

RESEARCH ARTICLE

ANALYSIS OF THE EFFECTS OF PRODUCTIVITY AND INVESTMENT SHOCKS ON EXCHANGE RATE FLUCTUATIONS USING THE THIRD-GENERATION MODEL OF THE CURRENCY CRISIS IN IRAN

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Abstract : Crisis prevention due to the sharp devaluation of the domestic currency is one of the important planning for economic policymakers. This research examines the positive effects of the exports on the devaluation of the domestic currency by the third-generation model developed by Agion, Bacchetta and Banerji (2001), the ABB model. In this study, using the GMM and TSLS estimation method and monthly time series data from 2004 to 2018, the modified ABB model is estimated. This research will also develop a theoretical model that empirically analyses the effect of interest rate policy, real and financial shocks. Results show that the Productivity shocks and shifts in investment risk (IPLM) impose their effects on the economy as an effect on the exchange rate. Also, using the modified ABB model in this research, Iran's currency crisis 2017-18 can be analysed with the third-generation ABB model. This article will show that the source of this currency crisis in Iran was the IPLM shock.

Keyword: Currency Crisis, ABB Model, Exports, Productivity Shock, IPLM Shock

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Introduction

Currency crisis and monetary instability are the most important economic issues that need to be understood in their mechanisms, or to find a way to deal with them. So far, many theories have been theorised. Although these theories are practical in many cases, they are unable to explain how the currency crisis occurs in some countries. Economics focuses more on policy feedback factors that prevent currency crises. In a normal economy, the private sector is larger than the public sector of the economy, and the private sector is highly affected by currency crises. In the private sector, the devaluation of money has both positive and negative effects on a company's stored income. Because the devaluation of the national currency by stimulating exports will increase sales to foreign countries. With the increase in foreign currency debt burden, the working capital of the company decreases. Thus, the ABB (Aghion, Bacchetta & Banerjee) model is the best model for export analysis. In the ABB model, the existence of foreign currency debts reduces the profits and income of companies, and as a result, there is a sharp decline in monetary value, which leads to lower investment and less production in the real sector of the economy.

Two of the most common shocks that can suddenly change the price of currency are: Productivity shock and shock is the change in IPLM (Interest-Parity-LM) investment risk (Putri et al., 2013; Taningco, 2018). In the explanation, it should be said that any sudden change in the overall productivity of the economy is called a productivity shock that which increases in productivity affects the exchange rate (Sami et al., 2022). For

example, improving production technology causes a positive productivity shock, and resource allocation if it is more incorrect than the previous period causes a negative productivity shock. Also, IPLM shock, a sudden change in public expectations, or a sudden change in the level of investment risk in the country, and its effect is on the exchange rate.

This research aims to analyse the impact of the IPLM curve, the productivity curve, and the wealth curve on the exchange rate as an independent variable under the conditions of high exports and foreign debt. We try to develop the theoretical analysis of currency crises by studying several shock scenarios and their emergent effects within the framework originally proposed by Aghion, Bacchetta, and Banerjee. The so-called wealth curve depicts the relationship between the exchange rate and future output. Precisely, we check the hypothesis that the export dynamics inclusion in the ABB model gives a better insight into currency crises and, as such, is a theoretical enhancement of the existing frameworks in the third generation of currency crises literature. Therefore, to achieve these objectives, this study introduces modifications to the original ABB model, focusing on the role that exports play as a vital factor in preventing currency crises. The sections that follow will review the relevant literature, explaining the theoretical underpinnings of our approach and how our research contributes to the continuing discussion of currency crises.

Literature And Research Background

A currency crisis can be defined as a sudden devaluation of the domestic currency that theoretically appears as a sudden increase in the value of international currencies. To better study the models built on currency crises, it must first define the different generations of the currency crisis and review a summary of the theories derived from these models. So far, there have been three generations of different models of currency crises (Flood & Marion, 1999; Pesenti & Tille, 2000; Aschinger, 2001; Goderis & Ioannidou, 2008; Ari, 2012; Agosin & Huaita, 2012; Armas et al., 2014; Sharma & Setia, 2017; Adams & Metwally, 2019; Mahmoudinia & Amroabadi, 2023). First-generation models focus on internal contradictions that are related to macroeconomic policies, such as a fixed exchange rate regime and a sustained government budget deficit, in which the government must ultimately earn revenue to return to equilibrium (Krugman, 1979). The first-generation model of the currency crisis predicts that an economic system with a fixed exchange rate will fall. From 1992 to 1993, member countries of the European Exchange Rate Mechanism (ERM) experienced severe currency crises; however, these countries were essentially stable and economically united. Thus, as Obsfeld (1994) argues, the first-generation model cannot explain the ERM crisis. So the second generation models of the currency crisis, to explain some crises which happened in European countries, developed. In second-generation models, policymakers weigh the costs and benefits of whether they should defend the current exchange rate or change the current exchange rate. In these models, the government maximises a goal function. In a developed model in which the central bank minimises the quadratic function of losses, which depends on inflation and production deviation from its normal rate, the government decides whether to keep the exchange rate stable or not. In this model of interaction between investors, their expectations, and the consequences of economic policies can lead to recurring crises (Wang, 2010). One of the features of the second-generation model is that crises should not be treated on a macroeconomic basis, as opposed to first-generation models. Another feature of the second-generation model is the occurrence of multiple equilibria. In this model, brokers may buy or sell by creating pressure to force the government to abandon the fixed exchange rate regime. Because they make it very expensive to maintain a fixed exchange rate regime. An attack on the exchange rate will only lead to a significant change in the exchange rate, a sufficient number of brokers participate. Turunen et al. (2011) criticised standard second-generation models. Because they assumed that the basic principles of science are general information and showed that the injection slightly quantified the signal of the economic agent, in the case of fundamental principles, it will lead to a unique balance. After the Asian currency crisis of 1997-1998, third-generation models were also developed. Third-generation models emphasise the financial sector in the economy, and they focus on how the financial market and the banking system deviate can lead to currency crises.

