A Model for Examining Exchange Rate Shocks Affecting Financial Sustainability in Export-Oriented Companies

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ARTICLE INFO

ABSTRACT

One of the variables affecting the behavior of enterprises is the exchange rate. Uncertainty about each firm's exchange rate volatility is considered a risk. This study aims to explain a model to investigate the effect of exchange rate shocks on the financial sustainability of export-oriented companies. In this regard, the data on the exchange rate, tax, oil revenue, and export variables on financial sustainability were collected for 19 groups of companies from 2008 to 2019. We used the panel vector autoregressive model (PANEL VAR) using the generalized method of moments (GMM) to analyze the data to achieve the research goal. Then, the results were interpreted using the impulse response function and variance decomposition. The results of the IRF show that the effect of exchange rate volatility on the financial sustainability variable is initially adverse, has a positive effect over time, and is neutralized after several periods. The same is for an impulse equal to a standard deviation in tax. Further, the oil revenues and exports impulse negatively and positively affect financial sustainability. According to the results of variance decomposition, it can be said that the effect of the exchange rate on financial sustainability is greater than that of sustainability on the exchange rate because the exchange rate shocks have more explanatory power for sustainability fluctuations.

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1. Introduction

One of the most significant elements in the economic policies of every country is the exchange rate. It is also one of the vital issues that should always be considered in the cost calculations of industrial entities. Exchange rate fluctuations are unexpected movements in which the exchange rate rises or falls over some time (Oloba and Abogan, 2013). Under the global economic circumstances in the last few years, the fluctuations from the exchange rate have become more determinant since exchange rates are among the most critical factors in international monetary markets. Exchange rate fluctuations impact economic and industrial activities, international banking transactions, and global wealth distribution. Today's exchange rate stability is a principal foundation for every economic activity, and volatility in exchange rates affects commodity demand, production costs, and enterprise income. It also leads to changes in the supply and demand in the labor market and investment.

In Iran, particularly in the past four decades, the Iranian Rial (IRR) has suffered extraordinary devaluations against foreign currency, mainly US Dollar. This dramatic loss of value has not taken place through a stable trend. Instead, various unpredicted shocks during different periods have negatively impacted the local currency. On this basis, the rise of the exchange rate has always grabbed particular attention in macroeconomic policy debates.

The exchange rate fluctuation makes planning for business firms, mainly exporting companies, difficult. It also causes the production costs to rise and consequently reduces manufacturers' competitiveness in marketing and selling the products. In the commodity market approach, movements in the exchange rates impact the enterprise's marketing, sales, and profit level, ultimately affecting its stock price. The real exchange rate is one element of enterprises' economic price competition.

Fluctuations influence the performance of multinational companies in exchange rates. Such fluctuations exacerbate the relationship between commercial entities and financing establishments. Commercial enterprises and financing firms considerably gain from exchange rate stability in analyzing the performance of purchases and funding, which reduces their risks. Interest rates, wages, unemployment, the quality of output, sells, profits, and other macroeconomic variables could be influenced by movements in the exchange rate. Ultimately, this may

result in macroeconomic disequilibrium. As uncertainty about the exchange rate fluctuation is considered a risk for any firm, it can affect its cash flow, lead to a financial crisis for companies, and affect sustainability.

Corporate sustainability has become a fashionable keyword in companies, large and small. Corporate sustainability is a growing concern among investors seeking economic profit and social benefits (Beattie, 2019). Sustainability is the key to company strategies (Liu et al., 2018), and financial stability benefits each country's economy, including economic growth and macroeconomic stability. In contrast, a lack of financial stability will increase the debt-to-GDP ratio and cause a crisis for central governments, as happened in East Asia and Argentina (Falahati et al., 2017).

The reaction of various economic parts to exchange rate shocks are different. Thus, the main goal of this investigation is to provide a model to examine the effect of exchange rate shock as one of the sources of uncertainty on the sustainability of export-oriented companies in various industries. The structure of the present article is as follows.

In continuation, the theoretical foundations and internal and external studies conducted on exchange rate fluctuations and the stability of companies are discussed. The next part includes the research method and the model used. In the fourth part, the model estimation results are reviewed and analyzed. The final section includes summaries, conclusions, and suggestions.

2. Theoretical foundations and research background

2.1. Theoretical foundations

2.1.1. Exchange rate shocks

The exchange rate is the equivalent value of a foreign currency against another currency unit. In other words, the rate at which one currency (local) is paid to acquire another (foreign) currency. It is also known as a conversion factor and has two branches: nominal and actual rates. Inflation affects the real exchange rate, while it does not affect the nominal. The nominal exchange rate can be described in terms of multilateral and bilateral.

