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Original Research Article

Ranking of Factors Affecting Currency Crises and Their Implications for the Iranian Economy

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This research aims to rank the most persistent factors influencing currency crises in Iran. It analyzes key variables using Bayesian averaging methods applied to seasonal data from 2001 to 2021. Unlike classical approaches, Bayesian analysis accounts for uncertainty and prior knowledge in model and parameter selection, offering a more accurate evaluation of the significance and effects of each variable on currency crises. By integrating uncertainty into the modeling process, Bayesian techniques improve the precision in identifying the most influential factors. The results reveal that nine key variables significantly impact exchange rate fluctuations. Among these, the export-to-output ratio, the deviation of the exchange rate from its equilibrium level, inflation, and the uncertainty index play crucial roles in determining exchange rate movements. Moreover, imbalanced liquidity growth and rising inflation intensify pressure on the exchange rate, thereby increasing the risk of currency crises. Excessive liquidity expansion combined with inflationary pressures can lead to financial instability.
This study not only identifies the main determinants of currency crises but also emphasizes the importance of economic policy reforms. According to the Bayesian model findings, variables that consistently exert influence regardless of other factors are termed "non-breakable." Prioritizing these non-breakable factors in policymaking is essential for maintaining financial stability. By focusing on these critical variables, economic authorities can develop more effective strategies to prevent currency crises and mitigate their adverse economic consequences.

Keywords: Currency Crisis, Bayesian Averaging, Factor Ranking, Uncertainty Index

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1 Introduction

Financial crises have always attracted the attention of policymakers due to their widespread impact on macroeconomic sectors. These crises can manifest in various forms, with one of the most significant being exchange rate crises. An exchange rate crisis, also known as a speculative attack, is defined as a sudden depreciation of a currency or a period of significant pressure on the exchange rate that could lead to substantial losses in foreign reserves or an increase in domestic interest rates to defend the currency (Berg et al., 2005). In developing countries, due to the dependence of production on imported capital goods, intermediate goods, and raw materials, which are highly currency-sensitive, exchange rate crises have a significant impact on the overall economic situation, making them of critical importance due to their effects on the economy.

Financial crises impose heavy costs on societies, leading to higher unemployment, reduced public trust, lower welfare, and increased income inequality (Bodea et al., 2019). Additionally, financial crises often result in a decrease in GDP, more severe social and political consequences in low-income countries compared to developed ones (United Nations, 2010). According to the Stiglitz Commission Report (2010), in developing countries, the ripple effect of the 2008 global financial crisis led to negative externalities and a social crisis due to a significant drop in living standards. Furthermore, small open economies will always experience spillover effects from global economic dynamics (Warjiyo, 2015).

Exchange rate crises are not only an economic challenge but also a strategic issue in the macroeconomic policies of countries. In the case of Iran, the country's economic policies focus on maintaining economic stability, strengthening national production, and reducing dependency on foreign currencies. However, Iran's high dependence on oil revenues and past exchange rate policies have made the country vulnerable to exchange rate fluctuations. In recent decades, Iran's exchange rate policies have largely been based on a fixed or managed float exchange rate system, which in certain years has been practically implemented as a fixed exchange rate. This approach, combined with other economic factors and external shocks, has paved the way for numerous exchange rate crises. Some of the most notable exchange rate crises in Iran in the past decade include the 2012 exchange rate crisis, caused by international sanctions and a sharp decline in oil exports, and the 2018 exchange rate crisis, which resulted from the U.S. withdrawal from the JCPOA and external and internal economic pressures. In both of these crises, a significant depreciation of the national currency, soaring inflation, economic

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instability, and a reduction in both foreign and domestic investments were observed, deeply affecting people's livelihoods and the economic conditions of the country.

Therefore, identifying and ranking the factors influencing exchange rate crises, especially non-vulnerable variables that maintain greater stability during economic instability, is a major goal of economic policymakers. This research focuses particularly on identifying factors that show less fragility in times of crisis and economic shocks, operating more sustainably. In this regard, ranking these factors and analyzing their impact on exchange rate crises in Iran can help policymakers manage and prevent crises more effectively. Thus, the goal of this study is to identify and rank the non-fragile factors that influence exchange rate crises in Iran's economy.

The structure of this paper is organized as follows: The next section presents the theoretical foundations and a review of empirical studies relevant to exchange rate crises. Following that, the methodology and modeling approach used in this research are described. The results are then presented and discussed, and finally, the paper concludes with policy recommendations based on the findings.

2 Theoretical Background

A currency crisis refers to a speculative attack where a weak currency is subjected to intense selling pressure, leading to a significant increase in the exchange rate in that country (Frankel & Rose, 1996). Technically, there are various definitions of currency crises. For instance, Kaminsky et al., (1998) define a currency crisis as occurring when the monthly depreciation of the exchange rate and foreign exchange reserves exceeds three standard deviations. Frankel and Rose (1996) also define a currency crisis as a situation where the nominal value of a currency falls by at least 25%, accompanied by an increase of at least 10% in the exchange rate.

2.1 Explanatory Approaches for the Causes of Currency Crises

The repeated occurrence of currency crises around the world has led to extensive discussions on the theoretical models of crises and empirical analyses, which have aimed to identify and introduce the determinants of crises, their effects on the macroeconomic status of countries, and the creation of systems for early warning of future crises (Bilson, 1979). The evolutionary progression of research in the area of currency crises includes four generations of models.

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In general, the first generation of models emphasizes the role of fundamental economic factors in explaining crises. They relate the occurrence of any crisis to persistent problems in the macroeconomy, structural economic factors, unstable government economic policies, and structural imbalances within national economies. In such situations, investors target the domestic currency for speculative attacks, leading to a devaluation of the national currency (Flood & Garber, 1984). Important studies related to this generation include those by Kaminsky et al., (1998), Babecký et al., (2014), Ari & Cergibozan (2018), and the earliest studies on currency crises in developing countries such as Mexico (1973-82) and Argentina (1978-81), (Edwards, 1984; Krugman, 1979). where excessive domestic expansionary policies were the main cause of these crises. These patterns suggest that the presence of a policy like a fixed exchange rate, along with an excessively expansionary economic structure before a crisis, leads the economy toward a crisis.