Aghion, Bacchetta & Banerjee (2001), focusing on foreign currency debts, evaluated the effects of credit restrictions on currency crises. They checked how financial market problems react to currency crises and how crises can have a real impact on the economy. Another Type of Third Generation Model by Chang & Velasco (2001) examined how deviations in the banking system could lead to a currency crisis. This model concluded that market-oriented policies improve welfare in the absence of banking activities, but it also makes the financial system more fragile and vulnerable and leads to a rapid diversion of capital flows and an increase in the probability of capital flight. Caballero & Krishnamurthy (2001) developed a model where there are domestic and international guarantees that explain how these two types of constraints deal with productivity shocks and how they ultimately lead to crises, which are more visible in developing countries. There is another type of third-generation model based on this idea, when the government guarantees the debt of the banking system can causing moral hazard problems (Burnside & Echenbam & Rebelo, 2001; Arduini et al., 2012; Sadeghi Amroabadi, 2021). The government uses its money to finance its guaranteed loans, which will lead to high inflation expectations and thus the currency will fall. García-Fronti, Miller & Zhang (2006) introduced demand-

side factors to the ABB model, Such as consumption and export. They showed that when production is determined by the demand side, an increase in interest rates will strengthen the national currency less than when production is determined by the supply side (Priti, 2016; de Lara-Tuprio et al., 2017; Nasr Azadani et al., 2023). They argued that an increase in interest rates may help maintain demand while easing the financial burden. However, they did not examine the effects of exchange rate fluctuations on exports. Kaminsky et al. (2003) stated that countries, when their economies are worn out by financial problems unable to raise trade credits to finance exports. In contrast, for countries without internal vulnerabilities, high exports are at the heart of their recovery from the currency crisis.

The thematic literature of economics has recently shown that exports are very important for currency crises. Deb (2006) and Mahmoudinia et al. (2016) found that faster export growth is a key factor in the recovery of the economy from the currency crisis (Rostamian et al., 2023). Bergman & Jellingsø (2010) used corporate data used local companies and multinational corporations to analyse the response to currency crises. They found that US multinational corporations, significantly more than local companies during and after the economic crisis, they experience an increase in sales, an increase in assets, and an increase in investment. Forbes (2002) as well as Asici (2011), found evidence to support the hypothesis that currency crises spread from one country to another due to trade links. Van Rijckeghem & Weder (2001) also found that financial relations play an important role in spreading the currency crisis. Adams & Metwally (2019), Sadeghi Amrabadi and Mahmoudinia (2020) and Rao and Paldi (2020) talked about the effects of trade and exports on currency crises and their importance. There have been many articles and research on currency crises so far published using foreign models (Salmani et al., 2017; Nasrollahi et al., 2017; DahmardeGhaleno & Pourshahabi, 2014). This study examines the impact of different types of shocks (productivity shock and IPLM shock) which leads to currency crises, analyzes. This study also examines the role of foreign currency debt and the effect of monetary policy examined to prevent a currency crisis. In other words, the reaction of monetary authorities to the currency crisis is in the form of monetary policy (Shutters & Waters, 2022). This article emphasises the efficiency and use of monetary policy tools, especially the legal reserve ratio tool, as one of the powerful monetary policy tools in the event of a currency crisis. In general, two types of shocks can cause currency crises. Productivity shock and IPLM shock. Productivity is the simultaneous realisation of effectiveness and efficiency. In other words, the amount of goods or services produced compared to each unit of energy or labour expended without reducing quality is called productivity. This study is more concerned with productivity change than productivity, because the productivity shock is one of the two types of shocks that trigger the currency crisis. Factors affecting productivity in a country's macro economy, technological progress, increasing resources, or better allocating resources, are macroeconomic. Productivity in a country's macroeconomy is called total productivity. The original ABB model shows that a negative shock to the total productivity factor (TFP) is the main cause of the economic recession and currency crisis. In principle, we know that the TFP greatly decreases during the currency crisis (Meza and Quentin, 2007; Chiang & Prescott, 2010; Aktas & Cortuk, 2012).

Theoretically, it is argued that the use of the productivity factor plays an important role in productivity movements in currency crises. Brandt et al. (2004) found that capital productivity can reduce TFP in Mexico. Meza and Quentin (2007) also found evidence that the productivity factor can explain a significant part of the TFP fall during the currency crisis. By measuring the model for the pre-crisis Mexican economic crisis, Paratap (1994-1995) and Orutia (2012) showed that financial factors that act as a constraint on capital, intended for intermediate goods, can endogenously cause a major drop in TFP; after an unexpected interest rate shock with intensified misallocation of inputs, in a way that causes a sharp decrease in TFP. Using Indonesian data, Auboin & Engemann (2012) found that productivity decline during the Indonesian crisis can be attributed to the inefficient distribution of resources in the industry. IPLM curve, a sudden change in public expectations or a sudden change in the level of investment risk in the country and shows its effect on the exchange rate. Bergman and Jellingsø (2010) showed that the slope of the IPLM curve is negative, proving the curvature of the IPLM curve. The slope of the IPLM curve is steep when the money supply is high and interest rates are low. The model equilibrium is obtained by the intersection of the IPLM curve and the wealth curve. The wealth curve shows the relationship between the exchange rate and future output, which was originally analysed by Agion, Bacheta and Banerjee. This curve is determined by the effect of the credit factor, and multiplication is determined by the company's wealth (or company savings). It is possible to obtain a graphical balance between the wealth curve and the IPLM curve found a link between exports and the currency crisis.

The three generations of currency crisis models have immensely enriched our understanding of currency devaluation mechanisms. As pointed out, however, a significant lacuna remains concerning explaining the interplay of modern economic variables and their roles in precipitating crises. Focusing on these concepts, this paper employs a distinctive methodological framework to further develop the theoretical discussion of currency crises and contribute toward improved predictive and policy capabilities. This paper, therefore, tries to fill in the gaps identified by introducing a more sensitive set of variables that cuts across both financial and macroeconomic dimensions. While past studies have placed greater emphasis on either structural weaknesses or market expectations within narrow contexts, this research will adopt a multidisciplinary approach. By

integrating real-time data on export dynamics, interest rates, and the implementation of market-oriented policies, the study will facilitate a more comprehensive understanding of how these factors interact to influence currency crises.