Furthermore, if we see any movement in the real exchange rate, we refer to it as the presence of fluctuation. Moreover, when we categorize the exchange rate function into different patterns, it is called an exchange rate regime. When an exchange rate remains

changed for a while, it is called a fixed exchange rate. This is where there is a fluctuation in the exchange rate. It is referred to as a system of floating exchange rates. The rate, which falls between the floating and fixed exchange rates, is known as the *managed* floating exchange rate.

According to the literature, exchange rate fluctuations must deal with the unusual movements of the exchange rate. Since decades ago, the effects of exchange rate fluctuations have been much noticed. The significance of the exchange rate is quite evident in all economic sectors and influences people's welfare and social life when it comes to international trade. Any increase or decrease in the exchange rate affects economic growth and changes income and expenditure levels for both exporting and importing countries.

Variations in other macroeconomic factors also cause movements in the exchange rate. For instance, changes in the supply and demand of a currency, in the long run, pertain to changes in the value of imported and exported goods. In countries with strong currencies, any adjustment in the exchange rate will have the most remarkable effects on the value of other currencies because those involved in international trade usually are looking for safe investments with as many favorable returns as possible. Similarly, if imports exceed exports, there will be a change in the trade balance, and the tendency for foreign exchange will increase, so the exchange rate for such countries will decrease. If GDP increases, real domestic currency depreciation declines. Thus, GDP affects exchange rate fluctuations and performs other variables as well. In addition, various macroeconomic parameters are severely affected by movements in exchange rates.

In this connection, the majority of commercial entities that function in an economy are directly or indirectly impacted by changes in the foreign currency market. Those industries active in international trade are the first directly impacted by the exchange rate fluctuations.

When there are frequent fluctuations in the exchange rate, such a rate will be unreliable because it can disrupt the economy's activity. From the literature on international trade, the value of a country's currency plays a vital role in determining export and import prices, if changed positively, resulting in economic prosperity. Thus, exchange rate volatility has a vital role in the flow of commercial trade. In other words, the definition of exchange rate volatility is the exchange rate's tendency

to change. The exchange rate volatility can lead to a high-cost economy because business actors tend to cover risks by putting up high prices on their products and services. Hence, the competitiveness of domestic products becomes low due to high price pressures. McKinnon and Ohno believe that the excessive exchange rate volatility and recurrence of misalignment may suppress trade flows, change the direction of investment policy, and the inaccuracy of site selection for multinational corporations. Moreover, the degree of exchange rate variation could reduce the volume of international trade because it makes the profitability of international transactions uncertain (Subanti et al., 2019).

The consequences of uncertainty in the exchange rate on international trade during the past four decades have been investigated in detail as both real and nominal exchange rates have experienced periods of severe fluctuations since the failure and collapse of the Bretton Woods system. However, regarding the direction and degree of impact on the volume of international trade, there is no one unique view on the precise effect of exchange rate uncertainty.

On the one hand, an upward movement in the exchange rate has a negative impact on international business because it leads to an increase in the cost associated with the rise in exchange rate risk. This is while some studies show that the effect of exchange rate volatility on international business is either vague or positive because such an effect depends on factors like hedging and options opportunities, the degree of risk aversion, and the currency denomination of the contract.

Changes in the country's currency value or rate of exchange bring about changes in local production costs and impact the labor market according to the appreciation or depreciation of currencies. The drop in exchange rate leads to the growth of local jobs in production or nonproduction sectors. At the same time, the investment volume may drop as higher volatility increases the uncertainty.

2.1.2. Sustainability

Corporate sustainability in large and small companies has become a keyword. Corporate sustainability is a growing concern among investors seeking economic and social benefits. Sustainability is often defined as meeting current needs without compromising the ability of future generations to meet those needs. There are three main pillars of sustainability, namely economic, environmental, and social, and these three dimensions

are informally referred to as people, land, and interests. Most businesses feel in a natural position in the economic dimension of sustainability. A business must be profitable to be sustainable. In other words, profit cannot surpass the other two pillars (Beattie, 2019).

Sustainability is a critical issue for big companies today (Jafari. Jam, 2016). A comprehensive and scientific indicator system is essential for sustainability assessment because it can provide helpful information for better decision-making and monitoring feedback mechanisms for dimensions of sustainability.

In order to be sustainable, a company must have an unreduced level of total net assets in its financial statement, appraised at the social cost. It must also be examined when its assets are valuated based on prevailing private costs. To make a pragmatic valuation of a firm or country's sustainability, one needs to pay attention to its economic and environmental performance. This definition relates sustainability to the fundamental preoccupation of commercial managers, investment productivity, and profit.

