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A Dynamic International Sanctions-Time Model for Determining Interest Rate Defense (Case Studies: Iran and Russia)[1]

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Abstract

The impact of international sanctions on interest rates as a measure to avoid the international sanctions has received less attention. Defensive interest rate is defined as fluctuations in interest rates due to speculation. These behaviors are more prevalent under international sanction conditions, especially in foreign exchange transactions. Thus, it is possible to pose the question of how the optimal interest rate should evolve in sanctioned economies when sanctions are being applied.

In this research, first, a dynamic programming model is used to define the intensity of international sanctions as a function of trading time conditions. From the solution of this research model, a new concept of defensive interest rate is introduced in terms of defensive interest elasticity, which is estimated with the help of the sanctions intensity parameter. Next, following the methodology developed by the authors, the sanctions intensity stochastic variable is calculated by summing the numbers of different sanctions according to version 4 of the Global Sanctions Database. To estimate the sanctions intensity parameter for the period 1979 to 2023 for Iran and 1993 to 2023 for Russia, the AR (1) model was selected among the Box-Jenkins models, in Eviews software. According to the research findings, if the intensity of sanctions increases by one percent in Iran and Russia, the interest rate should decline by 0.89 and 0.97 percent, respectively. The findings indicate that in Russia, there have been more periods of decreasing interest rates, compared to Iran, when sanctions were intensified.

Keywords: Sanctions-Time, Interest Rate Defense, Dynamic Programming

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Introduction

Sanctions are a comprehensive system of punishment within the realm of foreign policy. They are a popular tool for countries, either individually or with the assistance of international organizations, to achieve a variety of goals [Hatipoglu, Peksen, 2016]. Sanctions are still a subject of controversy as to their efficiency. On the one hand, some studies such as Wang et al. [2019], Hatipoglu and Peksen [2016], and Itskhoki and Mukhin [2022] support the influence of sanctions on economic factors while, Drezner [1999], Egger et al. [2024], Kholodilin and Netšunajev [2019], also show that sanctions do not influence economic indicators.

Economic sanctions often impact foreign exchange transactions. They have the potential to incite speculative attacks in the foreign exchange market, leading to depreciation of the domestic currency of the sanctioned country [Hatipoglu et al., 2023].

The central bank employs interest rate defense, borrowing defense, and direct intervention in the foreign exchange market to protect against such attacks. In a defensive borrowing strategy, the central bank halts the speculative attack by borrowing enough foreign reserves to repurchase its existing monetary supply. Following a speculative attack, the monetary authority may intervene directly in the foreign exchange market and reduce the exchange rate volatility by buying or selling foreign exchange reserves or indirectly by adjusting the interest rate. This kind of policy to counterbalance the exchange rate fluctuations with the help of changes in the interest rate is called the 'defensive interest rate' [Dobrynskaya, 2008; Drazen, 2000]. Since the exchange rate is sensitive to the conditions of international sanctions, the interest rate can be regarded as a protective measure against speculative actions under international sanctions.

According to the Global Sanctions Database[2] , in June 2023, sanctions against Iran and Russia have increased rapidly in the past decade compared to previous decades. As sanctions have escalated, World Bank data indicates that exchange rates in these two countries have risen sharply over the years. Russia and Iran have adopted two policies: reducing interest rates and increasing interest rates. Should interest rates in Russia and Iran be decreased or increased?

Concerning changes in interest rates, the theory of defensive interest rates postulates that an increase in interest rates assists a country in defending its exchange rate because it greatly increases the cost of holding foreign currency and thus discourages speculative attacks on the currency. Furthermore, higher interest rates can signal the monetary authority's commitment to a fixed exchange rate. However, this perception changed after the Asian crisis. Some critics have noted that it is paradoxical to raise interest rates since it hurts the economy. As the cost of high interest rates rises, the signal of the monetary authority weakens, and there is a higher expected depreciation of the currency, hence more pressure from the speculators. Thus, if the economy is

[2]Global Sanctions Database (GSDB): In the studies of Syropoulos et al. [2024], Felbermayr et al. [2020] and Kirikakha et al. [2021], the data of this database has been used.

sensitive to the impact of higher interest rates, the monetary authority's actions may actually raise the probability of a successful speculative attack rather than reduce it [Goderis, Ioannidou, 2008]. Sanctions, for instance, are the right policy measures in crises to help the economy bounce back quickly. However, the economy may take years to deal with crises with incorrect policy.

Previous case studies on Iran [Roudari et al., 2023; Mousavi et al., 2021; Jonaghani et al., 2021; Heydarian et al., 2021; Laudati, Pesaran, 2023; Zamani et al., 2024; McDonald, Reitano, 2016] have examined the effects of sanctions on economic variables such as economic growth, oil export revenues, Iranian currency value, inflation, production, employment, defense expenditures, and the stock market. Similarly, for the Russian economy [Dreger et al., 2016; Kholodilin, Netšunajev, 2019; Bali, Rapelanoro, 2021; Shirov et al., 2015; Nikulina, Kruk, 2016; Korhonen et al., 2018] the effects of sanctions on the Russian ruble, production and exchange rates, industrial prices, trade and economic relations, oil and gas industry, and food exports have been studied. Despite a significant number of studies on the political and economic impact of imposed sanctions, no precise analysis of the impact of sanctions on interest rates as a defensive tool in Iran and Russia has been developed. The present study aims to fill these gaps. The questions now are: How should interest rates change in the event of sanctions? What quantitative index can be used to measure the intensity of sanctions? How does the sanctions intensity index relate to interest rates?

A new model, the Sanctions-Time Model, has been introduced to estimate the opportunity cost of money, and address research questions. In this model, sanctions intensity is extracted as a variable affecting transaction time. By solving the research model, a new concept of defensive interest rate is introduced as defensive interest elasticity, which is measured based on the sanctions intensity parameter. To index sanctions intensity, an aggregation of all sanctions imposed against the target country is used building upon Ranjkeshan's work [2023].

Using the Box-Jenkins method, the sanctions intensity parameter is estimated using a first-order autoregressive model for the period 1979 to 2023 for Iran and 1993 to 2023 for Russia. The results indicate that as sanctions intensify, interest rates should decrease. Therefore, Russia experienced more periods of decreasing interest rates compared to Iran as sanctions increased.

2. Literature review

2.1. Quantitative Approach to Economic Sanctions

Hufbauer et al. [2009] put forth a conceptual structure for evaluating sanction potency. They have used qualitative and quantitative indicators to assess the success or failure of sanctions. In one of the quantitative indicators, they have introduced the percentage of sanctions that have achieved their objectives as the sanctions success rate. Sarau [2024] estimated a quantitative value for the effects of sanctions by multiplying the dummy variable for the sanctioned countries and the dummy variable for the post-sanction period. Dreger et al. [2016] have established a sanction index for the Ukrainian crisis case. This index has been expanded in Kholodilin and Netšunajev [2019]. This composite index is the aggregation of dummy variables over time. The dummy can be equal to one, two, or three, depending on the sanction type. Bali and Rapelanoro [2021] added an economic leverage and time factor to the sanctions index in order to complement the previous two works using a composite index. They have criticized Dreger et al. [2016] for not giving the sanctions a proportionate weight. In these previous studies, the authors' personal opinion has been applied in weighting the types of sanctions, which can be criticized by other researchers.

In our study, following by Ranjkeshan's work [2023] method, in order to avoid the authors' personal opinions for the sanction weighting, we first calculate the severity of sanctions imposed by each country to Iran and Russia for a certain period of time. In this way, we multiply numbers of sanctions of state or country countries by numbers of different sanctions, as the weights of sanctions, including trade, arms, military, financial, travel and other sanctions for each country sent the sanctions to Iran and Russia.

Then we integrated these severity sanctions for each year to make a quantitative time series of severity of sanctions. We then apply Box-Jenkins models to determine the proper model to estimate parameter of severity of sanctions imposed against Iran and Russia. All calculations are presented at the annexes.

2.2. Defensive Interest Rate

There is a belief that increasing interest rate during exchange rates fluctuations, decreases the motivations for speculative activities on the domestic currency. By increasing interest rates foreign investors stimulate investment, thereby reducing the motivations to hold domestic currency for buying and selling in exchange rates due to price increase. This stabilizes exchange rate volatilities [Sarpong et al., 2021]. The study by Kraay in 2003 which analyzed 75 samples of countries experienced speculative attacks revealed that the common belief that increasing interest rates can stop such attacks is ambiguous. There is evidence both supporting and refuting the effectiveness of this policy. For example, in 1992, Sweden faced speculative attacks against the krona between July and August. Swedish monetary authority responded by raising increased the central bank's marginal lending rate in September which successfully deterred speculative motivations. However, during the East Asian financial crisis in 1997, Korea encountered speculative pressures against its national currency. The policy implemented in this case failed to address [Kraay, 2003]. Russia experienced balance of payment crisis in 1998. Therefore, its prices responded to exchange rate fluctuations. In this case, the role of monetary policy should not be overlooked [Dobrynskaya, 2005]. In response to currency crises precipitated by speculative onslaughts, monetary authorities may opt for direct intervention in foreign exchange markets, addressing exchange rate fluctuations through purchasing or selling foreign currency reserves or indirectly through interest rate adjustments. This policy of smoothing exchange rate volatility via interest rate modulation is termed the "defensive interest rate" strategy [Dobrynskaya, 2008].