1. Research Methods

The present study is applied research in terms of purpose, which uses factual information and various statistical methods to refute or disprove hypotheses, and is in the field of positive research. Conducting this research based on a correlation analysis based on time series data regression method in Iran's economy. Theoretical foundations and research background have been obtained through library studies, articles, and sites. To analyse currency shocks, two curves need to be examined. These curves include the wealth curve and the IPLM curve. To examine the wealth curve, suppose a typical company produces one type of product in the country with a domestic price of p_t . These goods are sold to consumers inside and outside the country. The product is produced using capital, and its production function is written as follows:

$$y_t = f(k_t)(1)$$

Exports are added to the company's profit function. It is assumed that the exports to foreign exchange rates are a function of the real exchange rates and the external demand for those goods.

$$x_t\left(\frac{E_t p_t^*}{p_t}, y_t^*\right) \quad (2)$$

Where E_t is the price of foreign currency in domestic currency, and y_t^* is the foreign demand for the commodity. For simplicity, we assume that the price level of foreign countries (P_t^*) is rounded to one. Exports can then be written as a function of the real exchange rate as follows:

$$x_t\left(\frac{E_t}{p_t}, y_t^*\right)(3)$$

Note that exports, it increases when the domestic currency depreciates and foreign demand increases. When $\frac{E_t}{p_t}$ is higher, it means a real devaluation.

$$\frac{dx_t}{d\left(\frac{E_t}{p_t}\right)} > 0, \frac{dx_t}{dy_t^*} > 0 \quad (4)$$

In order to focus on the role of exports, the effects of the real exchange rate on domestic consumption are ignored. This assumption about price inflexibility, similar to the hypotheses of Agion, Bachta, and Banerjee (2001). PPP is assumed to exist at the beginning of period 1. After an unexpected shock, deviation from PPP ($E_1 \neq p_1$) occurs, corrected in period 2, $E_2 = p_1$. This shock may be like a change in actual productivity, or it may be a change in expectations. The timing of events can be summarised as follows: In period 1, the price p_1 is the default, and the company invests. Then an unexpected shock occurs. This coincides with the change in the nominal exchange rate E_1 . The shock will be accompanied by monetary policy adjustments set by the central bank. After that, production and profit occur in period 1, and the company's debt is repaid. Finally, a portion of the net income after repaying the company's debt is saved for investment in period 2. If we assume that working capital k_t completely disappears in a period, the company maximises the real net profit by repaying its loans:

$$\Pi_t = f(k_t) - (1 + i_{t-1}) \frac{p_{t-1}}{p_t} l_t - (1 + i^*) \frac{E_t}{p_t} l_t^* \quad (5)$$

Where l_t are the amount of loans in domestic currency and l_t^* are borrowed in foreign currency, and i and i^* are the interest rates on domestic and foreign loans, respectively. This study assumes that interest rates on foreign currency loans are stable over time. The study also hypothesises that when profits are positive, the company maintains a $(1-\alpha)$ ratio of profits and uses it for future investment. Therefore, the current stored income available for capital in the next period is as follows:

Due to the limited credit, the company must get the maximum loan amount it can:

$$L_t = l_t + l_t^* \quad (6)$$

Proportionate to its current real wealth w_t .

$$L_t \leq \mu W_t(7)$$

Where μ is a credit factor. Fixed credit ratio justification logic stems from considerations of moral hazard (Agion, Benarji, & Piketty, 1999). This credit constraint is assumed to be binding. Since capital is fully depleted over a period of time, investing in the current period will be equal to investing in the next period. Under the credit constraint, the equation of capital movement can be written as follows:

$$K_{t+1} = (1 + \mu)(1 - \alpha)\Pi_t(9)$$

Production is then specified by the production function:

$$y_{t+1} = f(k_{t+1}) = f((1 + \mu)(1 - \alpha)\Pi_t)(10)$$

Shows the equilibrium situation in the commodity market that the sum of domestic c_t and export sales is equal to the total production in the economy:

$$c_t + x_t\left(\frac{E_t}{p_t}, y_t^*\right) \frac{E_t}{p_t} = f(k_t)(11)$$

Using these conditions, production in period 2 can be written as follows:

$$y_2 = f((1 + \mu)(1 - \alpha)\{c_1 + \frac{E_t}{P_t} x_t (\frac{E_t}{P_t} \cdot y_t^*) - (1 + i_0) \frac{P_{t0}}{P_1} l_{1-(1+i^*)} \frac{E_1}{P_1} l_1^*\}) \quad (12)$$

This curve is actually called the "wealth curve", which shows the relationship between the exchange rate and future output, which was originally analyzed by Agion, Bacheta and Banerjee (2004). This curve by the effect of the credit factor, multiplication is determined by the company's wealth (or company savings) where the company's wealth is calculated as a savings rate, multiplied by the company's profit. Profit is defined as the sum of domestic and foreign sales minus the sum of the repayment of domestic and foreign debts. Using the exchange rate set in relation to production, the slope of the wealth curve can be calculated:

$$\frac{dE_1}{dy_2} | y_2 > 0 = \frac{\frac{P_i}{E_1 x_1 \frac{E_1}{P_1}} \cdot \frac{1}{f_{k2}}}{(1 + \mu)(1 - \alpha)\{x_1 + \frac{P_1}{P_1} - (1 + i^*) l_1^*\}} \lesseqgtr 0 \quad (13)$$

The formula for pulling export goods with respect to the real exchange rate is as follows:

$$\zeta = + \frac{\frac{E_1 x_1 \frac{E_1}{P_1}}{P_1}}{x_1} \quad (14)$$

Which can be used to simplify the slope of the wealth curve:

$$\frac{dE_1}{dy_2} | y_2 > 0 = \frac{\frac{P_i}{(1 + \mu)(1 - \alpha)\{(1 - \zeta)x_1 - (1 + i^*) l_1^*\} f_{kt}}}{\lesseqgtr 0} \quad (15)$$