The inability of first-generation models to explain the causes of currency crises, especially in European countries where crises occurred despite contractionary monetary policies, led to the development of second-generation models. In contrast to first-generation models, which focused more on domestic macroeconomic factors, second-generation models place greater emphasis on the role of expectations and government decisions, as well as the complex interactions between economic policies and external factors such as international market developments and global influences. The European currency crises of 1992-1993 laid the foundation for the development of these newer models. These models emphasize the role of expectations in triggering crises (Obstfeld, 1994). In these models, crises can occur without poor fundamental economic conditions. If economic policies are consistent with the exchange rate system, investors may adjust their expectations regarding the sustainability of the exchange rate, leading to speculative attacks.

The nature of crises in second-generation models differs from those studied in the first generation. First, in countries that experienced speculative attacks, factors such as the banking network, business cycles, and strict borrowing constraints due to the monetary policies of trading partner countries restricted policymakers' options and prevented the use of traditional methods to support the exchange rate. Second, it seems that speculative attacks, particularly in Europe, were unrelated to the economic structure (as predicted in first-generation models). Nevertheless, the 1997 crisis in Southeast Asia marked a turning point in currency crisis models. This crisis revealed the inadequacy of traditional crisis theories in explaining the sequential devaluation of the Thai baht in 1997, leading to multiple studies aimed at understanding its nature

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(Kaminsky1999, Krugman, 1999; Radelet & Sachs(1998); Corsetti et al., 1998; Aghion et al., 2000; Chang & Velasco, 1998).

Third-generation models of currency crises have become more complex and show how financial market volatility and banking system issues can trigger currency crises. These studies focus on the interplay between currency crises and other types of crises (Chiodo & Owyang, 2002; Castillo, 2006). The 1997-98 Asian crisis showed researchers that none of its features could be fully explained by first and second-generation models, meaning both perspectives could apply.

Fourth-generation financial crisis models were first introduced by Brewer (2006) and emphasize the importance of institutions in triggering these crises. According to this view, weak institutions can disrupt the health of the national economy and generate weak economic indicators, thereby creating the conditions for financial and especially currency crises. Institutions play a key role in guiding market actors by providing information on economic fundamentals and future conditions. If institutions are weak, this can create market instability, increasing uncertainty and speculative flows, thereby raising the likelihood of a currency crisis (Ghosh & Ghosh, 2002). Weak institutions linked to poor economic fundamentals lead to market instability, increased uncertainty about the likelihood of a currency crisis, and greater incentive for speculative attacks. Conversely, strong institutions, with healthy economic conditions, contribute to market stability, reducing uncertainty about potential currency crises and decreasing speculative behavior.

2.2 Factors Influencing Currency Crises

Currency crises are among the most significant economic challenges faced by countries, and they are influenced by a variety of domestic and external factors. Exchange rate fluctuations can be driven by factors such as monetary and fiscal policies, trade balances, foreign exchange reserves, market expectations, and political events. Each of these variables can directly or indirectly impact exchange rate stability, and if not properly managed, they can lead to severe currency crises. Below are the main factors influencing currency crises.

- **Oil Price Changes**: Changes in oil prices can significantly exacerbate currency crises, especially in oil-exporting countries that depend on oil revenues. A decrease in oil prices leads to lower foreign exchange earnings, which can result in a shortage of foreign reserves, depreciation of the domestic currency, and increased inflationary pressures, thus worsening the currency crisis (Hoshi & Kashyap, 2004).

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- **Real Output and Industrial Growth**: Low real GDP growth rates often lead to expansionary policies. Low GDP growth and value-added growth in the industrial sector signal poor economic conditions. When real GDP growth is low, the likelihood of a crisis increases (Berg & Patillo, 1999; Hardy & Pazarbasioglu, 1999).
- **Exports**: A decline in exports may indicate a likelihood of devaluing the domestic currency by authorities to boost exports. This situation can reduce competitiveness and lead to domestic investment challenges. Additionally, it can reduce the country's ability to generate foreign exchange to finance current account deficits (Kaminsky, 1999; Berg & Patillo, 1999; Brüggemann & Linne,2012).
- **Imports**: Excessive imports can indicate that a policy may be pursued to strengthen the domestic currency, which may reduce competitiveness and worsen current account problems (Edison, 2003; Kaminsky et al., 1998; Berg & Patillo, 1999).
- **Inflation:** An increase in inflation rates typically leads to higher interest rates, which can have undesirable effects on the real and financial sectors of the economy. Additionally, high inflation conditions tend to drive economic agents toward foreign exchange markets to preserve the value of their assets (Demirguc-Kunt and Detragiache, 1997; Lanoie & Lemarbre, 1996). Therefore, it is expected that with rising inflation, the probability of an increase in the exchange rate will be higher due to increased demand for foreign currency. However, it is worth noting that if interest rates rise in response to inflation, there is a possibility that small investments will return to banks, reducing pressure on the foreign exchange market and lowering the likelihood of a currency crisis.
- **Budget Deficit:** The budget deficit is related to the classic models explaining the crisis, particularly the first-generation models like Krugman's(1979). A high budget deficit increases the likelihood of a crisis as it can lead to high inflation and interest rates. This situation increases the economy's vulnerability to shocks and reduces investor confidence. Government spending that exceeds income also increases the likelihood of a crisis (Saqib, 2002). A high budget deficit can exacerbate problems in the current account, which can put pressure on the exchange rate (Zhuang and Dowling, 2002).
- **Government Spending:** High government spending can contribute to economic growth and increased production, thus improving foreign exchange earnings and strengthening foreign currency reserves (Barro, 1990). This condition can also lead to economic stability and reduce

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pressure on the exchange rate. On the other hand, if this spending increases unsustainably and without proper financing, it could lead to a budget deficit and increased government debt. This condition could affect the trade balance and increase inflation risks, ultimately leading to currency crises (Rogoff, 2003).