The conventional wisdom argues that an increase in interest rates could help a country defend its exchange rate against speculative attacks. In sanctioned environments where exchange rates exhibit an appreciation, monetary authorities view interest rate hikes as a means to elevate the opportunity cost of foreign currency holdings, thereby curbing currency speculators' inclination to flood the foreign exchange market [Goderis, Ioannidou, 2008]. Sanctions imposed by the European Union and the United States due to tensions between Ukraine and Russia, had a direct impact on Russia's interest rate [Bali et al., 2024]. They also affected the exchange rate due to import and export restrictions, asset freezes and trade embargoes [Eichengreen et al., 2024].

Diverse studies exist on the efficacy of defensive interest rates. Scholars such as Eijffinger and Karatas [2012] suggest that the nature of the defensive strategy may vary depending on the generation of the currency crisis. Therefore, the severity of a crisis impacts on the interest rates.

A review of existing literature reveals a dearth of studies examining how interest rates could serve as a defensive mechanism against sanctions.

2.3. Interest Rates and Sanctions

Daniëls et al. [2011], utilizing a modified global game theory model to examine defensive interest rate behavior during currency crises, conclude that defensive interest rates increase the risk associated with speculation. This may suffice to deter speculators when fundamental factors remain relatively robust. Goderis and Ioannidou [2008], employed a probit model for the period 1986-2002 to assess the interest rate increases in defending exchange rates against speculative attacks. Their findings confirm that the effectiveness of monetary policy in defending fixed exchange rates depends on short-term debt levels. Dobrynskaya [2008], in examining optimal policy under price stickiness and exchange rate fluctuations, utilizes a sticky-price general equilibrium model for an open economy, focusing on defensive interest rates against currency crises in the United States. The study concludes that the optimal interest rate response to exchange rate shocks is positively correlated with volatility and negatively correlated with price stickiness.

Given the contradictory effects of sanctions on macroeconomic variables, examining how imposed sanctions affect the interest rate as a defensive tool is necessary and essential. A review of existing studies revealed that the effect of sanctions on the important variable of interest rates for the Iranian economy has received less attention from researchers, and no study has been conducted on this topic for the Russian economy. This study has both theoretical and practical contributions. In terms of theory, it estimates the effect of sanctions on interest rates as a defensive tool against sanctions within the framework of a sanctions-time model using dynamic programming and introduces the concept of partial elasticity of defensive interest to sanctions. Its practical contribution is measuring the intensity of sanctions, where first an index for sanction intensity is defined, and then the sanction intensity parameter is estimated using a first-order autoregressive model. Subsequently, the economies of Iran and Russia are examined and compared in terms of the interest rates employed under sanctions conditions in light of the research findings. None of the previous studies have used this method to present both theoretical and practical the contributions.

3. Methodology and Data

This section begins by introducing three approaches to money inflow in the household utility function. This is achieved in order to justify the choice of the shopping-time model to determine the relationship between sanctions and the interest rate. Then, we argue how sanctions may increase transaction costs according to shopping-time model. Finally, the sanction-time model is derived.

In the next section, the sanction intensity parameter is estimated by first indexing, the sanction intensity. Subsequently, the sanction parameter is estimated using econometric models.

3.1. A Sanctions-Time Model

Regarding the inclusion of money in the household utility function, three approaches have been explicated in dynamic general equilibrium models:

Based on Sidrauski's [1967] theories, the first approach assumes that money has direct utility; thus, money enters the utility function of economic agents. These types of models are called Money in Utility (MIU) function models. The second approach focuses on the concept of transaction costs (TC), which arise from asset exchanges according to Baumol [1952] and Tobin [1956], as well as goods exchanges based on Kiyotaki and Wright [1989]. In this approach, the demand for money aims to reduce transaction costs. Additionally, in the views of Brock [1974], and Croushore [1993], money and time are combined to produce transaction services for accessing consumer goods. These models are known as shopping-time models, which posit that transactions are costly and money can reduce these costs. In these models, time is considered the transaction cost of purchasing; money can increase leisure time by reducing the time spent on shopping, thus indirectly entering the utility function. Based on Samuelson's [1958] theories, the third approach considers money like other assets that transfer resources between individuals. In fact, money serves as a medium of exchange used to purchase goods. In these models, known as Cash-in-Advance (CIA) models, in addition to the standard household budget constraint, a cash-in-advance constraint is also incorporated into the modeling [Walsh, 2017].

The shopping-time model is based on the assumption that money facilitates transactions and thereby reduces the amount of time and/or energy required in the process of 'shopping' [McCallum, Goodfriend, 1987]. In other words, money reduces transaction costs. On the other hand, the imposition of economic sanctions increases transaction costs due to factors such as the marginalization of licit commerce and economic activity [Neuenkirch, Neumeier, 2015], disrupting trading routes and trading ties with suppliers or customers [Bove et al., 2023].

Since it is assumed that sanctions increase the transaction costs of purchases in our model, which in turn lead to longer transaction times, this study utilizes a shopping-time model to incorporate the effect of sanctions. The model is called the sanctions-time model.

In a shopping-time model, the utility function of the representative household can be represented as follows:

$$U(c.m.l) = V(C.l) \quad (1)$$

Thus, consumption (c) and leisure time (l) are two decision variables in the utility function. Leisure time (l) is equal to:

$$l=1-n^{w}-n^{s} \quad (2)$$

$$n^{s} = g(c,m) \ , \qquad 0 < n^{s} < 1 \quad (3)$$

$$g_c > 0$$

$$g_m \leq 0$$

Where n^w is work time, and n^s is time for shopping or transactions. n^s is positively related to the level of consumption and negatively related to the real money balances. In other words, money saves time that would have been used in shopping or in making transactions.

With the imposition of sanctions, including financial and trade sanctions, obstacles to trade will be created. For example, under sanctions, a trading company must employ various routes to circumvent sanctions and conduct transactions for ordinary dealings. Therefore, it increases uncertainty when choosing the best or new routes, leads to trades that take longer to complete.

Political Institution also can influence transaction costs during sanctions. For example, democratic institutions can improve trust among agents and lead to decreasing transaction cost of sanctions [Morrow et al. 1998 ; Lektzian, Souva, 2001].

From a shopping-time perspective, it is argued that sanctions increase transaction costs by prolonging transactions or shopping (trade) time. Therefore, this model is modified to present sanctions as a factor accurately reflecting their impact on trade. The sanction function, s_i, increases trade costs by prolonging transactions or shopping time (g). Drawing inspiration from the works of Bastanifar [2024a; 2024b] and Bastanifar et al. [2024], who incorporated the effect of shocks on household preferences in a shopping-time model, the sanction function is introduced as a shock to shopping time.

The sanction function is incorporated into the shopping-time model as an enhancer of shopping time:

$$n^S = Sg(c.m) \qquad (4)$$

$$S = s^{-\rho} \qquad (5)$$

ρ is the sanction intensity, which is scaled between zero and one for convenience. Using equation 4, the time taken in shopping or transactions rises with the sanction intensity and hinders trade, n^s. Here, sanctions are introduced into the model as a function that increases shopping time.

$$E_t \sum_{j=0}^{\infty} \quad B^j u[c_{t+j}, 1 - n^w{}_{t+j} - g(c_{t+j}.m_{t+j})S] \quad 0 \leq \beta \leq 1 \qquad (6)$$

The above relation represents an intertemporal utility function for a representative household. E stands for expectation, which shows that a social planner makes a decision with some degree of risk concerning the future. c_t is per capita consumption at time t, and β is the time preference rate.

$$A_t = \tau_t N_t + \frac{(1+i^g_{t-1})B^g_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} \qquad (7)$$

A_t is non-human wealth, τ_t is a transfer payment, and B is government bonds that are floated to finance deficits. $1 + i^g_{t-1}$ is the yield paid on the previous period's bonds, which is funded through bonds. P_t is the price index, $M_{(t-1)}$ is the international money stock.

$$Y_t + (1-\delta)K_{t-1} + A_t \geq C_t + K_t + \frac{M_t}{P_t} + \frac{B^g_t}{P_t} \qquad (8)$$

$Y_t = F(K_{t-1}, N_t)$ is the total production function, K_{t-1} is the total capital stock at the end of the period, N_t is population, $\tau_t N_t$ is net transfer payments, δ is the depreciation rate of physical capital, P_{t-1} =(1+π_t) P_t and N_{t-1} =(1+n) N_t. The two above relations are divided by N_t:

$$a_t = \tau_t + \frac{(1+i^g_{t-1})B^g_{t-1}}{(1+\pi_t)(1+n)P_{t-1}N_{t-1}} + \frac{M_{t-1}}{(1+\pi_t)(1+n)P_{t-1}N_{t-1}} = \tau_t + \frac{(1+i^g_{t-1})b^g_{t-1}}{(1+\pi_t)(1+n)} + \frac{m_{t-1}}{(1+\pi_t)(1+n)} \qquad (9)$$

$$y_t + \frac{(1-\delta)}{(1+n)}K_{t-1} + a_t \geq c_t + k_t + m_t + b^g_t \qquad (10)$$