This equation shows that the conditions in the set brackets at the denominator, determines the slope of the wealth curve. These conditions show if the specified foreign currency debt (l_1^*) is greater, the slope of the wealth curve will be downwards:

$$(1 + \zeta) x_1 < (1 + i^*) l_1^* \rightarrow (\frac{dE_1}{dy_2} | y_2 > 0) < 0 \quad (16)$$

Conversely, if exports (x_1) are larger or export demand elasticity (ζ) is large, the slope of the wealth curve will be upward:

$$(1 + \zeta) x_1 > (1 + i^*) l_1^* \rightarrow (\frac{dE_1}{dy_2} | y_2 > 0) > 0 \quad (17)$$

The reasons behind this result are quite simple. When a large foreign currency of real money, increases the debt burden on the company also reduces its production in the current period. Conversely, if the economy has a large increase in sales, profits and finally increase the investment of exports, the evaluation of money product will increase in the next period.

To check the IPLM curve (Interest-Parity-LM) which is mainly determined by the policies of the central bank, real money demand is assumed to be a function of output and interest rates.

$$m_t^D = m^D(y_t, i_t) \quad (18)$$

The premise of this research is based on the fact that the demand for real money, is the same as increasing production and decreasing interest rates:

$$\frac{\partial m^D}{\partial y_t} > 0 \quad \text{and} \quad \frac{\partial m^D}{\partial i_t} < 0 \quad (19)$$

Investors trade between domestic and foreign currencies in the world that capital mobility is unrestricted, The terms of the interest parity (IP) equation are obtained:

$$1 + i_t = (1 + i^*) \frac{E_{t+1}^e}{E_t} \quad (20)$$

Where E_t Expected nominal exchange rate (foreign exchange price to domestic currency) at the beginning of the period t . is. Money market equilibrium can also be expressed by an LM equation:

$$M_t^S = P_t m^D(y_t, i_t) \quad (21)$$

Using the assumption $p_2 = E_2^e = E_2$, which is called the PPP assumption, money market equilibrium in period 2 becomes:

$$M_2^S = \frac{(1 + i_1) E_1}{1 + i^*} m^D(y_2, i_2) \quad (22)$$

By combining the IP conditions mentioned above, we have:

$$M_2^S = E_2^e m^D(y_2, i_2) \quad (23)$$

This equation shows the continuation of the IPLM curve, which represents the relationship between E_1 and y_2 :

$$E_t = \frac{1 + i^*}{1 + i_1} \frac{M_2^S}{m^D(y_2, i_2)} \quad (24)$$

Also Bergman and Jellingsso (2010) showed that the first-order derivative of the IPLM curve is as follows:

$$\frac{dE_1}{dy_2} = \frac{1 + i^*}{1 + i_1} \frac{M_2^S}{[m^D(y_2, i_2)]^2} m^D < 0 \quad (25)$$

Therefore, the slope of the IPLM curve is negative. Increasing production in the future will increase future demand for the balance of domestic real money, which in the future will lead to an increase in the value of the domestic currency. This expectation of future currency appreciation,

Increases people's interest in keeping money now. Because its exchange rate will increase in the future. When the money supply is high and domestic interest rates are low, it is easy to see that the slope of the IPLM curve is steep. The results of this research show the importance of productivity shock and IPLM shock in the onset of

currency crises. So, this is the first analysis that examines the effects of shock on currency crises, examining time series data using techniques. The original ABB model developed by Agion, Bacheta and Banerjee is as follows:

$$y_2 = f((1 + \mu(\frac{E_1}{P_1}))(1 - \alpha)\{y_1 - (1 + r_0)d_1^c - (1 + i^*)\frac{E_t}{P_t}(d_1 - d_1^c)\}) \quad (26)$$

Where y produced, E nominal interest rate, P domestic price level, r real interest rate, d amount of debt, i^* nominal foreign interest rate, $(\alpha-1)$ amount of savings after debt payment and μ is a constant value. The original ABB model considers foreign currency debt to be the only source of the currency crisis. In this study to investigate the effects of shocks on currency crises the time series data estimation technique was used with monthly data from 2004 to 2018 and also this research for estimating data from GMM and TSLS methods used in Eviews software 12. The ABB econometrics model developed by this research is as follows:

$$\Delta E_t = \Delta E_{t-1} + \Delta i_t + \frac{l_t^*}{GDP_t} + IPLMshock_t + Wshock_t + Wshock_t Wslope_t + \varepsilon_t \quad (27)$$

In the above model, ΔE , the change in the nominal exchange rate is a dependent variable and the impact of variables such as interest rate changes, Δi , the ratio of short-term foreign currency debt to GDP, $\frac{l_t^*}{GDP_t}$, specifies IPLM shock and productivity shock on nominal exchange rate changes. Also in this model, exports (x_t) are part of the components of the wealth curves shown by $Wslope$.

Table 1: Table of variables

Short-term foreign currency debt	l_t^*
Export	x_t & (x_1)
Shock to change the level of investment risk	IPLMshock
Productivity shock that moves the wealth curve	Wshock
Slope of Wealth Curve	Wslope
Highlights the effect of productivity shock on the structural vulnerability of the economy	WshockWslope
Gross domestic product i country in period t	GDP_t
Change the nominal exchange rate	ΔE_t
Change in interest rate t	Δi_t
Ratio of short-term foreign loans to GDP	$\frac{l_t^*}{GDP_t}$
Residuals	ε_t
Production	y_t

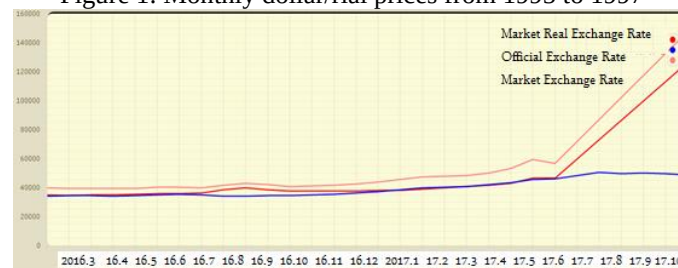
Source: Data gathered from Time Series Bank data of Central Bank of Iran

In summary, the model presented in this study, first, it imports into the original ABB model, and just like the original ABB model, determines the shape of the wealth curve. Then by placing the productivity curve over the IPLM curve in the model finds the amount of output and the exchange rate. When productivity shock or investment risk shock (IPLM shock) occurs, the price of currency in the country as well as the production of the economy also changes.