Due to the growing importance of financial stability and sustainability, especially after the recent financial crisis, there is no single definition for them. According to Alaoud and Al-Sadiq (2008), there are two main tendencies in defining financial stability and sustainability: The tendency that seeks to define financial instability and the tendency that seeks to define financial stability. A financial system is stable when it can facilitate the economy's performance and eliminate endogenous or unforeseen financial imbalances. In the opposite direction, according to Mishkin (2010), financial instability occurs when shocks to the financial system by interfering with the flow of information cause the financial system to be unable to perform its main task: the optimal allocation of funds. He believes that strengthening the stability of the financial system has prevented financial crises and should be one of the fiscal policy goals. This is because financial crises hinder the ability of financial markets to optimally direct the flow of funds to productive investments and lead to a sharp decline in economic activity. Further, he believes that a healthy and efficient banking system for countries is a significant prerequisite and the main factor of sustainable economic growth because it creates added value in various economic sectors, facilitates international relations, and attracts foreign investors (Asadi, Yavari, and Heydari, 2020).

2.1.3. The relationship between exchange rate shocks and a firm's sustainability

Exchange rate fluctuations indicate instability and uncertainty in the relative price trend, which increases risk and uncertainty in return on investment; hence, economic agents can predict their economic policies and fluctuations in their exchange rates. The exchange rate reduces production and, thus, increases the industry's value. As a result, sudden changes and fluctuations in the exchange rate can have a negative effect on economic growth by reducing investment, trade volume, and profitability (Namazi and Kasgari, 2007). In a given firm active in foreign trade and having foreign transactions, exchange rate fluctuations will increase or decrease in cost or revenues, thereby affecting the company's profitability. Exchange rate fluctuations will have a significant impact on the investment decisions of firms. Exchange rate fluctuations also affect the outlook for future cash flow due to the direct impact on the cost-effectiveness of firms (Torabi, 2014).

If the exchange rate fluctuates sharply, the value of exported goods and the cost of imported goods will fluctuate due to the time lag between the contract and the receipt of export earnings. Such fluctuations cause changes in the price of goods, and the resulting inflation will generally harm the economy. The outcome is an atmosphere of uncertainty, gambling, and speculation in the foreign exchange market and the general economy. Of course, the scope of this exchange rate game is not limited to the forex market but will also extend to the commodity market because exchange rate fluctuations will initially cause price fluctuations in goods of foreign origin and then even spread to local goods (Majbobi, 2010).

The relation between an entity's exchange rate and value is determined through its assets, function, and liabilities. Naturally, sudden exchange fluctuations may impact asset value, operations, and liabilities variations. In companies involved in product exports, local currency appreciations reduce their income to the national currency. This drop in income is due to the decrease in revenue per unit of product exported and reduced competitiveness and export of product quantity. On the contrary, weakening the local currency will increase the income of exporting firms due to increased competitiveness, export volume, and income of each manufactured item in the local currency. Therefore, an increase in the exchange rate benefits exporting companies and improves their stock returns.

In contrast to exporting companies, a rise in the exchange rate (depreciation of the local currency) increases the cost of the product, making imports more expensive and reducing the companies' profitability. Of course, in multilateral monopolies, the company can transfer the cost increase to a large amount to the ultimate end user and make itself significantly immune to variation in the exchange rate. When it comes to local companies, which have external competition, the rise in the exchange rate lowers the competitiveness of foreign companies in the host country, thereby making the shares of local companies profitable and valuable. When it comes to local companies with foreign exchange assets with investments abroad, an increase in the exchange rate makes foreign exchange assets and their investments more valuable, so the company stock prices increase. On the contrary, in companies with foreign currency debts, an increase in the exchange rate makes their debts heavier, thereby reducing the company's stock value.

One of the components of financial sustainability used in the present study is profitability. Companies with significant profits face less risk and are more interested in investors. Research has shown that low and stable earnings fluctuations indicate its quality. Thus, investors invest more confidently in the stocks of companies whose profit trends are more stable.

2.2. Research background

Concerning the importance of the subject under discussion, ample research has been conducted in this field, and some are mentioned below.

By examining the impact of exchange rate shock on the stock prices of selected firms, Koosha (2016) showed that exchange rate shock had a positive and considerable effect on the stock prices of the firms listed on the Tehran stock exchange. Also, the ratio of the book value to the market value negatively affected companies' stock prices. Moreover, the three variables of the liquidity ratio, dividend per share, and inflation positively and significantly affected companies' stock prices.

In 2017, the relationship between exchange rate movements and the profitability of exporting firms listed on the Tehran Stock Exchange was studied by Raei, Hassanzadeh, and Bayazidi. Furthermore, from 2004 to 2011, 56 export companies, which were divided into three industrial categories of chemical products (28 companies), primary metal products (20 companies), and metal ores (8 companies), were closely monitored. The combined/integrated regression models were used to test the hypotheses. The findings showed that in the

industries that were studied, the impact of fluctuations in the exchange rate on different performance criteria of the firms had not been felt.