Equation 10 is the per capita budget constraint of the household. The value function or Bellman equation is formed:

$$V(a_t, k_{t-1}) = \{u(c_t . 1 - n^w_t - g(c_t . m_t)S) + \beta E_t V(a_{t+1}, k_t)\} \qquad (11)$$

First-order conditions necessary for labor, consumption, real money balances, and real bond assets are obtained:

$$\frac{\partial V(a_t, k_{t-1})}{\partial n^w_t} = \frac{\partial u}{\partial l_t}\frac{\partial l_t}{\partial n^w_t} + \beta E_t \frac{\partial V(a_{t+1}, k_t)}{\partial k_t}\frac{\partial k_t}{\partial f}\frac{\partial f}{\partial n^w_t} = 0$$

$$\Rightarrow -u_l + \beta E_t \frac{\partial V(a_{t+1}, k_t)}{\partial k_t} f_n = 0 \qquad (12)$$

f_n is the marginal productivity of labor and equals the labor wage (in a competitive market).

$$\frac{\partial V(a_t . k_{t-1}, am_t)}{\partial c_t} = \frac{\partial u}{\partial c_t} + \frac{\partial u}{\partial l_t}\frac{\partial l_t}{\partial g} S - \beta E_t \frac{\partial V(a_{t+1} . k_t, am_{t+1})}{\partial k_t}\frac{\partial k_t}{\partial c_t} = 0$$

$$\Longrightarrow \; u_c - u_l g_c S - \beta E_t \frac{\partial V(a_{t+1} . k_t, am_{t+1})}{\partial k_t} = 0 \qquad (13)$$

$$\frac{\partial V(a_t . k_{t-1})}{\partial m_t} = \frac{\partial u}{\partial l_t}\frac{\partial l_t}{\partial g}\frac{\partial g}{\partial m_t} S - \beta E_t [\frac{\partial V(a_{t+1} . k_t)}{\partial a_{t+1}}\frac{\partial a_{t+1}}{\partial m_t} + \frac{\partial V(a_{t+1} . k_t)}{\partial k_t}\frac{\partial k_t}{\partial m_t} = 0$$

$$\Longrightarrow -u_l g_m S + \beta E_t [\frac{\partial V(a_{t+1} . k_t)}{\partial a_{t+1}}\frac{1}{(1+\pi_{t+1})(1+n)} - \frac{\partial V(a_{t+1} . k_t)}{\partial k_t}] = 0$$

$$\Longrightarrow -u_l g_m S + \beta V_a \frac{1}{(1+\pi_{t+1})(1+n)} - \beta V_k = 0 \qquad (14)$$

$$\frac{\partial V(a_t . k_{t-1})}{\partial b^g_t} = \beta E_t [\frac{\partial V(a_{t+1} . k_t)}{\partial a_{t+1}}\frac{\partial a_{t+1}}{\partial b^g_t} + \frac{\partial V(a_{t+1} . k_t)}{\partial k_t}\frac{\partial k_t}{\partial b^g_t}] = 0$$

$$\Longrightarrow \; \beta E_t \left[\frac{\partial V(a_{t+1} . k_t)}{\partial a_{t+1}} . \frac{1 + i^g_t}{(1 + \pi_{t+1})(1 + n)} - \frac{\partial V(a_{t+1} . k_t)}{\partial k_t}\right] = 0$$

$$\Longrightarrow \; \beta V_a = \beta V_k \left(\frac{(1+\pi_{t+1})(1+n)}{1+i^g_t}\right) \qquad (15)$$

Instead of βV_a in equation 14, equation 15 is substituted:

$$-u_l g_m S + \beta V_k \left(\frac{(1+\pi_{t+1})(1+n)}{1+i_t^g}\right)\left(\frac{1}{(1+\pi_{t+1})(1+n)}\right) - \beta V_k = 0$$

$$\Rightarrow\ -u_l g_m S = \frac{i_t^g}{1+i_t^g}\beta V_k \qquad (16)$$

From equation 12, βV_k can be written in terms of u_l and f_n:

$$\beta V_k = \frac{u_l}{f_n} \qquad (17)$$

Substituting βV_k from equation 17 instead of equation 16, we have:

$$-f_n g_m = \frac{i_t^g}{1+i_t^g}\frac{1}{S} \qquad (18)$$

Instead of S in equation 18, equation 5 is substituted:

$$-f_n g_m = \frac{i_t^g}{1+i_t^g} s^{\rho} \qquad (19)$$

The left side of equation 19 is the interest forgone on the opportunity cost of holding money. The relation $\frac{i_t^g}{1+i_t^g}$, which is the expected rate of return on bonds, is assumed to be equal to i.

$$-g_m f_n = i s^{\rho} \qquad (20)$$

The natural logarithm is taken from equation 20 and set equal to zero in the steady state:

$$\text{Ln}\,(-g_m f_n) = \text{Ln}\ i + (\rho)\ln(s) = 0 \ \Rightarrow Ln\ i = -(\rho) ln(s) \qquad (21)$$

Equation 21 is differentiated with respect to S:

$$\frac{\frac{\partial\ i}{i}}{\frac{\partial\ s}{s}} = -\rho \qquad (22)$$

Equation 22 is known as the partial elasticity of defensive interest to sanction where it is seen that the increase in the sanction intensity parameter has a negative impact on the elasticity of defensive interest to sanction. When the degree of sanctions rises, the policymakers should lower the demand for government debt securities.

3.2. Estimation of Partial Elasticity of Defensive Interest

To estimate the sanction intensity parameter derived in equation 22, the sanction intensity is first indexed. Subsequently, the sanction parameter is estimated using econometric models.

3.2.1. Indexing Sanction Intensity

Ranjkeshan [2023], in her study, for quantifying the share of each specific type of sanction (financial, trade, arms, etc.), utilized the sum of numbers assigned to that type of sanction over specified years in the GSDB. In this database, each type of sanction imposed by the sanctioning country against the target country is denoted by the number one, and the absence of sanctions is denoted by zero. For instance, to calculate the share of financial sanctions implemented by the European Union, the sum of the sum of those for this type of sanction over the years when the European Union imposed financial sanctions on various countries was used. In this research, inspired by her work, the time series data of sanction intensity is calculated using the following formula:

$$s_{jt} = \sum_{jt} S(jt)[(U(jt) + V(jt) + W(jt) + X(jt) + Y(jt) + Z(jt))] \qquad (23)$$

$S(jt)$ represents the number of sanctioning states that imposed against country j in year t. s_{jt} represents the severity of sanctions imposed on country j in year t, U(jt) represents financial sanctions imposed on country j in year t, V(jt) represents trade sanctions imposed on country j in year t, W(jt) represents arms sanctions imposed on country j in year t, X(jt) represents military sanctions imposed on country j in year t, Y(jt) represents travel sanctions imposed on country j in year t, Z(jt) represents other sanctions imposed on country j in year t.

Using data from GSDB, the intensity of sanctions against the target countries (Iran and Russia) is calculated by adding the numbers zero and one assigned to the types of sanctions imposed (trade, arms, military, financial, travel, other) in each year. For example, between 2011 and 2016, a total of 8 states (the European Union, Croatia, Macedonia, Montenegro, Iceland, Liechtenstein, Norway, and Moldova) imposed sanctions on Iran. Therefore, the number of sanctioning states(S(jt)was 8. The weights of the various sanctions, including trade, arms, military, financial, travel, and other sanctions, were 0, 0, 0, 1, 1, and 0, respectively. Therefore, weights of sanctions were two, when we multiply 8 by 2, we get 16, indicating the severity of the sanctions imposed by these countries on Iran in 2011 to 2016. To calculate the severity of the sanctions from 2011, we must consider the severity of the sanctions imposed by other countries in that year and add it to 16. The total number of sanctions intensity in 2011 was 45. The calculation of the severity of sanctions for Russia and Iran can be found in the annexes (Tables 9 to12 were included in annexes 1 and 2).

3.2.2. Estimation of the sanction intensity parameter

Box-Jenkins method has been used to estimate the sanctions severity parameter. In this method, all proposed models such as AR, MA and ARMA are estimated using the autocorrelation and partial correlation functions, then the best model is selected according to the number of data from the Schwartz, Akaike and Hanan-Quinn criteria to calculate the sanction intensity parameter. According to the stated contents, an AR(P)[3] model is used for the two countries of Iran and Russia to calculate the sanctions intensity parameter in relation 22.

[3] Autoregressive

$$s_t = \sum_{i=1}^{P} \rho_i s_{t-i} + \varepsilon_t \tag{24}$$

Where s_t is the sanction intensity variable at time t, ρ_i is the sanction intensity parameter, $s_{(t-i)}$ is the sanction intensity variable in period t-i, P is the order of the AR model, and ε_t is the model's error term. First, using equation 23, the time series of sanction data is obtained, then using equation 24, the sanction intensity parameter is calculated for both Iran and Russia.