2. Research results

There are two types of shocks in the ABB model that can cause currency crises. One of the shocks is related to the change in the country's risk level, which is represented by the IPLM shock in this model. This shock is statistically usually accompanied by a devaluation of money. Here, the Iranian currency crisis in late 2017 and early 2018 will be analyzed, as the purpose of this section is to examine the market price of currencies, specifically the ratio of the Rials to dollars and euros, which are the most commonly traded currencies in the market. The price of the Euro since 1994, which was approximately 38,000 Rials, fluctuated around 40,000 Rials until June 1996. Although the long-term exchange rate has always been rising in Iran, its increasing slope has usually been scared. In January 2017, there was an upward shock in the price of currencies in Iran. As a result, the market price of the euro increased from about 40,000 Rials to 156,980 Rials that arrived on September 4, 2016. It was a strong currency shock that reduced the value of Iran's national currency by less than half.

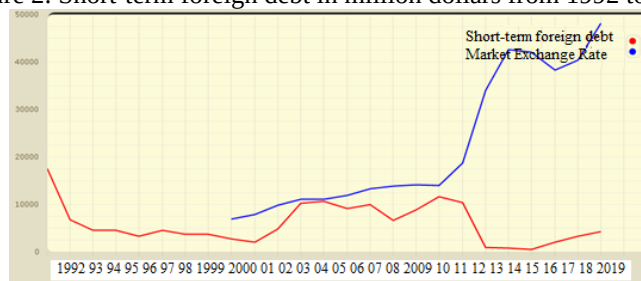
Figure 1: Monthly dollar/rial prices from 1995 to 1997



Source: Central Economic Statistics Office of the Central Bank of the Islamic Republic of Iran

According to the basic formula of ABB model, the source of any currency shock is foreign currency debt. In other words, the unbridled increase in foreign currency debt, according to the ABB model, which has been the best model for explaining the currency crisis since 2000, should be the source of this currency shock. But in the case of Iran, these conditions do not exist. To the chart below, which is in million dollars, shows Iran's short-term foreign currency debt from 1992 to 2017. Note:

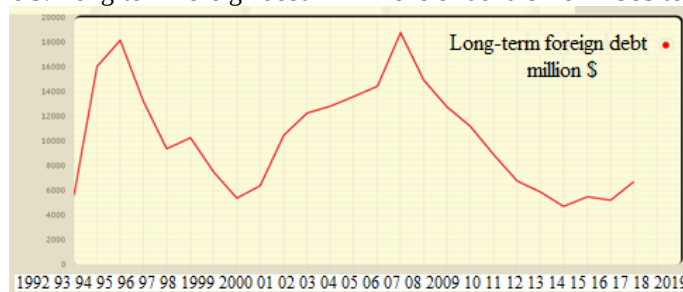
Figure 2: Short-term foreign debt in million dollars from 1992 to 2017



Source: Statistics and Foreign Exchange Liabilities Office of the Central Bank of Iran

Now look at the long-term chart of foreign currency debt denominated in millions of dollars:

Figure 3: Long-term foreign debt in millions of dollars from 1983 to 2017

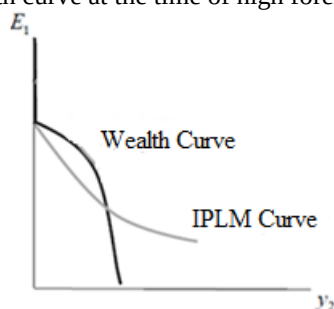


Source: Statistics and Foreign Exchange Liabilities Office of the Central Bank of Iran

The above diagrams show that since 1993 (which is the first year that statistics are available) by 2017, foreign debt in dollars has decreased. Of course, due to the constant rise in currency prices over the years, this debt has increased to Rials; But reducing this debt to dollars which something that does not fit with the original ABB model. The 2017-18 currency crisis in our country cannot be explained using the original ABB model; because Iran's foreign currency debt has not increased in recent years. So this research by adding exports to the original ABB model and the structure of the currency crisis in terms of origin (productivity shock or IPLM shock), trying to match the ABB model as the best developed model that explaining the currency crisis that has developed so far, it has countries like Iran with the characteristics of currency crisis. One of the key factors in the third generation model of the currency crisis and, for example, in the ABB model, is short-term external debt. The external short-term debt ratio is always positive relative to GDP. This means that higher foreign debt is associated with a devaluation of the domestic currency and shows that an increase in this variable helps to improve the situation of the currency crisis. This is in line with the prediction of the third generation model of currency crises. ABB model as the best available model for the structure of currency crises, it must be developed in a way that can also explain the currency crisis in Iran. This research increased exports by developing this model. The developed model in this paper describes the ABB model as one of the important factors and effective in currency crises is exports. Reduction of exports, or in other words, reduction of revenues and revenues from it in the country's economy can be one of the important factors causing currency shock. Since export earnings in Iran (especially oil exports) have declined due to sanctions, it may be best to note more closely that sanctions under this new model. What is it targeting and what changes has it made in Iran's economy? Sanctions have two main parts: oil export sanctions and banking sanctions. Sanctions on oil exports reduce Iran's export earnings, and banking sanctions that makes it impossible for the proceeds to return to Iran, even if exported. Sanctions are usually designed to hit a country's economy; But how? The biggest blow to any country's economy, Creating monetary instability and currency inflation. According to the original ABB model, only foreign currency debt could create this currency crisis. But this mechanism is not something that sanctions countries can influence. Because they cannot make Iran a significant foreign currency debt at once. Iran's sanctions do not target foreign currency debt, but exports. It seems that the planners of sanctions against Iran are fully aware of the impact of the export halt on a country's currency crisis; Even though there are no exports in the original ABB model. Whereas, theoretically, economists accept the impact of exports on currency crises; But the export factor was not in ABB's currency crisis model. Therefore, the original ABB model had to be modified to be more compatible with the actual conditions. In the model developed in this research, exports decline or an increase in