- **Bank Debt to the Central Bank:** Commercial banks have become more dependent on the central bank's resources, which can indicate weakness in the banking sector and instability in financing (Bernanke and Gertler, 1989). An increase in this ratio is typically associated with rapid growth in liquidity and credit, which can raise inflation and lead to depreciation of the national currency (Mishkin, 1996). In conditions where this phenomenon is accompanied by a reduction in the central bank's foreign exchange reserves, its ability to manage exchange rate fluctuations decreases, increasing the likelihood of a currency crisis (Kaminsky and Reinhart, 1999).
- **Foreign Exchange Earnings from Oil Exports:** An increase in oil revenue typically strengthens the central bank's foreign currency reserves and boosts foreign currency supply in the market, which in the short term can help stabilize the exchange rate and reduce inflationary pressures (Corden and Neary, 1982). However, in the long term, if these increased revenues are not managed properly, they can lead to Dutch disease, where the influx of foreign currency overvalues the national currency, reduces the competitiveness of the non-oil sector, and increases the economy's dependence on oil revenues (Sachs and Warner, 1995). This dependence increases vulnerability to oil price shocks, such that if oil prices suddenly drop, foreign exchange revenues decline and a currency crisis is aggravated (Gibbs, 1988).
- **Liquidity:** Rapid growth in the M2 compared to production growth, typically resulting from expansionary monetary policies or government debt, can lead to higher inflation and consequently reduce confidence in the national currency, putting significant pressure on the exchange rate (Feridun, 2008). In contrast, if the M2 grows in proportion to GDP, inflationary pressure and exchange rate fluctuations are reduced, and the monetary situation becomes more stable. Therefore, proper management of the M2 to production ratio through monetary policies can act as an effective tool in preventing currency crises.
- **Gap Between Official and Equilibrium Exchange Rates:** If the official exchange rate is lower than the equilibrium rate, speculative demand for the currency increases, leading to the creation of an unofficial market with

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higher rates (Krugman, 1979; Dornbusch, 1986). Moreover, in situations where the real exchange rate is higher than the equilibrium rate, import costs rise, inflation intensifies, and this can lead to economic instability (Calvo and Reinhart, 2000).

- **Uncertainty:** Economic uncertainty has a direct and indirect impact on exchange rate volatility. The exchange rate is determined by fundamental factors and macroeconomic policies (Krol, 2014), so when economic, financial, and political uncertainties change, expectations of economic agents also change, which in turn affects exchange rate volatility. Therefore, greater uncertainty leads to greater exchange rate volatility (Krol, 2014; Husted et al., 2018; Zhou and Yan, 2015).

3 Research Background

Numerous studies have been conducted on currency crises, each examining key factors and forecasting models. Comelli (2014), by comparing the parametric logit model and non-parametric signal models in emerging economies, demonstrated that GDP growth, the ratio of reserves to short-term foreign debt, international reserves, and the current account balance have a negative relationship with the occurrence of a crisis, while government instability and domestic M2 increase the likelihood of a crisis. Sevim et al., (2014), using decision trees, artificial neural networks (ANN), and logit models, found that the export-to-import ratio, bank credits, inflation, and trade conditions are among the most important factors for currency crises, with ANN providing better forecasting performance. Jdaitawi (2014), in a study of Jordan's currency crisis, showed that a decrease in international reserves, a worsening trade balance, and an increased M2raise the likelihood of a crisis. Feldkircher et al., (2014), examining 149 countries during the global financial crisis, showed that high inflation before a crisis intensified exchange rate pressures and that international reserves played a key role in reducing exchange rate fluctuations. Boonman (2019), by analyzing 35 emerging economies, showed that combining several indices is better for identifying currency crises than using a single index.

Ferdous et al., (2022), using monthly data from 1992 to 2011, analyzed currency crises in emerging economies of Asia and Latin America with the logit model. The results showed that macroeconomic and institutional variables such as low export growth, the current account surplus-to-GDP ratio, GDP growth, high real exchange rate growth, import growth, and the short-term debt-to-reserves ratio are key indicators for predicting crises.

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In Iran, several studies have also investigated currency crises. Nasrollahi et al., (2017) found that inflation, the loan-to-deposit ratio, GDP growth, and the ratio of bank debt to the central bank are key factors affecting Iran's currency crises. Bayani and Mohammadi (2019) using the TVP-VAR model, found that budget deficits, exchange rate deviations, inflation, the export-to-GDP ratio, and M2growth are the most significant variables influencing financial crises in Iran. Haji Shahverdi et al., (2019), by designing an early warning model, showed that the exchange rate, bank debt to the central bank, and non-performing loans are among the most important variables predicting banking crises in Iran.

Salmani et al., (2019), using logit and Markov switching models, showed that the government budget deficit-to-GDP ratio, the current account deficit-to-GDP ratio, and inflation increase the likelihood of a currency crisis. Nasrollahi et al., (2020), by designing an early warning system, found that during crisis periods, inflation is the most significant factor in exacerbating the crisis, while real GDP growth is the key factor for economic recovery. Bastanzad and Davoodi (2022), using data mining and Lasso regression, demonstrated that a domestic savings deficit and cash flow problems in banks lead to an increase in base money growth, a rise in general price levels, and a decline in international reserves, eventually causing a currency crisis. Khosrosereski and Dashtbani (2024), using the probit model, found that M2growth, exchange rate growth, declining foreign exchange reserves, oil revenue dependence, and sanctions are the most significant factors in Iran's currency crises, while global oil price growth and the real economy reduce the likelihood of a crisis.

Various studies on currency crises have examined key factors and forecasting models. The findings show that factors such as inflation, exchange rates, international reserves, GDP growth, the export-to-import ratio, budget deficits, M2growth, and dependence on oil revenues have a significant impact on the occurrence of currency crises. Some studies have employed logit and probit models to identify important crisis indicators, while others have used data mining techniques such as decision trees, artificial neural networks, and Lasso regression to improve prediction accuracy. Studies conducted in Iran have also shown that inflation, M2growth, exchange rate deviations, bank debt to the central bank, and sanctions are the most significant factors in the country’s currency crises.

Given the importance of this issue, it is crucial to use a model that can identify the most important crisis indicators and reduce the uncertainty related to the selection of indicators and forecasting models. One appropriate method

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in this regard is Bayesian Model Averaging (BMA), which allows for the combination of results from several models, improving the accuracy of predicting currency crises.

4 Research Method

4.1 Bayesian Model Averaging (BMA) Approach

One of the key challenges in econometrics is the disagreement over how to select variables and specify models, which can lead to different results in analyses. Increasing the number of variables, due to sample size limitations, reduces the precision of the results. Researchers may personally include certain variables in the model or introduce errors through multiple testing. These methods may not lead to reliable results. One solution is to perform sequential tests to add or remove variables, but these methods, due to hypothesis testing issues and cumulative errors, may not yield satisfactory results (Poirier, 1995).