4. Results

Based on equation 24, the time series of sanctions for the economies of Iran and Russia have been calculated. Tables 1 and 2 show the results of the time series data of sanction intensity for Iran and Russia, respectively, based on formula 23. In the case study of Iran, i represents the years 1979 to 2023, and j includes the United States, Japan, Australia, Canada, South Korea, Croatia, Macedonia, Montenegro, Iceland, Liechtenstein, Norway, Moldova, Switzerland, Albania, Bosnia and Herzegovina, Ukraine, the United Nations, and the European Union. For the Russian case study, i represents the years 1993 to 2023, and j includes Albania, Germany, the European Union, Australia, the United States, Italy, Iceland, Ukraine, Britain, Taiwan, Canada, South Korea, Kosovo, Georgia, Liechtenstein, Macedonia, Montenegro, Norway, New Zealand, Japan, G7, Singapore, Switzerland, and France.

Table 1 presents the time series of sanction intensity for Iran. Sanctions against Iran commenced in 1979 following the Islamic Revolution for reasons that remain ambiguous and continue to this day. The Table quantifies sanction intensity from 1979 to 2023. Global powers have imposed these sanctions citing allegations of terrorism and human rights violations, with the objectives of policy alteration and conflict prevention.

Table 1: Time Series Data of Sanction Intensity for Iran

year	sanction	Year	sanction	year	sanction	year	sanction
1979	2	1990	4	2001	5	2012	72
1980	3	1991	4	2002	5	2013	73
1981	3	1992	4	2003	5	2014	73
1982	0	1993	4	2004	5	2015	73
1983	0	1994	4	2005	5	2016	85
1984	3	1995	5	2006	9	2017	15
1985	3	1996	5	2007	11	2018	19
1986	3	1997	5	2008	17	2019	22
1987	4	1998	5	2009	17	2020	25
1988	4	1999	5	2010	25	2021	29
1989	4	2000	5	2011	45	2022	43
						2023	88

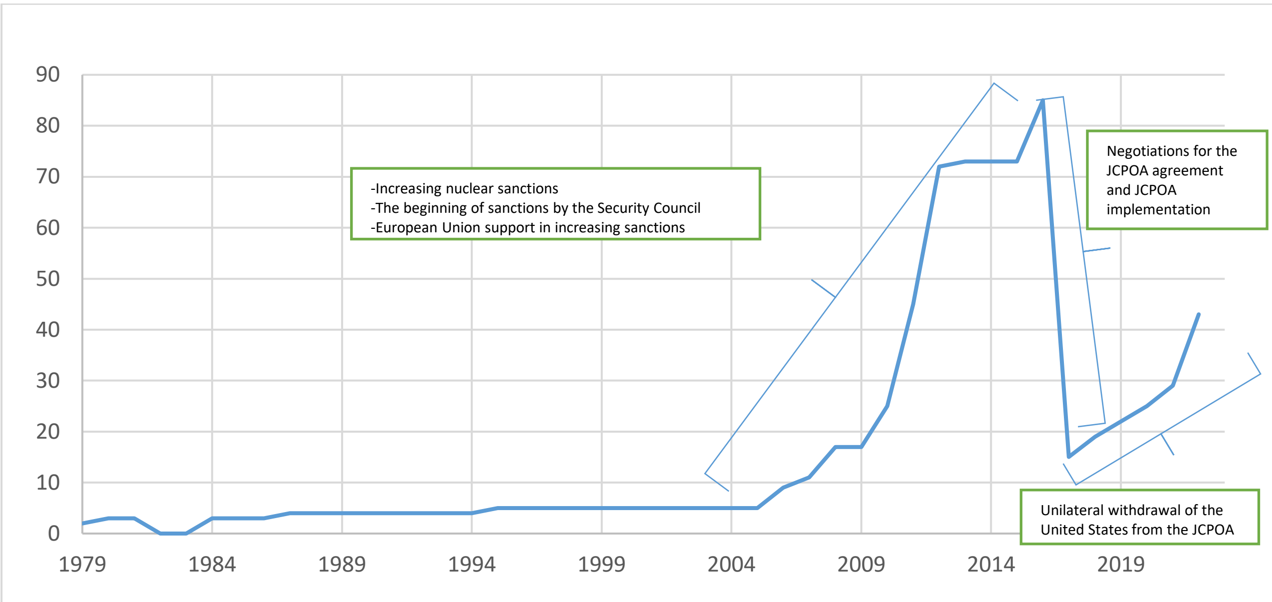
Source: Research calculations using GSDB data

As illustrated in Figure 1, the intensity of sanctions has increased, largely due to the concerted efforts of the European Union and the Security Council. While the JCPOA[4] agreement

[4]Joint Comprehensive Plan of Action

led to a temporary decline, the graph continues to indicate high values due to the incomplete lifting of sanctions. The unilateral withdrawal of the United States from the JCPOA in 2018 has once again propelled the graph on an ascending path.

Figure 1: The severity of sanctions in Iran during 1979-2023



Source: Research findings

Ukraine initiated the first sanctions against Russia in 1993, aiming to influence policy. In 2014, coinciding with the onset of hostilities between Russia and Ukraine, several nations imposed sanctions on Russia with the goal of ending the conflict. These sanctions intensified in 2021 as more countries joined the effort. Table 2 depicts the time series of sanction intensity against Russia from 1993 to 2023.

Table 2: Time Series data of Sanction Intensity for Russia

year	sanction	year	sanction	year	sanction	year	sanction
1993	2	2001	0	2009	1	2017	48
1994	2	2002	0	2010	1	2018	48
1995	2	2003	0	2011	1	2019	50
1996	2	2004	0	2012	0	2020	54
1997	0	2005	0	2013	0	2021	59
1998	0	2006	0	2014	46	2022	156
1999	0	2007	0	2015	46	2023	212
2000	0	2008	1	2016	46		

Source: Research calculations using GSDB data

Figure 2 illustrates that from 2014 to 2022, due to the Russia-Ukraine conflict, numerous countries, including Australia, Canada, the European Union, Montenegro, Iceland, Albania, Liechtenstein, Norway, Ukraine, Japan, New Zealand, Switzerland, and the United States imposed sanctions on Russia. The graph shows a sharp increase in 2021 as additional countries such as

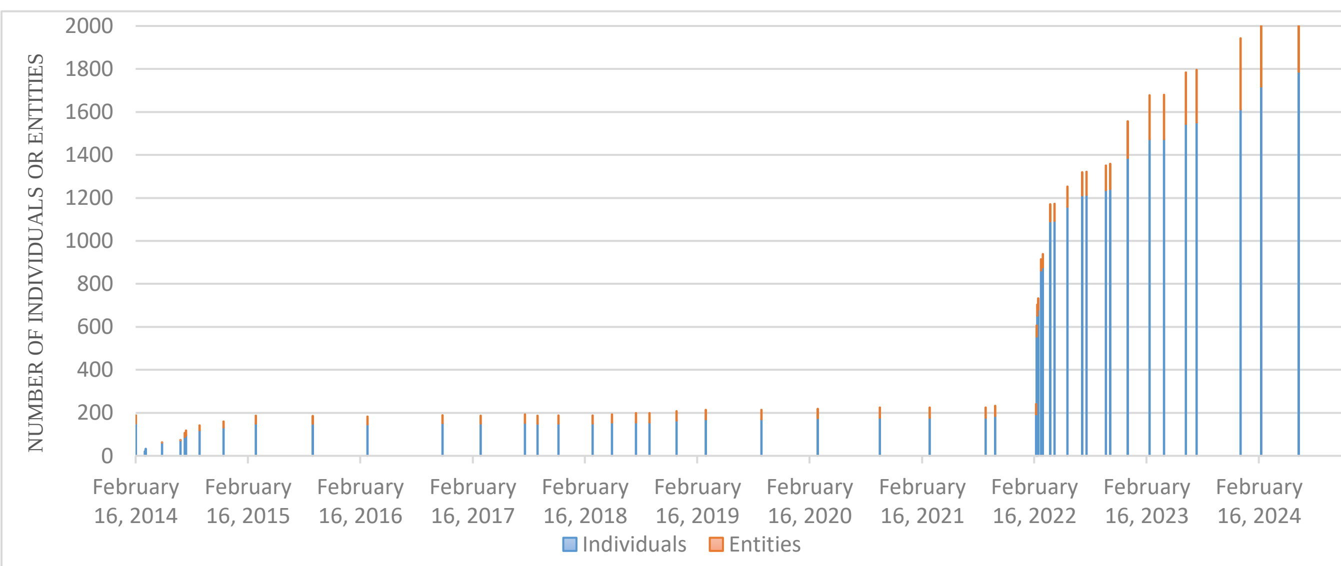
Macedonia, Kosovo, Germany, South Korea, Singapore, Taiwan, Britain, France, and Italy joined the sanctioning nations.

Figure 2: The severity of sanctions in Russia during 1993-2023

Source: Research findings

But the trend of sanctions began to rise dramatically since February 23, 2022. Figure 3 indicates the number of sanctions imposed by the European Union (EU) against Russian individuals and entities from March 2014 (during the Russian Ukraine tensions) to February 2024.