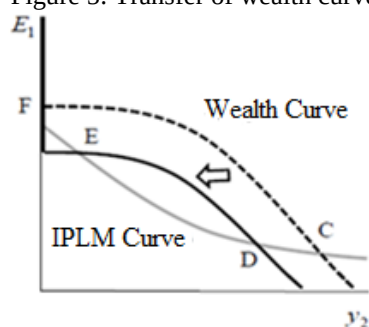
foreign currency debt will cause a currency shock. It should now be seen that according to the model developed in this research that how can the currency crisis of Iran 97-96 be explained? If the designated foreign currency debt is large, the slope of the wealth curve will be downward. According to the formula:

Figure 4: Wealth curve at the time of high foreign currency debt



So in fact, we know that the slope of Iran's wealth curve is downward. The model also confirmed that when interest rates are high in an economy, the wealth curve is steep. So Iran's wealth curve is steep and steep. We also proved in Formula that the slope of the IPLM curve is always descending. First, this section confirms that the currency crisis of 2017-18 happened because of sanctions or at least the risk of sanctions in the future and no other reason. This connection is simply indicated by the simultaneous representation of events and currency shocks are verifiable. It was said that the IPLM curve of investment risk (expectations) shows in a country and shift this curve. In fact, changing the level of investment risk in the country shows a positive or negative direction. If we want to coincide with the IPLM shocks that led to the currency crisis, to give an example, the best example is the withdrawal of the United States from Joint Comprehensive Plan of Action. On May 7, 1997, when the United States withdrew from the UN Security Council, the price of the dollar suddenly rose from about 40,000 rials to more than 80,000 rials. The following figure shows how to move the IPLM curve which was created as a result of changing the amount of investment risk in the country. This shift in the IPLM curve indicates a change in public expectations of the future of the economy and shows the increasing investment risk in the country. Also this level of reaction to an external factor which led to a reduction of more than half the value of the rial in one day, indicates the vulnerability of the Iranian economy and its high impact on political events. Also export sanctions imposed on the Iranian economy that it also causes the wealth curve to move to the left:

Figure 5: Transfer of wealth curve



So as predicted in the model developed in this study, the decline in exports is similar to the foreign currency debt owed by ABB, it could be another factor. The IPLM curve also shows that increasing the likelihood of future economic risk can cause currency shocks due to the impact on public economic expectations. Therefore, in the currency crisis of 97-96, there were actually two factors that caused the currency shock. The first is the change in public expectations (IPLM shock) and the second is the decline in export earnings. The IPLM shock caused the IPLM curve to move upwards (Increase in the amount of investment risk) and decrease in the country's export income that it also caused the wealth curve to move to the left. Both of these movements caused a relatively large currency crisis in late 2017 and it was early 2018. If the currency crisis of 2017-18 Iran with the original ABB model developed by Agion, Bachta, and Banerjee will be unable to identify the cause of the currency crisis. In Iran, statistics on investment risk change are not published annually. If we want to find statistics close to IPLM results, it can refer to the statistics of foreign investment. This statistic can be inversely related to the IPLM curve. In other words, increase foreign investment indicates reduced investment risk and reduced foreign investment can be a sign of increased investment risk. This statistic shows that foreign investment has been declining from 2012 to 2015. From 2015 to 2016 increase and from 2016 to 2017, which is the latest published statistics so far, foreign investment statistics are declining. Now, by comparing the chart of

foreign direct investment and foreign debt, it can judge how investors' expectations for the Iranian economy changed during the years 1997 to 2017 (the latest available statistics):

It can be seen that since 2016, foreign direct investment has decreased, and fixed debts have risen. In this study to obtain productivity shock statistics, published statistics from the National Productivity Organization were used; but the source of the 2017-18 currency crisis in Iran is the IPLM crisis, not the productivity crisis. For summary statistics, it can be said, that its productivity growth has been erratic, influenced no doubt by the impact of sanctions and changes in oil prices, averaging around 0.5% annually. Investment levels have been volatile, with surges in public investment, especially in the oil and gas sector, while overall foreign direct investment has remained low because of geopolitical tensions. The same was the case with exports, which were predominantly oil-based, peaking around 2011 and falling drastically after 2012 as a result of international sanctions, with average annual export values around US\$50 billion. Foreign debt increased steadily, reflecting the reliance on external financing, reaching more than \$10 billion by 2018, while the nominal exchange rate faced significant depreciation, especially from 2004-2018, which added to higher inflation and instability of the economy. The average nominal exchange rate has changed dramatically, from 9,000 IRR/USD in 2004 to around 100,000 IRR/USD by 2018, showing the extent of difficulties the Iranian economy had to pass through during such a period. Overall, these statistical indicators reflect a complex interplay of domestic policies, international relations, and economic conditions affecting the economic landscape of Iran between 2004 and 2018.

To estimate the models, first of all, needs unit root tests for checking the variables stationary. This test was done by the Augmented Dickey-Fuller test. The results of ADF show all of the variables are stationary except exchange rate and interest rate and these two variables are I(1), which means are stationary by one differentiation. After that, it should indicate which kind of method, linear or non-linear is fit on our data. The BDS test was developed by Brock, Dechert, and Scheinkman (1987) to determine the presence of nonlinearity in a time series. This test is to determine the absence of dependence and to test the residuals obtained from non-linear structures after removing the linear structure from the previously filtered data. This test is based on the correlation integral that evaluates the randomness of the process that creates a time series against the presence of an overall correlation in it (Ozcelebi& Izgi, 2023). Here the z statistic in the BDS test is calculated for the residuals of the model. If the calculated z statistic was not significant, the linearity of the time series is not rejected, or in other words, the presence of a linear process in the model is confirmed.

