following methods are used for validation.

Boundary adequacy test. In this test, the adequacy of variables and the constructed structures are examined with respect to the stated goals and the problem at hand. The structure must be consistent with the study objectives. As explained in the causal modeling section, the impact of changes in the real exchange rate on various economic variables such as exports, imports, and national production was modeled. Therefore, the structure of the designed models covers the study's objective.

Boundary conditions: Is the model meaningful in extreme conditions? Does the model respond logically to policies, shocks, and parameters under boundary conditions? For example, does the designed system conform to the fundamental laws of economics? We simulated a surge in the exchange rate, and the model results were consistent with economic principles (Figure 2).

Model structure evaluation test. This test examines the conformity of the model structure with the existing knowledge of the system. For example, does the designed system align with fundamental economic laws? During model execution, it was observed that the results obtained were economically fully valid (Figures 1 to 5).

Dimensional consistency test. This test analyzes the dimensions and units of the model's equations. This was confirmed in the units check section within the Vensim software.

4. Conclusion

Given the importance of the foreign exchange market in the trend of macroeconomic variables and the correct selection of an appropriate exchange rate regime, efforts were made to examine the relationship between types of exchange rate policies and national economic stability by introducing and estimating a system dynamics model. Using the mentioned system dynamics model, the impact of exchange rate changes on economic stability can be evaluated. The base year was considered 1400 (2021/2022). For sensitivity analysis, the model was run for the period 1400–1420 (2021–2041) using Vensim software under four different exchange rate scenarios.

We first simulated the trade balance and gross domestic product (GDP) assuming exchange rate stability until 1420. Then, the exchange rate was subjected to a multiple surge. Under exchange rate stabilization, since exports were less than imports, the balance of payments remained negative throughout. In the second scenario, the exchange rate was increased; in the first few years of the simulation, the balance of payments was positive because exports exceeded imports, but later, as imports surpassed exports, the balance of payments turned negative. However, overall, the balance of payments experienced a relative improvement. Severe exchange rate fluctuations had a negative impact on exports such that the negative effects arising from uncertainty and exchange rate volatility on the balance of payments partially offset the positive impact of exchange rate increases.

The exchange rate was increased by 20%, and its impact on the trade balance and the national GDP growth rate was examined, compared to exchange rate stability conditions. Considering the positive effect of exchange rate increases on exports and its negative effect on imports, the trade balance remained positive for most of the period under review and became negative only in the last few years of the simulation, yet it performed better than under exchange rate stability. On the other hand, the national GDP growth rate was higher due to the increase in the exchange rate, compared to its stabilization period.

The exchange rate was continuously increased over several years, starting with a 20% increase in the first year, and subsequently increased annually based on the difference between domestic inflation and global inflation. Model results show that the balance of payments remained positive throughout the entire simulation period. Given the different sensitivities of exports and imports to exchange rate changes and the relative improvement in the trade balance under the managed floating exchange rate system, the model results indicate that the national GDP growth rate improved, compared to situations when other exchange rate policies were implemented.

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