In order to provide an appropriate solution for addressing the uncertainty in selecting parameters and models, Bayesian Econometrics has recently been introduced. This approach was first proposed by Jeffreys (1961) through a method called Bayesian Model Averaging, which was further developed by Leamer (1978). Additionally, researchers such as Wasserman (2000), and Koop and Potter (2003) developed more comprehensive methods in this field. In these approaches, it is assumed that there is random behavior in the models and parameters, and their distributions are estimated based on prior information (Draper, 1995). In the Bayesian Model Averaging method, all possible models are examined, and the impact of each variable on the currency crisis is assessed, considering the presence or absence of other variables. This method answers the question of which variables maintain their effect in the presence of other variables and which ones lose their impact. If the effect of a variable changes or becomes meaningless in the presence of other factors, that variable is considered fragile; otherwise, it is deemed non-fragile.

The use of Bayesian Model Averaging (BMA) in forecasting currency crises offers several advantages. First, this method reduces model uncertainty by using all possible models rather than relying on a specific model, thus decreasing the error caused by incorrect model selection (Ciccarelli & Rebucci, 2006). Additionally, BMA improves forecasting accuracy by combining results from multiple models and utilizing prior information, particularly in economically volatile conditions. This approach is highly flexible and capable of adapting to structural changes in the economy and the

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emergence of new variables, offering reliable forecasts (Moral-Benito, 2012). Furthermore, using prior information in Bayesian models allows BMA to leverage historical data and previous crises to improve predictions (Catania and Beilou, 2021).

The foundation of this method is based on Bayes' Theorem, which states that if Y represents the dataset available and (Θ) is the vector of the parameters of interest, the probability of the parameters conditional on the available dataset (i.e., $P\left(\frac{\Theta}{Y}\right)$) is expressed as:

$$P\left(\frac{\Theta}{Y}\right) = \frac{P\left(\frac{Y}{\Theta}\right)P(\Theta)}{P(Y)} \quad (1)$$

Also, since $P(Y)$ is not a function of (Θ), we have:

$$P(\Theta/Y) \sim P(Y/\Theta)P(\Theta) \quad (2)$$

In equation (2), $P(\Theta)$ is not dependent on the data and actually represents a set of information related to the model parameters that, prior to observing the data, is used as the researcher's subjective probability. For example, if (Θ) represents the production scale efficiency parameter in a production process, it often makes sense to assume a certain scale efficiency constraint. In such cases, without observing the data, the researcher assigns a probability of $P(\Theta)$ equal to one for the parameter (Θ), and thus $P(\Theta)$ is referred to as the prior probability. It is important to note that in cases where no such information is available, one can use a non-informative prior, such as a uniform distribution, which does not influence the parameter estimation results. Informative priors, which contain information about how and with what accuracy the parameters influence the dependent variable, are called informative priors.

$P(Y/\Theta)$ in the equation above represents the probability density or the data likelihood conditional on the model parameters, essentially referring to the process that generates the data. For example, in linear regression models, it is often assumed that the errors have a normal distribution, which implies that $P(Y/\Theta)$ also has a normal density. $P(Y/\Theta)$ is called the likelihood function. $P(\Theta/Y)$is referred to as the posterior distribution, which is computed based on the prior and likelihood functions. In fact, the posterior distribution is the probability of the parameters (Θ) after observing the data.

Before explaining the mechanism of the above method, it is assumed that for modeling a dependent variable, generally R different models are available. For example, here M_r represents the r-th model and Θ_r represents its

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parameters. These parameters also have prior $P(\Theta_r, M_r)$, likelihood $P(\frac{Y}{\Theta_r}, M_r)$, and posterior $P(\frac{Y}{\Theta_r}, M_r)$ functions. Therefore, we can write:

$$P\ (\Theta r/\mathrm{Y}, \mathrm{M}_r) = \frac{P(Y/\Theta_r, \mathrm{M}_r)P(\Theta_r/\mathrm{M}_r)}{P(Y/\mathrm{M}_r)} \quad (3)$$

Also, based on Bayes' theorem, the probability of any given model (such as M_r) can be derived as follows:

$$P\ (\mathrm{Mr}/Y) = \frac{P(Y/\mathrm{M}_r)P(\mathrm{M}_r)}{P(Y)} \quad (4)$$

In the above relation, $P(M_r)$ is the prior probability of the model M_r, which calculates the likelihood of its correctness without considering the data. $P(\mathrm{Y}/\mathrm{M}_r)$ is also the likelihood function of the model M_r. By integrating both sides of the above equation and knowing that we have:

$$\int P(Y/\Theta_r, \mathrm{M}_r)P(\Theta_r/\mathrm{M}_r)d\Theta_r = 1$$
$$P\ (Y/\mathrm{M}_r) = \int P\quad (Y/\Theta_r, \mathrm{M}_r)P(\Theta_r/\mathrm{M}_r)d\Theta_r \quad (5)$$

Finally, by simultaneously using the odds ratio of the posterior probability function (POR) and the assumption that the sum of the posterior model probabilities equals one $\left(\sum_{r=1}^{r} P(\mathrm{M}_r/Y) = 1\right)$, the probability of each model can be calculated. However, when the number of models is large, calculating the probability of each model using the above method becomes time-consuming. Therefore, algorithms are employed that, through sampling from all available models, estimate the probability only for the sampled models. One of the most important algorithms in this regard is the MC algorithm, which, based on the posterior probability of each model, performs sampling from all models.

Now, if we assume that Y is a vector of N dependent variables for N individuals or countries and the matrix $\mathrm{x}_{\mathrm{N}*\mathrm{K}}$ contains K potential explanatory variables that could influence the dependent variable Y, then by using combinations of the existing explanatory variables, $R = 2^k$ different linear regression models can be designed. All of these models have an intercept, but they differ in the combinations of explanatory variables.

In this context, the following regression model includes all $\mathrm{R} = 2^{\mathrm{k}}$ models that can be formed with these K variables:

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$$Y = \alpha Ln + X_r\beta_r + \varepsilon \quad (6)$$

where:

- Ln is a unit vector of size $N \times 1$.
- x_r is a matrix of size $N \times K_r$, which includes some or all of the columns of the matrix $x_{N\times K}$

Due to the large number of models, it is not possible to compute the likelihood function for each model separately. Instead, it can be calculated using an appropriate algorithm written in the R software, based on the usual method for computing the likelihood function.

However, unlike the likelihood function, the prior function cannot be calculated exactly using the same method. This is because to use the prior function, one must write the parameters related to the distribution of the prior function for all 2^k models, which is impossible. Even if this task were possible, it is clear that having information about all the variables and possible models is unlikely. Therefore, in practice, it is not possible to use an informative prior function for the parameters of the "Bayesian Model Averaging" (BMA) method.