Table 2: BDS test for RESID

<u>Dimensio</u>				
<u>n</u>	<u>BDS Statistic</u>	<u>Std. Error</u>	<u>z-Statistic</u>	<u>Prob.</u>
2	-0.003067	0.012605	-0.243297	0.8078
3	-0.009385	0.026736	-0.351027	0.7256
4	-0.019080	0.042498	-0.448970	0.6535
5	-0.032177	0.059164	-0.543861	0.5865

The result shows the BDS figure by m=5 is -0.032 by the probe of 0.586, which is not significant and indicates the linearity model (It is also shown for m=2,3&4 with the same results). The following are the results of the regression test using the linear model by the GMM method:

Table 3: Coefficient of GMM test results

Dependent Variable: ΔE , the change in the nominal exchange rate

Method: Generalized Method of Moments

Sample (Adjusted): 2004:M02 2018:12

Instrument Specification $\Delta E, \Delta i, \frac{l^*_t}{GDP_t}, IPLMshock, Wshock, Wshock_t, Wslope_t$

Variable	Std. Error	Coefficient	Prob.
C	-1.39E-10	-8.145	0.0000
ΔE_{t-1}	0.999	8.145	0.0000
Δi_t	-1.81E-12	-6.996	0.0000
$\frac{l^*_t}{GDP_t}$	7.41E-11	7.431	0.0000
$IPLMshock_t$	2.45E-16	7.583	0.0000
$Wshock_t$	-1.30E-12	-8.591	0.0000
$Wshock_t Wslope_t$	2.84E-12	6.456	0.0000

0.99999 Adjusted R-squared

0.99999 R-squared

As predicted by the theory, the interest rate policy coefficient is negative which refers to the fact that the central bank's support for interest rates leads to an increase in the value of the domestic currency and so it can prevent a currency crisis. One of the key factors in the third generation model of the currency crisis and, for example, in the ABB model, is short-term external debt. The external short-term debt ratio is always positive relative to GDP. This means that higher foreign debt is associated with a devaluation of the domestic currency and shows that an increase in this variable helps to improve the situation of the currency crisis. This is in line with the prediction of the third generation model of currency crises. There are two types of shocks in the ABB model that can cause currency crises. One of the shocks is related to the change in the country's risk level which is shown as IPLM shock in this model. This shock is statistically usually accompanied by a devaluation of money.

The IPLM shock coefficient is also positive. This means an increase in risk in the country that shift the IPLM curve reduces the value of the domestic currency. This conclusion is consistent with the prediction of the model developed in this study. Another type of shock, which is analyzed in the ABB model, is the productivity shock. The table shows that a negative productivity shock is associated with a devaluation of money. Productivity shock coefficient is negative. In other words, the results show that the positive productivity shock increases the value of the domestic currency while a negative productivity shock reduces the value of the domestic currency. This conclusion is consistent with the ABB model prediction; because in the presence of a negative productivity shock, the wealth curve moves to the left (right), leading to a decrease (increase) in the value of the domestic currency. Thus, an increase in productivity leads to an increase in production and an increase in the value of the domestic currency. Conversely, the opposite result occurs from negative productivity shocks. The TSLS test must now be performed to study these variables more closely. In baseline estimation, this study uses TSLS estimators. In this estimator, the independent variables are not exogenous at all and there are distinct fixed effects and also have automatic alignment and correlation. In particular, this study uses one-step TSLS estimation with a small sample correction. This estimate is intermittently effective against the initial conditions and the distribution of the error statement.

Table 4: Coefficient of TSLS estimates

Dependent Variable: ΔE , the change in the nominal exchange rate

Method: Two-Stage Least Squares

Sample (Adjusted): 2004:M02 2018:12

Instrument Specification $\Delta E, \Delta i, \frac{l_t^*}{GDP_t}, IPLMshock, Wshock, Wshock_t Wslope_t$

Variable	Coefficient	t-Statistic	Prob.
C	-1.38E-10	-12.233	0.0000
ΔE_{t-1}	0.999	1.96E+16	0.0000
Δi_t	-1.82E-12	-9.564	0.0000
$\frac{l_t^*}{GDP_t}$	7.42E-11	8.902	0.0000
$IPLMshock_t$	2.44E-16	7.892	0.0000
$Wshock_t$	-1.29E-12	-11.474	0.0000
$Wshock_t Wslope_t$	2.83E-12	5.652	0.0000

0.999 Adjusted R-squared

0.999 R-squared

0.00000 Prob. F

6.920 F statistic

The baseline estimation results are shown. This study showed that the effect of shock on the currency of each country depends on the degree of structural vulnerability of that country, which is determined by the relative size of the country's foreign exchange exports and debt (Slope of wealth curve). D-Watson test estimates show the number 2.04, which indicates no serial correlation of the residues. One problem is that when we use TSLS estimation for small samples can be affected by the large number of tools used. Roodman (2009) suggested that to solve the problem of a large number of tools in estimating TSLS, the number of delays must be reduced to 1. The std.error row, which is the standard deviation or standard error, indicates the reliability of the estimate. As the standard error rate for all variables except the fixed variable indicates an acceptable level. We see that here, R-squared represents the number 0.99, and the adjusted R-squared again indicates the number 0.99. Also, all p-values are equal to zero.