Figure 3: The number of sanctions imposed on Russia from March 2014 to February 2024



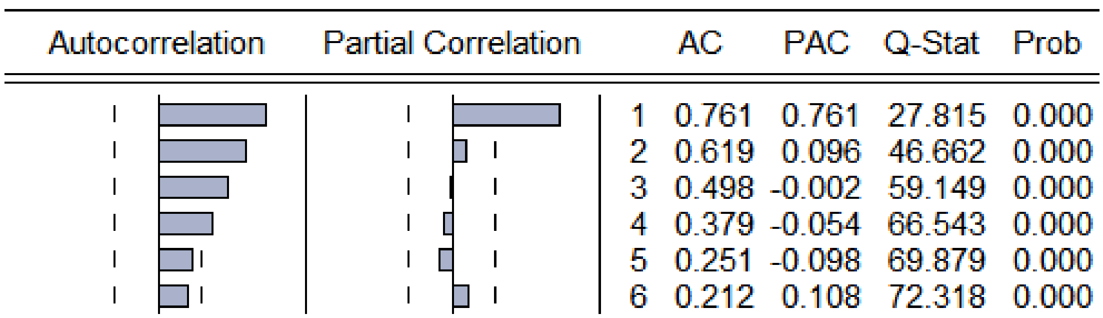
Source: Statista Research Department (Statista) [2025]

Figure 3 shows that the number of sanctions increased generally three fold from February 23, 2022(607), to February 23, 2024(2137). The proportion of individual sanctions compared to entities also significantly rose during this time. Consequently, the severity of the sanctions increased during these periods.

In studies [Bali, Rapelanoro, 2021; Dreger et al., 2016; Kholodilin, Netšunajev, 2019], VAR and SVAR models have been used to estimate the impact of sanctions shock on economic variables, which are appropriate models according to the objectives of the aforementioned research. In our research, the aim is to estimate the sanctions parameter to estimate the intensity of future sanctions increase according to a one percent increase in current sanctions. Then, this parameter will be an alarm for policymakers to increase or decrease interest rates according to our research findings.

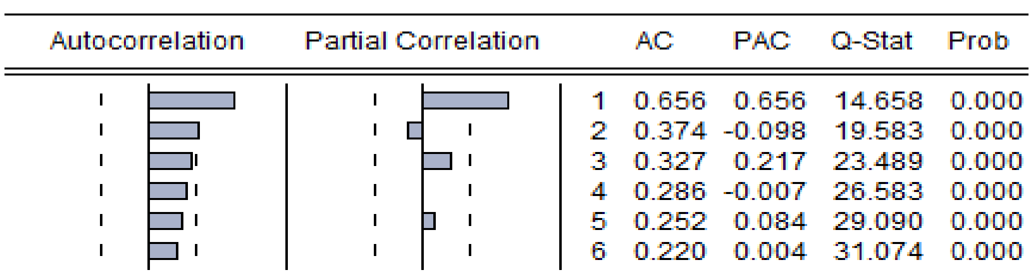
Following sanction time series data extraction, autocorrelation and partial correlation functions for Iran and Russia were plotted using EVIEWS software (Figures 4 and 5).

Figure 4: Correlation Figure of time series of sanctions data in Iran



Source: Research findings

Figure 5: Correlation Figure of time series of sanctions data in Russia



Source: Research findings

Considering the autocorrelation and partial correlation of the sanctions data time series in Russia and Iran, which is decreasing and sinusoidal; the Box-Jenkins approach suggests AR(p), MA(q), and ARMA(p,q) models. As per the Box-Jenkins approach, AR(p), MA(q), and ARMA(p,q) models can be used for estimation, as shown in Tables 3, 4, and 5.

Table 3: AR(1) model estimation results for Iran

Variable	Coefficient	Std.Error	t-Statistic	Prob
AR(1)	0.89	0.13	6.59	0.00

R-squared	0.70	Akaike info criterion	8.24
Adjusted R-Squared	0.68	Schwarz criterion	8.36
		Hannan-Quinn criter	8.28

Source: Research findings

The estimation of the AR(1) model for Iran is shown in Table 3. The sanction intensity parameter in this model is 0.89. The coefficient is statistically significant at the 95% level of confidence. The model can be considered reliable enough, as the coefficient of determination is 0.70.

Table 4: MA(4) model estimation results for Iran

Variable	Coefficient	Std.Error	t-Statistic	Prob
MA(1)	0.56	315.3	0.001	0.99
MA(2)	1.00	698.7	0.001	0.99
MA(3)	0.56	471.5	0.001	0.99
MA(4)	0.99	1387.1	0.001	0.99
R-squared	0.80	Akaike info criterion		8.13
Adjusted R-Squared	0.78	Schwarz criterion		8.37
		Hannan-Quinn criter		8.22

Source: Research findings

The estimation results of the MA(4) model for Iran are presented in Table 4. At the 95% level of significance, estimate of MA(1) is statistically significant, while that of MA(2) to MA(4) are statistically insignificant.

Table 5: ARMA(1,4) model estimation results for Iran

Variable	Coefficient	Std.Error	t-Statistic	Prob
AR(1)	0.56	0.23	2.37	0.02
MA(1)	0.18	202.6	0.0008	0.99
MA(2)	0.70	402.3	0.001	0.99
MA(3)	0.40	250.7	0.001	0.99
MA(4)	0.75	941.1	0.0008	0.99
R-squared	0.81	Akaike info criterion		8.05
Adjusted R-Squared	0.79	Schwarz criterion		8.33
		Hannan-Quinn criter		8.15

Source: Research findings

Table 5 shows the ARMA (1,4) model estimation for Iran. At the 95% confidence level, the AR(1) is statistically significant out of all the coefficients.

In the case of Iran, all coefficients of the MA(4) model are meaningless. In the ARMA(1,4) model, only the AR(1) coefficient is significant. Therefore, the AR(1) model provides a better estimate among the three models.

Table 6: AR(1) model estimation results for Russia

Variable	Coefficient	Std.Error	t-Statistic	Prob
AR(1)	0.97	0.07	12.17	0.00
R-squared Adjusted R-Squared	0.79 0.77	Akaike info criterion Schwarz criterion Hannan-Quinn criter		9.35 9.49 9.39

Source: Research findings

Table (6) presents the estimation of the first-order autoregressive model for Russia. In this model, the sanction intensity parameter is at 0.97. The obtained coefficient is statistically significant at the 95% confidence interval. Thus, hypothesis H1 is supported. The model can be considered reliable enough, as the coefficient of determination is 0.79.

Table7: MA(2) model estimation results for Russia

Variable	Coefficient	Std.Error	t-Statistic	Prob
MA(1)	1.57	0.09	17.44	0.00
MA(2)	0.82	0.11	7.2	0.00
R-squared Adjusted R-Squared	0.78 0.75	Akaike info criterion Schwarz criterion Hannan-Quinn criter		9.40 9.58 9.46

Source: Research findings

The estimation results of the MA(2) model for Russia are given in Table (7) below. When it comes to the 95% confidence interval, all estimated coefficients for all MA lags are statistically significant.

Table 8: ARMA(1,2) model estimation results for Russia

Variable	Coefficien t	Std.Error	t-Statistic	Prob
AR(1)	0.92	0.23	3.99	0.0005
MA(1)	0.51	0.29	1.72	0.09
MA(2)	0.14	1.82	0.08	0.93
R-squared Adjusted R-Squared	0.82 0.80	Akaike info criterion Schwarz criterion Hannan-Quinn criter		9.22 9.45 9.29

Source: Research findings

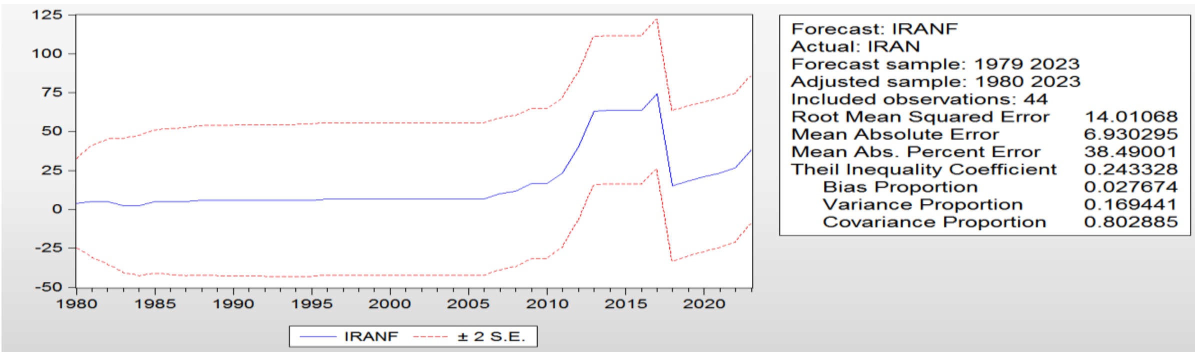
In the Box-Jenkins approach, the decision on which model is to be used is made by comparing the AIC and SC values. The model with lower values is considered superior [Loganathan, Ibrahim, 2010]. The estimation result of the ARMA(1,2) model for Russia is presented in Table (8). At 95% confidence level, the AR(1) is statistically significant out of all the coefficients. Therefore, the Schwarz and Akaike information criteria were used to distinguish between AR(1) and MA(2). The values of the Schwarz criterion and Akaike information criterion in the AR(1) model are 9.49 and 9.35, which are lower than these values for the MA(2) model. Therefore, the selected model is AR(1). For both Iran (Equation 25) and Russia (Equation 26), the first-order autoregressive model provides a better estimate.