A solution to this problem seems to be using a non-informative prior function for all models. However, it must be noted that since the computation of the posterior likelihood ratio is only possible for the parameters that appear in all models, we can conclude that the non-informative prior function can only be used for the intercept and parameter h. Moreover, the use of a non-informative prior function is likely to increase the error in coefficient estimation to a large extent.

Therefore, for the parameters β_r, we use a different prior function known as the g-prior. This type of prior was introduced by Zellner in 1986 and later developed by him. It can automatically estimate the prior function for all relevant models using an algorithm. Thus, if we consider a conjugate normal prior function, we can say:

$$\beta_r/h \sim N(\beta_r, h^{-1}v_r) \quad (7)$$

Now, since we can have many potential explanatory variables, many of which may be irrelevant and have no effect on the dependent variable, we assume $\beta_r = 0$. However, to obtain V_r, we use the **g-prior**, and we have:

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$$v_r = [g_r, x^{'}x]^{-1} \quad (8)$$

As it is clear, to use the **g-prior**, only the selection of the g_r parameter needs to be specified. The details of how to choose this parameter will be discussed after explaining the calculation of the posterior function parameters. However, the parameters of the posterior function can be obtained by combining the likelihood and prior functions. Therefore, the mean and variance of the parameter β\betaβ, which follows a t-distribution, can be derived as follows:

$$E(\beta_r/Y, M_r) = \beta_r = v^{-}{}_r x^{'} y \; Var(\beta_r/Y, M_r) = \frac{v^{-} s_r^2}{v^{-}-2} \quad (9)$$
$$v^{-}{}_r = [(1+g_r)x^{'}x]^{-1}$$

We also have:

$$s_r^2 = \frac{\frac{1}{g_r+1} y^{'} p_{xr} y + \frac{g_r}{g_r+1}(y-y^{-}l_n)^{'}(y-y^{-}l_n)}{v^{-}} \quad (10)$$

The final likelihood function for each model is as follows:

$$v^{-} = N \quad (11)$$
$$p_{xr} = I_N - x_r(x_r^{'}x_r)^{-1}x_r^{'}$$
$$p\ (y/m) \sim \left(\frac{g_r}{g_r+1}\right)^{\frac{Kr}{2}} \left[\frac{1}{g_r+1} y^{'} p_{xr} y + \frac{g_r}{g_r+1}\left(y-y^{-}l_n\right)^{'}\left(y-y^{-}l_n\right)\right]^{-\frac{N-1}{2}}$$

To calculate the posterior probability of the model, the following equation can be used:

$$P(M_r/y) = c\ p(y/M)p(M_r) \quad (12)$$

Which c is a constant and the same for all models, and given that $\sum_r^R p(M_r/y) = 1$, it can be computed. Additionally, we assume the prior probability for all models is equal and consider it for each model as:

$$p(M_r) = \frac{1}{R}$$

If we disregard the prior probability, the posterior probability of any given model (r) can be obtained as:

This means that the posterior probability of model M_r is proportional to the likelihood of the data given the model, where the constant factor c is ignored.

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$$p\ (M_r/y) = \frac{p(y/M_r)}{\sum_{j=1}^{R} p(y/M_r)} \tag{13}$$

The method outlined above allows us to make a decision about selecting g_r is a value between zero and one, such that $g_r = 0$, the prior becomes completely uninformative. On the other hand, if we wish to give equal weight to the prior information and the information obtained from the data, we should set $g_r = 1$.

However, many researchers argue that $g_r = 1$ is too large for this parameter. Therefore, after conducting numerous experiments with synthetic data for large values of N, researchers such as Fernández and Steel (2001) recommended the following value for gr. This value is commonly suggested when dealing with larger sample sizes.

$$p(M_r) = \begin{cases} \frac{1}{K^2} & N \leq K^2 \\ \frac{1}{N} & N > K^2 \end{cases} \tag{14}$$

The above value for g_r is a number between zero and one, and it serves as the basis for determining the prior in this study.

In studies related to forecasting currency crises, such as Feldkircher et al., (2014), the Bayesian Model Averaging (BMA) approach has been used to identify leading indicators and macroeconomic variables that could predict the occurrence of currency crises (Krolzig, 2003). Through this method, a set of potential variables that play a significant role in triggering currency crises can be identified and then utilized for modeling. Since many variables can be considered as factors influencing currency crises, and based on first, second, and third-generation crisis identification methods, certain variables can be viewed as leading indicators of currency crises. In this study, using the Bayesian Model Averaging approach, the most significant variables affecting currency crises will be determined.

Generally, several approaches are used to select the factors that influence crises, which include:

- Indicators derived from a specific theoretical model
- Selection of indicators based on a systematic review of existing literature
- Use of all available indicators from accessible databases and testing whether at least some of these indicators are useful in explaining the crises.

In this study, with an emphasis on the second approach (systematic review of studies related to the Iranian economy), 20 variables have been selected as

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explanatory variables in the context of the currency crisis model. The data for the years 2001 to 2021 (1380 to 1400 in the Iranian calendar) are provided on a quarterly basis (Table1).

Table 1
Selected Variables Explaining Currency Crises

Symbol	Variable Name	Symbol	Variable Name
XPR	Export-to-output ratio	INF	Inflation
ONG	Deviation of unofficial exchange rate from official	BGR	Budget deficit-to-output ratio
OPC	Oil price changes	GGR	Government expenditure-to-output ratio
MEG	Percentage gap of market exchange rate from equilibrium	RGR	Real GDP growth
REG	Growth of foreign exchange revenues from oil exports	IGR	Industrial production growth
XIM	Exports-to-imports ratio	EXG	Customs export growth
FER	Foreign exchange income-to-reserves ratio	MGR	Growth of m2-to-output ratio
ALR	Foreign assets-to-foreign debt ratio of the Central Bank	LDR	Loan-to-deposit ratio
DML	Ratio of bank debt to the Central Bank's base money	GPG	Changes in global gold prices
MLR	M1-to-M2 ratio	UNI	Uncertainty Index

Source: Research findings

All these variables were taken from the Central Bank's data and were standardized. In this study, variables affecting currency crises are categorized into two groups: economic and non-economic factors. For the non-economic section, the Uncertainty Index is considered as a representative of non-economic factors.