In 2017, two economic researchers (Rashid and Waqar) studied how the movements in the exchange rate and its volatility impacted the export behavior of manufacturing firms. Their research also revealed that the exchange rate variation and its volatility impacted companies of various sizes differently. Using the two-step system generalized method of moment estimator on their data for a sample of 221 Pakistani production firms, they found that the real exchange rate depreciation had positive impacts. In contrast, the exchange rate volatility influenced the company's exports negatively. They also learned that small and medium-sized exporting companies (SMEs) most probably benefited from currency devaluation compared to large firms.

Regarding the effect of exchange rate volatility, the two researchers found that the adverse impact of exchange rate volatility was weaker for large-sized entities than for SME firms. New findings confirmed the nonlinearity in export-deterring (favoring) effects of exchange rate volatility (depreciation) on exporting behavior depending on firm size. The outcome was based on estimation, indicating that even though the exchange rate fluctuated in the companies' foreign sell operation, the effect size was considerably different from one company to another. In other words, those medium-sized companies that were not listed in the stock market and those that were not so dependent on exports experienced the severe adverse effect of exchange rate movement, while other companies, by far, stayed safe and immune to the depressing impact of exchange rate fluctuations. Moreover, the extent to which the fluctuations in the exchange rate affect a firm's exports depends on the age of the business entity and the sector in which it is active.

The exchange rate, its asymmetric shocks, and distributions were investigated by Demian and Mauro back in 2018. The ability of exports to change and adapt to the movements of the exchange rate has been a hot topic among financial experts, but without reaching a shared understanding and agreement. Using a novel sector-level dataset based on firm-level information, Demian and Mauro showed that exchange rate elasticities increased two-fold when the country and sector-specific firm productivity distribution was considered in empirical estimates. Further, exports became sensitive toward serial exchange rate increases but were unaffected by rate drops. Ultimately, significant variations in the rate of exchange appeared necessary.

In 2020, the effects of exchange rate fluctuations on the financial performance of quoted conglomerates in Nigeria in 12 years from 2007 to 2018 were examined by P. Uche, Iliemena, and Happiness. This study used a multiple-regression analytical estimation technique with the help of SPSSv21. The findings indicated that exchange rate movements had a considerable negative effect on ROCE and ROE while a positive but mild effect on ROA. The conclusion drawn from this study was that foreign exchange fluctuations significantly negatively affected quoted conglomerates' financial performance.

In 2020, the impacts of exchange rate volatility on Indonesia's primary export commodities to the top five export markets, such as China, India, Japan, South Korea, and the United States, were studied by Sugiharti, Esquivias, and Setyorani. The GARCH model, with monthly data from 2006 to 2018, was used to estimate the value of exchange rate volatility. Total exports were compared using a linear (ARDL) and a nonlinear autoregressive distributed lag model (NARDL). The impacts resulting from exchange rate movements were both negative and positive (expected) in exports at commodity and trade partner case-to-case levels. Both aggregate ARDL and NARDL models suggested that Indonesian exports were negatively affected by exchange rate fluctuations.

The asymmetric and nonlinear effects of the real exchange rate shock on the stock indices of various export-oriented companies like petrochemical, primary metal, and mining industries in the Tehran Stock Exchange from 2012 to 2020 were studied by Saadati, Honarmandi, and Zarei. The conclusion drawn from the NARDL approach illustrated that exchange rate shocks had significant effects on different stock indices, but these relationships were asymmetric and nonlinear.

3. Methodology

The present study is descriptive/correlational, and because it provides a model to study the effect of exchange rate shock on the stability of companies, its results are used by investors and owners. Therefore, it is practical. In this research, the presented model investigates the effect of currency shocks on the stability of export-oriented companies using panel VAR and annual data in the last 12 years from 2008 to 2019. The statistical population of this research is all export-oriented companies of the industry plan with more than 10 employees from 2008 to 2019. The present sample is

19 groups of companies along with the ISIC classification following the activities of companies during the last 12 years, the Statistics Center of Iran has collected, and data analysis is conducted based on the model in the form of STATA software.

4. Materials and methods

Vector autoregressive (VAR) models in macroeconomic literature are an alternative to the model of simultaneous multivariate equations. All the variables in a VAR system are usually examined endogenously although the effect of exogenous shocks on the system may impose the identification of constraints based on theoretical models or statistical methods. In the equations in which estimating the specific invisible effects of each production group and the existence of a dependent variable interval in the explanatory variables are significant problems, the generalized method of moments (GMM), based on dynamic panel models, is used. The vector autoregression model with panel data, assuming the variables are endogenous, allows the researcher to investigate the effect of shock on each variable. In addition, the panel data has more information, more variability, less collinearity, a higher degree of freedom, and higher efficiency than time series and cross-sectional data. The primary purpose of this study is to investigate the effect of the exchange rate, taxes, oil revenues, and exports on the stability of production groups using the panel data technique in the form of the PVAR model for 19 companies from 2008 to 2019. Due to the significant advantages of the panel data method and the limitations of using time series models in short periods, such as statistical limitations and uncertainty about the exogenousness of a variable, it is possible to alleviate this concern using the autoregressive method in panel data format. As usual, after examining the descriptive statistics of the variables, the durability of the variables must be ensured in the first step. Then, in the next step, the studied model is estimated by the GMM and uses the impulse response reaction to interpret the results. All variables are considered in a logarithmic form in the model. Using the logarithmic form causes the estimated coefficients to be independent of the units of measurement of the variables because of the relative changes (Gujarati, 2011). The logarithmic form of the vector autoregression model for each index corresponds to the following relation.