$$SANCTION = 0.89\, SANCTION(-1) + \varepsilon_i \quad (25)$$

$$SANCTION = 0.97\, SANCTION(-1) + \varepsilon_i \quad (26)$$

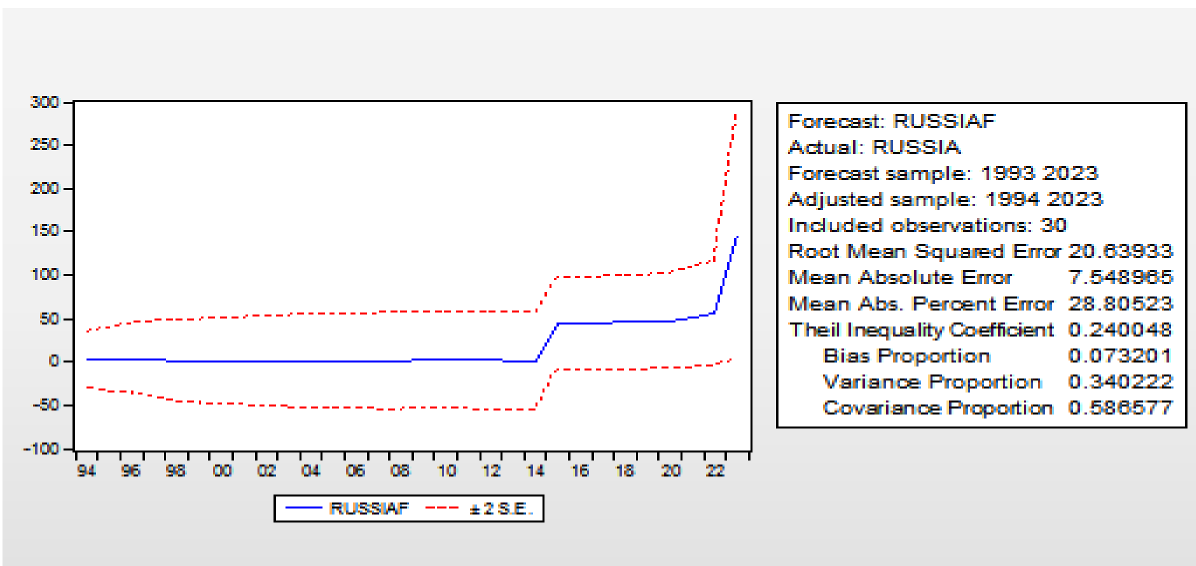
As depicted in Figures 6 and 7, forecast power graphs of equations 25 and 26 have been drawn to check the accuracy of the models. Thus, evaluating the predictive capability of the models, it was identified that the Covariance Proportion for both countries is more than 0.50, which implies that the models have high predictive capability.

Figure 6: Forecast power of AR(1) model in Iran



Source: Research findings

Figure 7: forecast power of AR(1) model in Russia



Source: Research findings

To justify the choice of the AR(1) models, the autocorrelation and partial correlation of the error terms of the estimated models for Iran and Russia are presented in Figures 8 and 9. Thus, the error terms are stationary because they are within the Bartlett confidence interval. According to the Box-Jenkins approach, it was concluded that the estimated AR(1) models are adequate.

Figure 8: Correlation Figure of sanctions data error term in Iran

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.043	0.043	0.0730	0.787
		2	-0.092	-0.094	0.4115	0.814
		3	0.063	0.072	0.5743	0.902
		4	0.008	-0.007	0.5773	0.966
		5	-0.052	-0.040	0.6971	0.983
		6	-0.004	-0.003	0.6978	0.995

Source: Research findings

Figure 9: Correlation Figure of sanctions data error term in Russia

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.028	0.028	0.0272	0.869
		2	0.043	0.043	0.0937	0.954
		3	0.045	0.043	0.1690	0.982
		4	-0.020	-0.024	0.1842	0.996
		5	0.021	0.019	0.2023	0.999
		6	0.053	0.052	0.3152	0.999

Source: Research findings

Equations 25 and 26 show that when sanction intensity rises by one percent, the interest rate in Iran and Russia should decline by 0.89 and 0.97 percent, respectively.

5.Discussion

Not all sanctions may increase transaction costs. It depends on the scale of the economy and the type of sanctions imposed, whether there be individual sanctions or restrictions on deep oil extraction technologies. The methodology of the paper is based on shopping time, which considers the length of trade as a transaction cost. It is assumed that sanctions impact the length of trade and ultimately lead to an increase in transaction costs.

According to equation 20, sanctions will decrease the opportunity cost of holding money. To get the effect of sanctions on the bond interest rate, the natural logarithm of equation (20) was taken, the cost of holding money was then set equal to zero under steady state, and the coefficient of the bond interest rate to sanctions was estimated. Thus, the results obtained in this paper are opposite to the conventional view of defensive interest rates, which calls for raising interest rates to deter speculator attacks.

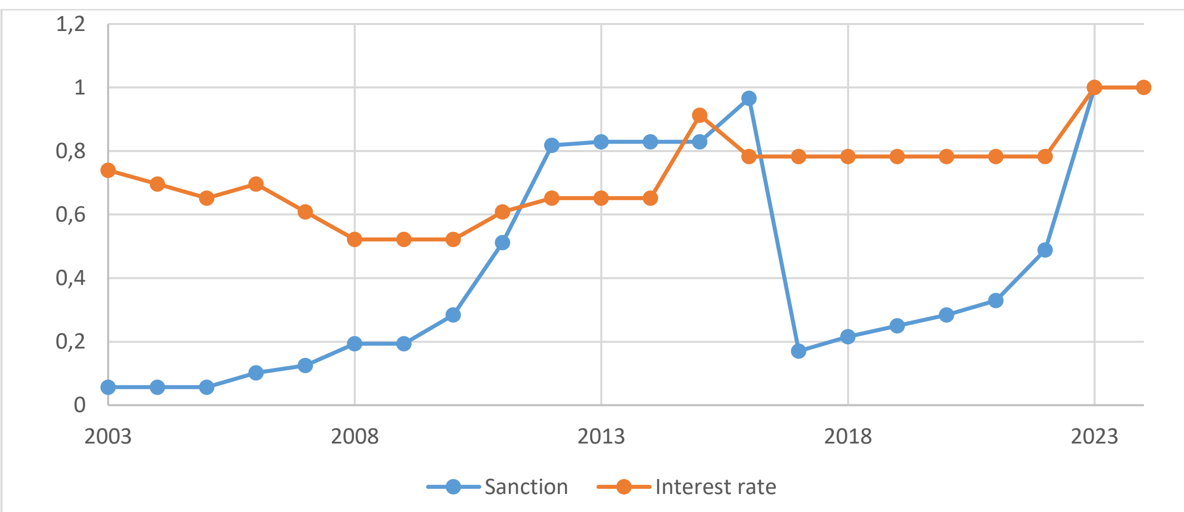
A time series for the sanction index was first created to estimate the sanction intensity parameter, and no previous studies have done this. Some researchers have applied the dummy variables of zero and one to estimate the impact of sanctions, which denote the existence of sanctions. Other works have utilized artificial variables or the method of scenario construction for sanction intensity, which in some way includes the author's subjective opinion and cannot account for the intensity of various sanctions. The sanction intensity index developed in this research can also be applied in other research.

Studies Ershov [2016], Heydarian et al. [2021] and Astrov et al. [2022] have supported increasing interest rates against increasing sanctions. One of the policy suggestions of Pourshahabi & Dahmardeh [2014], raising interest rate to make strung the currency in the short run against increasing sanctions. The results of these studies are in contrast with our study. Astrov et al. [2024] also find that rising interest rates against increasing sanctions in the long run cause a decrease in economic growth. Jones and Whitworth [2014] do not advocate raising interest rates, but rather see it as a temporary measure with negative consequences. These two studies do not recommend increasing interest rates against increasing sanctions, which are consistent with the results of our study.

Based on the research findings, with a one percent increase in sanction intensity, policymakers should reduce the bond interest rate by 0.89 percent in Iran and 0.97 percent in Russia. This indicates that Russia has a higher elasticity of defensive interest in response to sanctions compared to Iran.

According to Figure 9, Iran's interest rates have shown an upward trend over the years. Starting at a rate of 17 % in 2003, it peaked at 23% in 2023. It is clear that the monetary authority in Iran did not decrease interest rates in most of the years when faced with severe sanctions. This monetary policy persisted despite research findings suggesting the country, as interest rates actually increased as sanctions intensified. The only year in which Iranian monetary authority followed the findings was 2003 to 2008. In those years, with the increase in the severity of sanctions, interest rates decreased seldom. In all other years, the response of interest rates to the intensity of sanctions was contrary to the research findings.