4.2 Uncertainty Index and its Relationship with Exchange Rate

Economic uncertainty, as one of the key variables, plays a significant role in exchange rate volatility. According to theoretical perspectives, exchange rates are determined by fundamental economic factors and macroeconomic policies (Krol, 2014). In such a context, changes in the level of economic, financial, or political uncertainty can alter the expectations of economic agents, thereby contributing to fluctuations in exchange rates (Krol, 2014; Husted et al., 2018; Zhu and Yan, 2015).

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Despite the importance of this variable, the existing literature lacks a precise and universally accepted definition and measurement of economic uncertainty. Consequently, most studies rely on proxy indicators to approximate uncertainty. Generally, the methods for measuring uncertainty are classified into three main categories:

Financial market-based indices (e.g., implied stock market volatility)

Forecast-based indices (e.g., dispersion of economic forecasts or model-based uncertainty)

News- or media-based indices (e.g., frequency of uncertainty-related terms in publications)

In this study, to avoid potential media bias and to construct an index that reflects public perception and concern about the economy, we utilize the Internet Search Volume Index based on Google Trends data. The primary advantage of this index lies in its focus on the behavior of internet users in response to uncertainty, rather than the perspective of media sources (message senders). It thus captures how the general public perceives and reacts to uncertain events.

The process of constructing the uncertainty index using Google Trends involves the following steps:

1) Keyword Selection: A list of keywords related to economic, political, and financial uncertainty is compiled. These terms are selected based on their frequency of use and sensitivity to macroeconomic developments. Examples include: “economic uncertainty,” “sanctions,” “inflation,” “financial crisis,” “recession,” “instability,” etc.
2) Data Collection: Using Google Trends, the search frequency data for each selected keyword is gathered for the desired time period (weekly or monthly) and specific to Iran.
3) Data Normalization: Google Trends provides search volume data in a normalized form, where the value of 100 represents the highest recorded search frequency within the selected timeframe. All other values are scaled relative to this peak.
4) Index Construction: The search data for the selected keywords are then aggregated to form a composite uncertainty index. This aggregation can be done through a simple average or a weighted average. In the case of a weighted average, each keyword is assigned a weight based on its correlation with key macroeconomic indicators.
5) Index Validation: To validate the constructed index, its historical trend is compared with significant economic events in Iran (e.g., exchange rate

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shocks, international sanctions, political crises) to assess its consistency and reliability as a measure of perceived uncertainty.

Using this internet search-based index as a proxy for economic uncertainty allows for a more nuanced analysis of the relationship between uncertainty and exchange rate volatility. Since the index is grounded in public behavior in the digital space, it provides a closer approximation to socioeconomic realities than many traditional media-based indicators.

4.3 Exchange Market Pressure Index

To analyze currency crises, the Exchange Market Pressure Index is used, which is a weighted average of exchange rate changes, loss of foreign reserves, and interest rate changes. The equation for the Exchange Market Pressure Index is as follows:

$$EMP_t = \frac{\Delta_{e_t}}{e_t} - \frac{\sigma_e}{\sigma_r}\frac{\Delta r_t}{r_t} + \frac{\sigma_e}{\sigma_i}\Delta i_t \quad (15)$$

Where:

- EMP_t is the Exchange Market Pressure Index
- e_t is the exchange rate against the U.S. dollar
- r_t is foreign reserves
- i_t is the nominal interest rate
- Δe_t is the standard deviation of relative exchange rate changes
- Δr_t is the standard deviation of reserve change rates

This index is used for identifying currency crises, and combining it with other variables helps in better analyzing the currency crisis.

After calculating the Exchange Market Pressure (EMP) index, a model is needed to convert the index into a binary time series that indicates whether a currency crisis occurred or not. To do this, a threshold method can be used, where if the index exceeds 1.5 times the standard deviation plus the mean of the index, it is marked as 1 (indicating a crisis). Otherwise, it is marked as 0 (indicating no crisis). Other values like 2 or 3 can also be considered (Table 2).

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Table 2
Studies and Their Chosen Threshold Levels for Identifying Currency Crises via EMP Index

α = 1.5	**α = 2**	**α = 2.5**	**α = 3**
Tinakorn (2002)	Adiningsih et al., (2002)	Tinakorn (2002)	Kibritçioğlu et al. (2001)
Eichengreen et al. (1995)		Kamin & Babson (1999)	Bousier and Fratcher (2006)
Yap (2002)	Edison (2003)	Kaminsky et al., (1998)	Berg and Patillo (1999)
Peng & Bajona (2008)	Bali et al. (2014)		

Source: Research findings

5 Empirical Studies on Currency Crisis Thresholds

Empirical studies show that criteria for determining currency crisis ranges differ across economies. In industrial economies with low inflation, a devaluation of the national currency or pressure on the exchange market by 50% compared to the historical trend is considered a currency crisis. However, in developing economies with high inflation, the crisis threshold depends on deviations of more than three standard deviations from the historical trend.

In Iran, due to high inflation, a currency crisis is considered to occur when the exchange market pressure index exceeds 2.5 standard deviations above the historical trend.

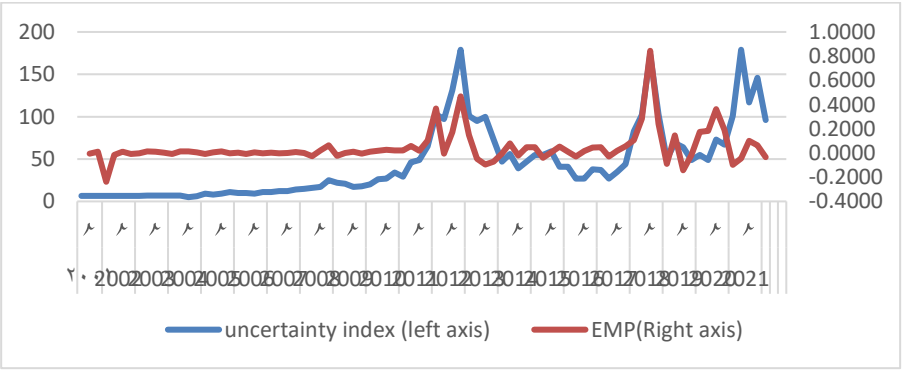

Figure 1. status of the currency market pressure index and the uncertainty index
Source: Research findings

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6 Results of Bayesian Model Averaging (BMA)

Given the uncertainty in determining the variables, this section aims to identify the factors affecting currency crises. In this study, no pre-determined model is considered the correct one. Instead, the model should be extracted based on the data. To obtain the result, calculations need to be performed across all models in the model space. Considering the number of variables under investigation, the number of models in the model space is equal to 2^{20}, which results in more than 1,048,576 regressions. Even with suitable processors, if each model is estimated in one second, it would take several days to complete all regressions. If the number of variables increases from 20 to 21, the volume of computations and required time at least doubles. Therefore, model sampling should be done.