$$\text{lfs}_{it} = \alpha_1 + \beta_1 \text{lex}_{it} + \beta_2 \text{lxerc}_{it} + \beta_3 \text{loilr}_{it} + \beta_4 \text{ltaxr}_{it} + \varepsilon_{it} \text{lex}_{it}$$
$$= \alpha_2 + \beta_6 \text{lfs}_{it} + \beta_7 \text{lxerc}_{it} + \beta_8 \text{loilr}_{it} + \beta_9 \text{ltaxr}_{it} + \varepsilon_{it}$$

$$\text{lxerc}_{it} = \alpha_3 + \beta_{11} \text{lex}_{it} + \beta_{12} \text{lfs}_{it} + \beta_{13} \text{loilr}_{it} + \beta_{14} \text{ltaxr}_{it} + \varepsilon_{it}$$

$$\text{loilr}_{it} = \alpha_4 + \beta_{16} \text{lex}_{it} + \beta_{17} \text{lxerc}_{it} + \beta_{18} \text{lfs}_{it} + \beta_{19} \text{ltaxr}_{it} + \varepsilon_{it}$$

$$\text{ltaxr}_{it} = \alpha_5 + \beta_{21} \text{lex}_{it} + \beta_{22} \text{lxerc}_{it} + \beta_{23} \text{loilr}_{it} + \beta_{24} \text{lfs}_{it} + \varepsilon_{it}$$

where *i* represents the production group, lfs_{it} is the sustainability of the production group, lex_{it} indicates the export of the production group, lxerc_{it} represents the real exchange rate, $loilr_{it}$ is oil revenue, and $ltaxr_{it}$ is the tax paid by the production group.

4.1. Variables

Financial Sustainability: The financial sustainability variable derived from the economic dimension of corporate sustainability has been introduced in a study conducted by Jiang et al. (2018). A composite index consisting of several components was estimated by the PCA method and calculated as follows to estimate financial sustainability:

$$fs = \sum W_{ji} X_t = W_{j1} X_1 + W_{j2} X_2 + \cdots + W_{jP} X_P$$

where *W* represents the coefficients of factor scores, and *p* represents the number of variables.

The components of financial sustainability used in this research are as follows:

- Corporate profitability: The profitability of the production group is measured by the ratio of profits to cost and the rate of return on common stockholders' equity.
- The debt-to-asset ratio measures the debt-paying ability.
- The cash-obtaining ability is measured by net working capital.

Export is the export variable of a production group whose definition includes the supply of goods and services by persons (natural and legal) residing to non-resident persons (natural and legal) and is given in dollars in the model.

Real exchange rate: In fact, an exchange rate has been adjusted. In other words, in order to be able to calculate the purchasing power of the desired currency correctly, in addition to the exchange rate in the open market, the domestic price index and the price index of the country's major trading partner must be considered. In other words, in the real exchange rate, the relative prices of the two countries are taken into account.

Oil revenue is from crude oil exports, inspections, and natural gas. Oil revenues enter the country's economy in dollars, but since the official exchanges are done in rials, the central bank, as the government bank, receives the oil dollars from the government and pays the equivalent in rials to the government.

Taxes paid by the production group include mandatory and performance taxes paid by the production group to the government each year.

In the next section, before estimating the research model, the statistical characteristics of the variables and then the stationary test are examined. The optimal lag is determined according to the first step of the estimation process. Then, the basic pattern of the research is estimated, and the results related to its stability are reported. Then, using the impulse response function, the reaction of variables in the case of impulse is analyzed. Finally, the variance decomposition of the research variables is analyzed.

4.2. Descriptive statistics of model variables

Table 1 presents descriptive statistics on the exchange rate, taxes, oil revenues, exports, and sustainability variables. As can be seen, exports have the highest and sustainability has the lowest average. Further, the smallest data is related to sustainability, and the most significant is related to exports. The standard deviation calculated in the table shows that the export fluctuations are greater than the other variables.