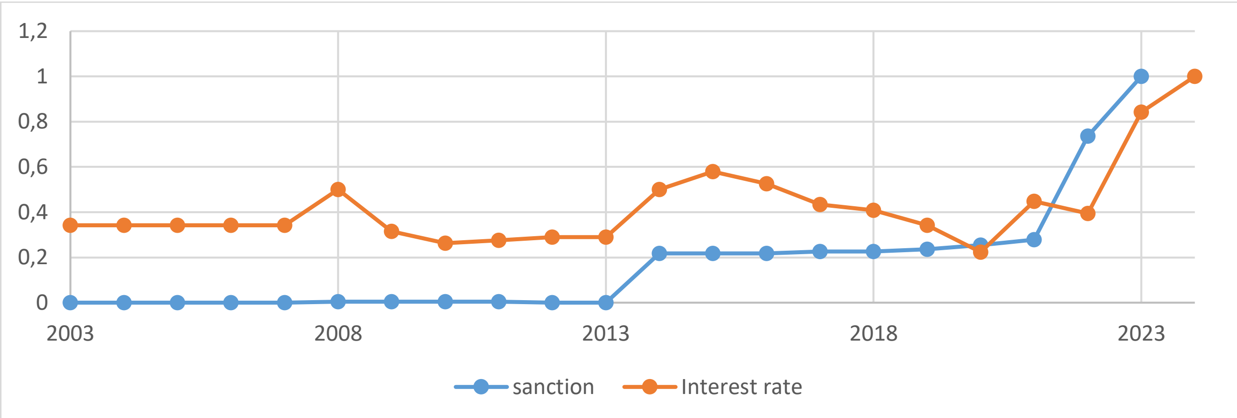
Figure 9: Interest rates and sanctions index in Iran during 2003-2024



Source: Research findings

However, in Russia, there are more periods of decreasing interest rates than Iran, when sanctions were increased. For example, in 2015 to 2020, when the intensity of sanction increased, the interest rate decreased. In 2022, there was a significant increase in sanction intensity (from 59 to 156), leading to a decrease in the interest rate from 8.5 to 7.5. (See Figure 10). To better compare the severity of sanctions with increasing and decreasing interest rates in figures 9 and 10, the numbers are normalized by dividing by the highest number in each time series.

Figure 10: Interest rates and sanctions index in Russia during 2003-2024



Source: Research findings

6. Conclusion

Based on the results obtained from the research, as sanctions intensify, interest rates should decrease. In line with the research findings, Russia has reduced its interest rate as sanctions have intensified more than Iran. However, contrary to the research findings in Iran, in most of years interest rates have increased as sanctions have intensified. An increase in interest rates raises production costs for firms, leading to higher prices for goods, resulting in higher inflation and a decrease in the value of the national currency. With rising interest rates and a declining value of the national currency due to inflation in Iran and Russia since 2022, the likelihood of the Iranian and Russian currencies securing a position in the BRICS[5] basket diminishes. As a result, the two countries, Iran and Russia, cannot achieve political convergence in the international arena regarding BRICS affairs and de-dollarization towards participation in realizing an emerging common currency. On the other hand, Iran's trade development by joining the BRICS group could increase investment incentives within the country and reduce the monetary authority's concerns about lowering interest rates, which could lead to bank runs. Therefore, the policy of reducing bank interest rates in Iran under sanctions and increasing foreign investment opportunities could lead to a paradigm shift in monetary policy in Iran, where interest rates should be lowered instead of increased under sanction conditions.

To counter sanctions, Iran and Russia can, potentially, collaborate by taking measures to make their economies more stable and resilient. This can be achieved through expanding their international financing and trade. Implementing a similar system of instrumental settlements, such as Bilateral SWIFT, and adhering to the same monetary policy rule, such as decreasing interest rates during sanctions, based on target inflation and macroeconomic stability. Additionally, it is

[5]It is an intergovernmental organization that was originated by the initial members including Brazil, Russia, India, China and South Africa.

recommended to increase the inclusion of alternative currencies, such as the Yuan and common digital currencies in the basket of foreign reserves alongside the Dollar, Euro and Pound.

Limitation: The paper uses Russia and Iran to analyze the parameter of intensity of sanctions and interest rate policies. Due to expanding sanctions policies in the international environment, other countries can also be considered. In future studies, other indicators can be combined with the index created in this research and evaluate the effect of sanctions severity on interest rates and other macroeconomic variables, including government debt. Future method of calculation sanction index studies can also categorize the impacts of sanctions based on different transaction costs, taking into account the length of time of trades. Due to the methodology applied in this paper and the lack of detailed information on the Global Sanctions Database (GSDB) about sanctions, the paper assumes that sanctions increase the length of all trades, leading to an increase in transaction costs. Future studies can address this limitation by developing more comprehensive data.

Data Availability

Data used in the research would be made available by the corresponding author on reasonable request.

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Annex: (1)

Table 9: How to calculate the severity of sanctions Imposed against Russia by each country

sanction ed state	sanctioning state	Num er of Sanc ning – tates	begin	end	N er le cti s	N er ns cti s	N ber f tary tion s	N ber f ncial tion s	N ber avel tion s	N ber ther tion s	Tota mber of ctions = (trad rms+mil ary+ fina l+trave other	Severity sanctions= (Number sanctioned states)* (Total umber of anctions)
Russia	Ukraine	**1**	**1993**	**1996**	**1**	**0**	**1**	**0**	**0**	**0**	**2**	**2**
Russia	Georgia	**1**	**2008**	**2011**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
Russia	Australia	**1**	**2014**	**2023**	**1**	**1**	**1**	**1**	**1**	**0**	**5**	**5**
Russia	Canada	**1**	**2014**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	EU	**1**	**2014**	**2023**	**1**	**1**	**1**	**1**	**0**	**0**	**4**	**4**
Russia	EU, Montenegro, Iceland, Albania, Liechtenstein, Norway, Ukraine	**7**	**2014**	**2023**	**1**	**0**	**0**	**1**	**1**	**0**	**3**	**21**
Russia	Japan	**1**	**2014**	**2023**	**1**	**0**	**1**	**1**	**1**	**0**	**4**	**4**
Russia	New Zealand	**1**	**2014**	**2023**	**0**	**0**	**0**	**1**	**1**	**1**	**3**	**3**
Russia	Switzerland	**1**	**2014**	**2023**	**1**	**1**	**1**	**1**	**0**	**0**	**4**	**4**
Russia	United States	**1**	**2014**	**2023**	**1**	**0**	**0**	**1**	**1**	**0**	**3**	**3**
Russia	United States	**1**	**2017**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	United States	**1**	**2019**	**2023**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**2**
Russia	United Kingdom	**1**	**2020**	**2023**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**2**
Russia	United States	**1**	**2020**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	United Kingdom	**1**	**2021**	**2023**	**1**	**1**	**1**	**1**	**1**	**0**	**5**	**5**
Russia	Poland	**1**	**2022**	**2023**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**

Russia	United States	**1**	**2022**	**2023**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**2**
Russia	United Kingdom	**1**	**2022**	**2023**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**2**
Russia	Australia	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**
Russia	Canada	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**
Russia	EU, Macedonia, Albania, Kosovo	**4**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**16**
Russia	G7, EU	**2**	**2022**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**4**
Russia	Germany	**1**	**2022**	**2023**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**2**
Russia	Iceland	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**
Russia	Japan	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**0**	**3**	**3**
Russia	Korea, South	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	Liechtenstein	**1**	**2022**	**2023**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**
Russia	Monaco	**1**	**2022**	**2023**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**
Russia	New Zealand	**1**	**2022**	**2023**	**1**	**1**	**1**	**0**	**1**	**0**	**4**	**4**
Russia	Norway	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**
Russia	Poland	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**0**	**3**	**3**
Russia	Singapore	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	Switzerland	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**
Russia	Taiwan	**1**	**2022**	**2023**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Russia	United Kingdom	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**
Russia	United States	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	United States	**1**	**2022**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**
Russia	United States, EU, Japan, United Kingdom, Canada, France, Germany, Italy	**8**	**2022**	**2023**	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**16**
Russia	United States, United Kingdom, Canada	**3**	**2022**	**2023**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**3**
Russia	United States, United Kingdom, Japan, Canada	**4**	**2022**	**2023**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**4**
Russia	United States	**1**	**2023**	**2023**	**1**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	Czech Republic	**1**	**2023**	**2023**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**
Russia	Kazakhstan	**1**	**2023**	**2023**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Russia	Latvia, Lithuania, Estonia	**3**	**2023**	**2023**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**3**
Russia	Ukraine	**1**	**2023**	**2023**	**1**	**0**	**0**	**1**	**1**	**0**	**3**	**3**
Russia	United States, United Kingdom	**2**	**2023**	**2023**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**2**
Russia	EU, Macedonia, Montenegro, Albania, Iceland, Switzerland Bosnia and Herzegovina, Liechtenstein, Norway, Liechtenstein	**10**	**2023**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**40**
Russia	Ukraine	**1**	**2023**	**2023**	**1**	**0**	**0**	**1**	**1**	**1**	**4**	**4**

Source: Research findings based on GSDB data

Note: In common time periods, numbers related to the severity of sanctions are added together. The calculation method is shown in the table below.