Table 3
Results of the Bayesian Model selection (BMS)

Variable Name	Abbreviation	PIP
Export to Production Ratio	XPR	1
Inflation	INF	1
Exports to Imports	XIM	0.998
Budget Deficit to Production Ratio	BGR	0.979
Real GDP Growth	RGR	0.977
Uncertainty Index	UNI	0.973
M2 to Production Ratio Growth	MGR	0.966
M1 to M2 Ratio	MLR	0.823
Market Exchange Rate Gap from Equilibrium	MEG	0.675
Debt of Banks to the Central Bank to Monetary Base Ratio	DML	0.279
Loan to Deposit Ratio	LDR	0.273
Oil Price Changes	OPC	0.188
Foreign Assets to Foreign Debt of the Central Bank Ratio	ALR	0.140
Global Gold Price Changes	GPG	0.131
Deviation of Unofficial from Official Exchange Rate	ONG	0.112
Government Expenditures to Production Ratio	GGR	0.110
Growth in Foreign Revenues from Oil Exports	REG	0.108
Industrial Production Growth	IGR	0.076
Foreign Revenue to Foreign Reserves Ratio	FER	0.068
Customs Export Growth	EXG	0.040

Source: Research Findings

7 Interpretation of Results

According to the findings of the Bayesian Model Averaging (BMA), several factors, including trade, monetary, fiscal, and psychological variables, play a role in the occurrence of currency crises. In this study, the most influential

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non-breakable variables affecting currency market pressures and the likelihood of a currency crisis are as follows:

1) **Export-to-output ratio and export-to-import ratio:** These two indicators reflect the degree of the economy's reliance on exports and the country's trade balance. In Iran, the heavy dependence on oil exports has resulted in global oil price fluctuations having a direct impact on foreign exchange revenues. A decrease in oil prices leads to a reduction in export revenues and an increase in the trade deficit, which in turn increases pressure on the exchange rate. For example, in recent years, the decline in oil prices has led to a reduction in the country's foreign exchange resources and an increase in the exchange rate. This dependence on oil has made the Iranian economy vulnerable to external shocks and exacerbates exchange rate fluctuations.
2) **Exchange rate gap from the equilibrium rate:** This variable indicates the difference between the actual exchange rate in the market and the equilibrium exchange rate. A large gap between these two rates can lead to increased speculative activities and sharp fluctuations in the currency market. For example, during periods when the official exchange rate has significantly diverged from the market rate, demand for foreign exchange in the informal market has increased, exacerbating currency crises. This gap can lead to increased inflationary expectations and reduced confidence in monetary policies, which itself becomes a factor in increasing demand for foreign currency and intensifying the currency crisis. For instance, between 2018 and 2020, due to sanctions and a decrease in foreign exchange revenues, the exchange rate in the free market increased significantly, deviating from the equilibrium rate. This gap resulted in increased inflationary expectations and speculative activities, which worsened the currency crisis.
3) **M2-to-output ratio and M1-to-M2ratio:** An increase in liquidity without production backing can lead to higher demand for foreign currency. In Iran, liquidity growth driven by expansionary monetary policies and the government's budget deficit, without a corresponding increase in production, has led to higher inflation and a decline in the national currency's value. This has resulted in an increase in demand for foreign currency and exacerbated currency crises. For example, in recent years, uncontrolled base money growth has led to higher inflation and a decrease in the value of the rial against foreign currencies. In the early 2010s, inappropriate monetary policies and an increase in liquidity

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without production backing led to inflation and a decline in the value of the rial, ultimately causing a currency crisis.

4) **Inflation rate and budget deficit-to-output ratio:** High inflation and chronic budget deficits are structural problems in Iran's economy. Inflation leads to a decrease in purchasing power and an increase in demand for foreign currency as a safe asset. Furthermore, the government's budget deficit, often financed by borrowing from the central bank, increases the monetary base and inflation, which puts additional pressure on the exchange rate. For example, in recent years, increasing government spending without securing sustainable financial sources has led to a rise in the budget deficit, subsequently increasing inflation and decreasing the value of the national currency. Between 2018 and 2020, the increase in inflation and the government's budget deficit, due to declining oil revenues and sanctions, led to a rise in the exchange rate and a currency crisis.
5) **Real output growth:** Sustainable economic growth can increase the supply of goods and services and reduce dependence on imports, helping stabilize the exchange rate. In Iran, fluctuations in economic growth and reliance on oil have caused periods of recession to see increased demand for foreign currency, exacerbating currency crises. For instance, during periods of negative economic growth, a decline in domestic production has led to higher imports and, consequently, increased demand for foreign currency. Between 2018 and 2020, the reduction in economic growth due to sanctions and reduced investment led to a decline in the value of the rial and a currency crisis.
6) **Uncertainty index:** Political and economic uncertainties can lead to capital outflows and increased demand for foreign currency. In Iran, international sanctions and political tensions have increased uncertainty and led to capital outflows, putting pressure on the exchange rate and exacerbating currency crises. For example, in recent years, rising political tensions have resulted in reduced foreign investment and the outflow of domestic capital, increasing demand for foreign currency and exerting pressure on the exchange rate. Between 2018 and 2020, with the increase in political tensions and sanctions, uncertainty in the Iranian economy rose, leading to higher exchange rates and a currency crisis.

Overall, the findings from this section indicate that currency crises in Iran are influenced by a combination of various economic factors. Some variables, such as the exchange rate gap from equilibrium and the export-to-output ratio, have a stronger impact on exchange rate fluctuations, while variables such as

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the uncertainty index and real output growth have a moderate effect. Therefore, reforming exchange rate policies, reducing reliance on oil revenues, controlling liquidity and inflation, managing expectations in the foreign exchange market, and creating stability in the economic environment are key solutions to reduce currency crises in the country.