Our result is aligned with the work of Bergman and Jellingso (2010) regarding the shape of the IPLM curve and its impact. A comparison of the findings of this study against contemporary literature calls for a

structured approach. Also, results are in line with the work of Forbes (2002), as well as Asici (2011) and Rao and Paldi (2020), which support the impact of trade on currency crises. The effects of foreign debt on currency crisis are as shown by Van Rijckeghem & Weder (2001) and Adams & Metwally (2019). These findings are consistent with the modified ABB model in showing that the impact of currency crises is usually multi-dimensional and determined by the level of external debt and the structure of the dominant exports. Further, Kaminsky and Reinhart (2003) also found that currency and banking crises usually occur together. This agrees with the assertion of the present study that twin crises in currency devaluation and banking instability have a spillover effect on investor confidence, domestic output, and external trade. This study further relies on the conclusions of Moriyama (2016), who reiterated that currency crises might worsen because of changing investor expectations. This correspondence with the literature supports the fact that the expressions developed here are appropriate.

Conclusion and Recommendations

According to a model developed by Agion, Bachta, and Benerji (2001), this study add export to the third generation model of the currency crisis in companies with foreign currency debts, he added. In the original model, the devaluation of the domestic currency had only a negative effect on the economy, but this research by adding export to the ABB model showed that the devaluation of the domestic currency has both a positive and a negative effect on the economy. Because as the domestic currency depreciates, exports increase, but the value of the economy's foreign currency debt will also increase. Hence, the relationship between the currency crisis and exports was confirmed. This paper develops and extends the original ABB model of currency crises by incorporating a deeper understanding of the interlinkages between banking crises and fluctuations in currency. The investigation shows, through a thorough analysis, how banking instability can be transmitted through the economy and significantly affect exchange rates, especially when driven by investor expectations. The findings also point out the legal reserve ratio as an important monetary policy tool in dampening currency crises, which could imply that a multifaceted monetary policy approach, incorporating a variety of tools, may further increase the resilience of currencies to economic shocks. These results are aligned to Paldi (2020) and Adams & Metwally (2019). This study showed that graphical descriptions with wealth curve and IPLM curve useful to see this connection. The present paper defined a simple and intuitive formula that determines the slope of the wealth curve, determines when companies export to foreign countries. In this article, it was confirmed that Iran's wealth curve is declining and steep. It was also shown in the same section that in the currency crisis of 2017-18, there were actually two factors that caused the currency shock. The first is the change in public expectations (IPLM shock) and the second is the decline in export earnings. The IPLM shock caused the IPLM curve to move upwards (Increase in the amount of investment risk) and decrease in the country's export income that also caused the wealth curve to move to the left. Both of these movements caused a relatively large currency crisis in late 2017 and early 2018. But in fact in the currency crisis of Iran 2017-18, the shock effect of IPLM was much greater than the shock effect of productivity. These result confirmed by Chiang & Prescott (2010), Aktas & Cortuk, (2012) and Auboin & Engemann (2012).

Present research differs from the fundamental ABB model in developing further the analysis of the effects of currency crises on the part of companies with foreign currency debt and spillover to banks, allowing for a more realistic representation of economic processes. This paper, therefore, undertakes an analysis of the mechanisms through which banking crises can originate and spill over into other economic sectors, with the eventual model development that best explains the twin currency-banking crisis. By explaining how these crises are initiated through the expectations of investors, a subtle interrelationship between the banking sector and currency stability is exposed that was not well captured in previous literature. The manuscript develops a rich narrative around the influence of foreign currency debt and the consequent implications for monetary policy in the fight against currency crises. It presents key findings that, during currency shocks, the immediate reaction often involves an increase in interest rates by government entities, while critiquing the outdated reliance on legal reserve ratio tools as inadequate in addressing these crises. This study confirms the potency of the legal reserve ratio in stabilizing exchange rates and, thus, provides empirical evidence that directly complements earlier findings in the field, suggesting a paradigm shift in monetary policy approaches which is aligned with Priti, (2016) and de Lara-Tuprio et al. (2017). Secondly, the research provides essential analysis concerning how contractionary policies by a central bank can meaningfully influence currency value in the context of a twin crisis. The findings underscore how the linkages of structural vulnerabilities in the economy and the response of the currency to external shocks open ways for new strategies toward improving resilience within economic systems prone to adversity. This comprehensive approach forms a significant contribution to the existing literature by illustrating how productivity shocks and country risk factors interactively cause fluctuations in the exchange rate, thereby enriching the theoretical framework of understanding currency crises, especially regarding Iran's 2017-18 financial turmoil.

Based on our results from this Iranian context analysis, several policy recommendations appear:

1. Diversification of Monetary Instruments: The study suggests that employing multiple monetary policy tools, particularly modern applications of the legal reserve ratio, can help manage currency volatility. The findings align with the strategic regulatory frameworks of Fischer (2016) that advocate for a dynamic approach to monetary policy in volatile environments.
2. Export Growth Needs Strengthening: This present research has brought into existence how well export growth goes alongside stability in currency, implying that policies should put high effort towards export competitiveness through infrastructural investments, training, and market access.
3. Strengthen Banking Resilience: Since this banking model is sensitive to shifts in the exchange rate from these findings, it leads us directly to the need for tighter regulation to ensure banks in periods of currency volatility possess increased buffers of capital.
4. Communication Strategies: Expanding from the IPLM shocks observed during the crisis of 2017-2018, monetary authorities have to be communicative with the market to manage expectations and reduce uncertainty by incorporating aspects of behavioral economics into monetary policy.

Here we have some limitations in our study. Only looking into the monthly data covering just from 2004 to 2018, although such data spans significant economic disturbances, the broader long-run variations of the exchange rates might be missed. Because some shocks in the market happen through such channels, the effect on currency fluctuations is different when speaking about the mentioned interval and therefore requires a very subjective interpretation. This might also lead to omitted variables, as further, even more macroeconomic indicators might have been excluded to better comprehend the complex relationship among productivity, investment shocks, and exchange rates. The valuable insight this study has contributed to the relationship between variables in Iran cannot deny that some limitations provide a gateway for more comprehensive research. Using an increased data range and inclusion of related external variables can be used for future research, and greater depth into global economic perspectives opens up insights into policy implications driving currency crises. Therefore, future studies need to build on what was laid down by this research in addition to overcoming some of its limitations.

Resources

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