Table 10: Time Series data of Sanction Intensity for Russia

year	sanction	year	sanction	year	sanction	year	sanction
1993	**2**	**2001**	**0**	**2009**	**1**	**2017**	**(5+2+4+21+4+3+4+3+2)=48**
1994	**2**	**2002**	**0**	**2010**	**1**	**2018**	**48**

1995	**2**	**2003**	**0**	**2011**	**1**	**2019**	**(5+2+4+21+4+3+4+3+2+2)=50**
1996	**2**	**2004**	**0**	**2012**	**0**	**2020**	**(5+2+4+21+4+3+4+3+2+2+2+2)=54**
1997	**0**	**2005**	**0**	**2013**	**0**	**2021**	**(5+2+4+21+4+3+4+3+2+2+2+2+5)=59**
1998	**0**	**2006**	**0**	**2014**	**(5+2+4+21+4+3 +4+3)= 46**	**2022**	**(5+2+4+21+4+3+4+3+2+2+2+2++5+1+2+2+4+4+16+4+2+4+3+2+1+1+4+4+3+2+4+1+4+ 2+4+16+3+4)= 156**
1999	**0**	**2007**	**0**	**2015**	**46**	**2023**	**(5+2+4+21+4+3+4+3+2+2+2+2++5+1+2+2+4+4+16+4+2+4+3+2+1+1+4+4+3+2+4+1+4+ 2+4+16+3+4+2+1+1+3+3+2+40+4)= 212**
2000	**0**	**2008**	**1**	**2016**	**46**		

Source: Research calculations using GSDB data

Annex: (2)

Table 11: How to calculate the severity of sanctions Imposed against Iran by each country

sanc ed state	**sanctioning state**	**Nu er of Sa oning tates**	**be gin**	**en d**	**N ber rade tion s**	**N er ns tio**	**N er f tar ctio s**	**Number of financial sanctions**	**N er vel tio**	**N er er tio**	**Total nber of ctions = (trad ms+mili ary+ finan trave+o ther**	**Severity of anctions= (Number sanctioned states)* (Total number of Sanctions**
Iran	United States	1	1979	1981	1	0	0	1	0	0	2	2
Iran	United States	1	1980	1981	1	0	0	0	0	0	1	1
Iran	United States	1	1984	2016	1	1	0	1	0	0	3	3
Iran	United States	1	1987	1995	1	0	0	0	0	0	1	1
Iran	United States	1	1995	2016	1	0	0	0	0	0	1	1
Iran	United States	1	1996	2023	1	0	0	0	0	0	1	1
Iran	Japan	1	2006	2016	1	0	0	0	0	0	1	1
Iran	UN	1	2006	2016	1	0	0	1	1	0	3	3
Iran	EU	1	2007	2016	0	1	0	0	0	0	1	1
Iran	UN	1	2007	2016	0	1	0	0	0	0	1	1
Iran	Australia	1	2008	2016	1	1	1	1	1	0	5	5
Iran	UN	1	2008	2016	0	0	0	0	1	0	1	1
Iran	Canada	1	2010	2016	1	1	0	1	0	0	3	3
Iran	Korea, South	1	2010	2012	1	0	0	0	0	0	1	1
Iran	UN	1	2010	2016	1	0	0	1	0	0	2	2

Iran	UN	1	2010	2020	0	1	1	0	0	0	2	2
Iran	Canada	1	2011	2016	1	0	0	0	0	0	1	1
Iran	EU, Croatia, Macedonia, Montenegro, Iceland, Liechtenstein, Norway, Moldova	8	2011	2016	0	0	0	1	1	0	2	16
Iran	Switzerland	1	2011	2016	1	0	0	1	1	0	3	3
Iran	Canada	1	2012	2016	1	0	0	1	0	1	3	3
Iran	EU	1	2012	2016	1	0	0	0	0	0	1	1
Iran	EU, Croatia, Macedonia, Montenegro, Iceland, Albania, Bosnia and Herzegovina, Moldova, Liechtenstein, Norway, Ukraine,	11	2012	2016	1	0	0	1	0	0	2	22
Iran	United States	1	2012	2023	0	0	0	1	0	0	1	1
Iran	Canada	1	2013	2016	1	0	0	1	0	0	2	2
Iran	Australia	1	2016	2023	1	1	1	1	1	0	5	5
Iran	Canada	1	2016	2023	1	0	0	1	0	0	2	2
Iran	Djibouti	1	2016	2023	0	0	0	0	0	1	1	1
Iran	Switzerland	1	2016	2016	1	0	0	0	1	0	2	2
Iran	UN	1	2016	2023	0	1	1	0	0	0	2	2
Iran	United States	1	2017	2021	0	0	0	0	1	0	1	1
Iran	Korea, South	1	2018	2023	1	0	0	0	0	0	1	1
Iran	United States	1	2018	2023	1	0	0	1	1	0	3	3
Iran	United States	1	2019	2023	0	0	0	1	0	0	1	1
Iran	United States	1	2019	2023	0	0	0	1	1	0	2	2
Iran	United States	1	2020	2023	1	0	0	1	1	0	3	3
Iran	United States	1	2021	2023	1	1	1	1	0	0	4	4
Iran	United States	1	2021	2023	1	0	0	1	0	0	2	2
Iran	Canada	1	2022	2023	0	0	0	1	1	0	2	2
Iran	EU	1	2022	2023	1	0	0	1	1	0	3	3
Iran	EU	1	2022	2023	0	0	0	1	1	0	2	2
Iran	New Zealand	1	2022	2023	0	0	0	0	1	0	1	1
Iran	United States	1	2022	2023	1	0	0	1	0	0	2	2
Iran	United States	1	2022	2023	0	0	0	1	0	0	1	1
Iran	United States	1	2022	2023	0	0	0	1	1	0	2	2
Iran	United Kingdom	1	2022	2023	0	0	0	1	1	0	2	2
Iran	United Kingdom, United States, Canada	3	2023	2023	0	0	0	1	1	0	6	6
Iran	Australia	1	2023	2023	0	0	0	1	1	0	2	2
Iran	Canada	1	2023	2023	0	0	0	1	0	0	1	1
Iran	EU, Macedonia, Montenegro, Albania, Ukraine, Bosnia and Herzegovina Moldova, Iceland, Liechtenstein, Norway	10	2023	2023	1	0	0	1	1	0	30	30
Iran	United Kingdom	1	2023	2023	1	0	0	1	1	0	3	3
Iran	United States	1	2023	2023	1	0	0	0	0	0	1	1
Iran	United States	1	2023	2023	1	0	0	1	0	0	2	2

Source: Research findings based on GSDB data

Table 12: Time Series Data of Sanction Intensity for Iran

year	sanction	Year	sanction	year	sanction	year	Sanction Intensity
1979	2	1990	(1+3)=4	2001	(1+3+1)=5	2012	(3+1+1+1+3+1+1+1+5+3+1+2+2+1+16+3+3+1+22+1)=72
1980	(1+2)=3	1991	4	2002	(1+3+1)=5	2013	(3+1+1+1+3+1+1+1+5+3+2+2+1+16+3+3+1+22+1+2)=73
1981	(1+2)=3	1992	(1+3)=4	2003	(1+3+1)=5	2014	(3+1+1+1+3+1+1+1+5+3+2+2+1+16+3+3+1+22+1+2)=73
1982	0	1993	(1+3)=4	2004	(1+3+1)=5	2015	(3+1+1+1+3+1+1+1+5+3+2+2+1+16+3+3+1+22+1+2)=73
1983	0	1994	(1+3)=4	2005	(1+3+1)=5	2016	(3+1+1+1+3+1+1+1+5+3+2+2+1+16+3+3+1+22+1+2+5+2+1+2+2)=85
1984	3	1995	(1+3+1)=5	2006	(3+1+1+1+3)=9	2017	(1+2+1+5+2+1+2+1)=15
1985	3	1996	(1+3+1)=5	2007	(3+1+1+1+3+1+1)=11	2018	(1+2+1+5+2+1+2+1+1+3)=19
1986	3	1997	(1+3+1)=5	2008	(3+1+1+1+3+1+1+1+5)=17	2019	(1+2+1+5+2+1+2+1+1+3+1+2)=22
1987	(1+3)=4	1998	(1+3+1)=5	2009	(3+1+1+1+3+1+1+1+5)=17	2020	(1+2+1+5+2+1+2+1+1+3+1+2+3)=25
1988	(1+3)=4	1999	(1+3+1)=5	2010	(3+1+1+1+3+1+1+1+5+3+1+2+2)=25	2021	(1+1+5+2+1+2+1+1+3+1+2+3+4+2)=29
1989	(1+3)=4	2000	(1+3+1)=5	2011	(3+1+1+1+3+1+1+1+5+3+1+2+2+1+16+3)=45	2022	(1+1+5+2+1+2+1+3+1+2+3+4+2+23+2+1+2+1+2+2)=43
						2023	(1+1+5+2+1+2+1+3+1+2+3+4+2+2+3+2+1+ 2+1+2+2+6+2+1+30+3+1+2)=88

Source: Research calculations using GSDB data