Additionally, to refine the model, the BAS method has been used, and the results confirm the previous method. The five primary models with the highest probability of occurrence can be extracted. The posterior probability of each model is calculated based on Bayes' rule. This method enables the assessment of the uncertainty of each model and variable, which is particularly important in economic analysis. Various models have been estimated simultaneously using the available data, and by comparing the probabilities of each model and variable, the best model for prediction and analysis can be chosen. This table includes the results of comparing models based on various criteria, which helps in the more precise and transparent analysis of these models. Thus, among the models with the variables listed above, the one with the highest explanatory power is selected.

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Table 4
result of Bayesian Averaging of Submodels(BAS)

	P(B != 0 | Y)	Model1	Model2	Model3	Model4	Model5
Intercept	1	1	1	1	1	1
XPR	0.99	1	1	1	1	1
ONG	0.34	0	0	0	1	0
OPC	0.38	0	0	0	1	1
MEG	0.83	1	1	1	1	1
REG	0.38	0	0	1	1	0
XIM	0.99	1	1	1	1	1
FER	0.30	0	0	0	1	0
ALR	0.31	0	0	0	1	0
DML	0.37	0	0	0	1	0
MLR	0.93	1	1	1	1	1
INF	0.99	1	1	1	1	1
BGR	0.99	1	1	1	1	1
GGR	0.32	0	0	0	1	0
RGR	0.99	1	1	1	1	1
IGR	0.31	0	0	0	1	0
EXG	0.33	0	0	0	1	0
MGR	0.99	1	1	1	1	1
LDR	0.45	0	1	0	1	0
GPG	0.37	0	0	0	1	0
UNI	0.94	1	1	1	1	1
BF	-	1	0.31	0.31	0.00	0.27
PostProbs	-	0.03	0.00	0.00	0.00	0.00
R2	-	0.72	0.72	0.72	0.74	0.72
dim	-	10	11	11	21	11
logmarg	-	32.02	30.88	30.88	18	30.73

Source: Research findings

The results presented in this table indicate that in various models, some variables consistently have a significant and strong impact on the dependent variable. Based on the probability of impact, it is evident that variables like the export-to-production ratio, the market rate gap from equilibrium, export-to-import ratio, M1-to-M2 ratio, inflation, budget deficit-to-production ratio, real output growth, M2-to-production growth ratio, and uncertainty index are significant in most models, with their probabilities being close to 1. This indicates a strong relationship between these variables and the dependent variable and highlights their importance in various analyses.

On the other hand, some variables do not have a significant impact in certain models, or their probability of impact is low, suggesting less importance in explaining the behavior of the dependent variable in those models. Additionally, the results of different criteria such as R^2, Log Marginal,

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and PostProbs suggest that Models 1, 2, and 3 have the best fit and higher accuracy, while Models 4 and 5 show a decline in performance and predictive quality. Therefore, Model 1 outperforms the other models in terms of all criteria.

8 Discussion and Conclusion

Currency crises are one of the most significant economic challenges in developing countries, including Iran. A proper understanding of the factors affecting these crises can assist policymakers in developing appropriate strategies to control exchange rate fluctuations and reduce economic damage. Given the complexities in the macroeconomy and the uncertainty in choosing precise economic models, the use of Bayesian Model Averaging (BMA and BAS) methods as an innovative approach allows for more accurate identification of the key variables influencing currency crises.

In this study, 20 frequently occurring variables were identified based on relevant economic studies related to Iran. Using Bayesian Model Averaging techniques, 9 non-breakable variables were identified as key factors in currency crises. These variables include the export-to-output ratio, the percentage gap between the market exchange rate and the equilibrium rate, the export-to-import ratio, the M1-to-M2 ratio, the inflation rate, the budget deficit-to-output ratio, real output growth, M2-to-output ratio growth, and the uncertainty index. The results of this study show that the proposed model is significantly able to explain the factors affecting currency crises in Iran and can be used to provide policy recommendations.

Based on the findings of this research, a set of policy recommendations for managing currency crises in Iran is presented:

1) **Reforming Exchange Rate Policies and Reducing the Exchange Rate Gap:** Moving towards a managed floating exchange rate system, reducing multiple exchange rates, and strengthening foreign exchange reserves can help prevent severe fluctuations. Clarifying exchange rate policies and reducing unnecessary government interventions will also enhance the confidence of economic actors.
2) **Managing Liquidity and Controlling Inflation:** Reducing liquidity growth through controlling the monetary base, directing financial resources towards productive activities, and strengthening anti-inflationary policies are effective measures in this area.
3) **Reforming Fiscal Policies and Reducing the Budget Deficit:** The government should diversify its financial resources by reforming the tax system, increasing sustainable revenues, and reducing dependence on oil

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revenues. Managing current expenditures and improving public expenditure efficiency can also be effective in this direction.

4) **Strengthening Real Output Growth and Economic Infrastructure:** Supporting investment in productive sectors, improving export infrastructure, and reducing business barriers plays an essential role in strengthening domestic production and reducing dependence on imports.
5) **Diversifying Exports and Reducing Dependency on Oil:** Developing non-oil exports, strengthening knowledge-based industries, increasing trade interactions with neighboring countries, and utilizing bilateral monetary agreements can help alleviate exchange rate pressures. Additionally, supporting domestic producers to enhance the competitiveness of export goods is crucial.
6) **Reducing Economic and Political Uncertainties:** Creating stability in economic policies, improving international relations, and strengthening economic transparency can significantly impact the reduction of currency crises. Disseminating accurate and transparent information regarding macroeconomic policies will also help reduce speculative behaviors and enhance public trust.

This set of policy recommendations aims to reduce exchange rate pressures and create a stable and resilient economic environment against currency crises. The implementation of these policies can help stabilize the exchange rate, reduce currency fluctuations, and ultimately strengthen the national economy.

Finally, it is important to emphasize that the direction of relationships among the variables in the model has been established based on robust evidence and documentation from previous domestic and international studies, which confirm the role of these variables as influential factors on exchange market pressure. The present study's approach is grounded in the hypothesis of causal relationships among these variables, which serves as the foundation for the analyses and policy recommendations presented. However, due to the inherent complexities of macroeconomic systems and methodological limitations employed, the comprehensive and statistical assessment of causality direction was not fully feasible in this research. Therefore, this aspect has been acknowledged as a natural limitation in interpreting the results and has been carefully considered in formulating policy recommendations, ensuring that the analyses remain within a rigorous scientific and logical framework.

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