Table1: Descriptive statistics for the vector autoregression model variables

Variables	Mean	Max	Min	Sd	Skewness	Kurtosis	*N*
Lxerc	9.191687	10.9669	8.013447	0.7054435	0.2675472	2.500084	228
Taxr	0.0117596	0.2490281	0.2490281	0.0278701	6.482668	48.06867	228
Loil	1.559415	6.883227	–3.012734	2.161231	0.1433026	2.381677	228
Lex	13.32595	19.58383	5.924256	2.993473	0.1263487	2.348416	228
Lfs	–1.955411	–0.5782746	–3.63325	0.5984951	0.0272253	2.736289	228

4.3. Variables stationary assessment

Static tests are used to prevent false regression estimation. In the panel data, there are different tests to assess the statics of the variables. In this study, the Im-Pesaran-Shin unit root test was used. Hypothesis 0 of Im, Pesaran, and Shin test indicates the variable's nonstationary. Therefore, if the calculated statistic value is greater than the critical value at the current confidence level, the null hypothesis based on nonstationary will be rejected. The results in Table 2 and the study of the values of the calculation statistics show that the null hypothesis of nonstationary variables is rejected. In other words, all model variables are stationary.

4.4. Selection of the optimal lag

Information criteria of Akaike (AIC), Schwarz, and Hannan Quinn were used to estimate the optimal lag selection of the model. The results of estimating the mentioned statistics for the first to third time are given in Table 3. Considering that the optimal model is the model

that has the lowest value of MQIC and MAIC MBIC (Andrews and Lu, 2001), based on the criteria for selecting the optimal lag of the model, the second order was selected as the optimal order of the model.

Table 2: Im-Pesaran-Shin unit root test (with width from the process origin)

Variables	Z statistic	P value
lfs	–19.9198	0.0000
lex	–15.784	0.0000
loilr	–12.352	0.0000
lxerc	–13.3673	0.0000
ltax	–13.5948	0.0000

Table 3: Selection of the optimal lag based on the criteria

lag	CD	J	Jp value	MBIC	MAIC	MQIC
1	0.979474	70.42884	0.0299682	–180.7652	–29.57116	–90.99142
2	0.989097	31.48487	0.1734625	–94.11215	–18.51513	–49.22527
3	0. 990773	0	0	0	0	0

4.5. Model estimation

The next step is to implement the model based on the lag, and, as observed, the second time lag is selected. The panel autoregression model is estimated using the GMM method. Table 4 summarizes the model estimation results, which show the model coefficients. As can be seen, in situations where the variable of financial sustainability is a dependent variable, it has a negative and significant relationship with one lag with itself and a

negative and significant relationship with the variables of oil revenues, exports, and taxes with two lags. The basis of the vector autoregression model, whether time series mode or panel data, is predictive, and due to the presence of lag variables that are difficult to interpret, the coefficients estimated in PVAR are not directly economically interpreted. Accordingly, impulse response function and variance decomposition are used to interpret the outputs of this statistical and econometric method.

Table 4: The estimation of coefficients of the panel vector autoregression model

loilr	lxerc	lex	Ltaxr	lfs	
0.7284093	0.0558192	−1.861911	0.1531863	−0.3689098	Lfs(−1)
1.60	1.76	−2.96	0.80	−3.02	
0.2183423	−0.0421502	−0.370803	0.1342623	−0.0808731	ltaxr(−1)
0.90	−1.92	−0.97	1.38	−1.04	
0.0621302	−0.0354076	0.1892328	0.0209838	0.0301947	lex(−1)
0.41	−2.80	0.81	0.33	0.67	
1.059415	0.6849168	−1.304373	−0.6050617	−0.3174718	lxerc(−1)
1.07	4.99	−1.04	−1.22	−1.38	
0.3408966	−0.0666837	−0.0736175	−0.0062637	−0.0131314	loilr(−1)
1.21	−2.71	−0.18	−0.05	−0.15	
−0.7861982	0.0822297	1.034557	0.1077462	−0.1173041	Lfs(−2)
−2.08	2.63	1.88	0.47	−1.18	
0.7282405	−0.0597408	−1.340029	0.2285535	−.2724119	ltaxr(−2)
3.62	−3.23	−4.57	2.05	−4.52	
0.244327	−0.0390331	−0.3356459	0.091775	−0.084837	lex(−2)
2.11	−3.19	−1.67	1.36	−2.29	
−0.68629	0.1269156	−0.3815505	0.6316219	0.111508	lxerc(−2)
−0.83	1.06	−0.37	1.50	0.55	
0.8045127	−0.0588165	−1.368634	0.1006361	−0.1288288	loilr(−2)
4.54	−2.89	−4.69	0.84	−2.19	

Note: The first line for each variable represents the estimated coefficients, and the second line represents the Z statistic.

4.6. Panel var model stability test

The model stability test or model stability indicates that the model is reversible and contains an infinite moving average vector that can be used to impulse response function and variance decomposition. The results of model stability are shown in Figure 1. Considering that the specific values of this model are less than one, and the root of the companion matrix is located inside the unit circle, the condition of stability is established in the PVAR model.
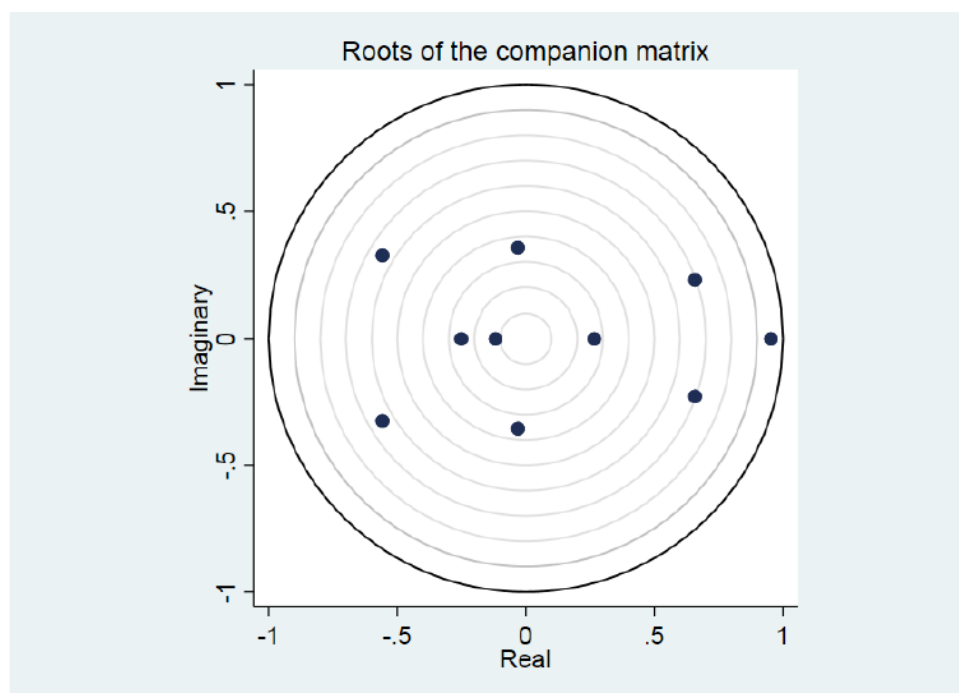
Figure 1: The stability test of the model

4.7 Analysis of impulse response function

The last step is to analyze the model by generating a shock. Figure 2 shows an overview of the effects of the momentum of specific variables on sustainability. In other words, the impulse response function investigates the long-term effects of exchange rate shocks. Since the shock size depending on the standard deviation is variable, the shock size due to currency disturbances is the same in all models. The results of the model are shown in the figure below, considering that the eigenvalues of this model are less than one and the root of the companion matrix is located inside the unit circle. Therefore, the condition of stability (sustainability) in the PVAR model holds. The estimated coefficients in vector autoregression models often do not have a specific economic interpretation. However, by-products (such as impulse response function and forecast error variance decomposition) obtained after estimating the vector autoregression model can contain essential interpretations. The impulse response function examines the behavior of variables over time due to a standard deviation of change in the equation disorder to check the effect of a particular shock on the variable. It is shown that if a sudden change (shock) occurs in a variable, what will be the effect on it and other variables during different periods? Figure 2 shows the impulse response

of variable *lfs* versus the shocks received as a standard deviation from the pattern variables.

According to the IRF chart, if the response of the variables to the shock caused by their disorders is downward and tends to zero in the long run, the model is stable. Otherwise, the model is divergent and is removed from future analyzes. The bold lines in the middle represent the instantaneous reactions of variable *lfs*. The upper and lower margins of the positive and negative margins for the standard deviation of the instantaneous reactions are at the 95% confidence level, which is calculated using the Monte Carlo simulator with 1000 repetitions.

As can be seen, oil revenue shock has a negative effect on sustainability and almost reaches balance after seven periods. The reason for this is also due to the Dutch disease. This is while the effect of exports on sustainability has been positive and is neutralized after three periods. Regarding taxes, it is observed that initially, it has a negative effect on sustainability and then a positive effect on sustainability and is neutralized after four periods. Although this effect is minor, in a way, in the form of an exogenous growth pattern, it can be concluded that tax ultimately has a positive effect on the sustainability of companies.
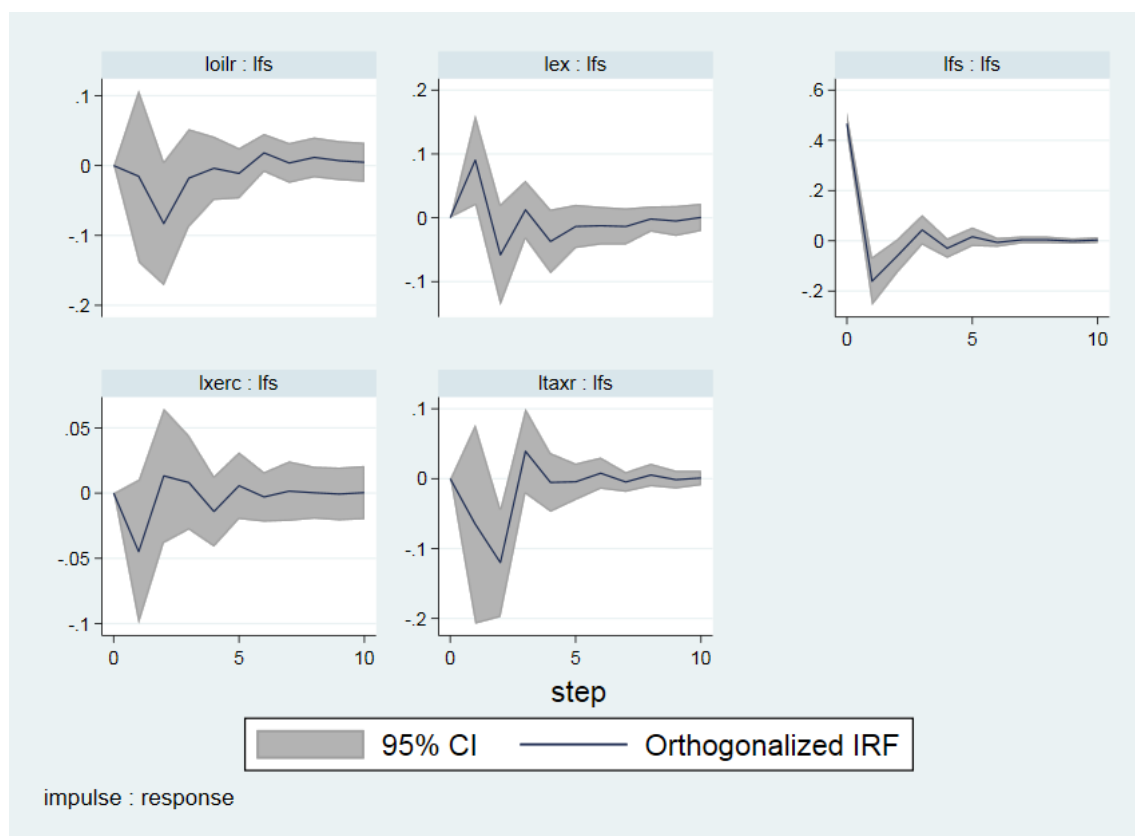
Figure 2: The response of the sustainability variable to the shocks received by the explanatory variables

An impulse has an adverse effect on sustainability initially, as much as a standard deviation in the exchange rate, but it has a positive effect over time; after five periods, this effect is neutralized. Thus, the exchange rate volatility affects the sustainability of companies. The reflection of these changes is obtained in the balance sheet, profits or losses of companies, and changes in the output and sales of the company. On the other hand, exchange rate volatility affects the cost of imported raw materials and equipment and changes the cost of production and, consequently, the company's profit margin. With the rise in the exchange rate, the value of the company's products increases, especially export goods. Investors react to this increase, and the stock index increases. This reaction occurs according to the rational expectations theory before the company's assets increase. The reaction of *lfs* from their shocks is positive, which tends to zero after six periods. Therefore, a positive shock in *lfs* increases it. According to the chart

above, the effect of this shock is somewhat short-lived, so after about a period, the positive effect of the shock is eliminated. In companies with high profitability, investment growth positively and significantly affects the relationship between profit and current value per share (Izadinia and Azimi Dastgerdi, 2014). In other words, a positive shock occurs in the incoming *lfs*. This is a sign for other investors to invest or increase their investment, leading to greater profitability.

4.8. Results of variance decomposition

While the impulse response function represents an endogenous variable's reaction over time to the impulse caused by another variable in the system, variance decomposition measures the share of each impulse in the variance of the endogenous variable of the system. The results of variance are presented in Table 5.

Table 5: The results of the forecast error variance decomposition of sustainability

loilr	lxerc	lex	Ltaxr	Lfs	Period
0	0	0	0	1	1
0.0003683	0.0071385	0.0300948	0.0181049	0.9442935	2
0.0232333	0.0070401	0.039063	0.0655985	0.8650652	3
0.0238884	0.0071567	0.0390182	0.0703318	0.859605	4
0.0237141	0.0077788	0.0432108	0.0698584	0.8554381	5
0.0240692	0.0078687	0.0437079	0.0697924	0.8545618	6
0.0251673	0.0078814	0.0440956	0.0698669	0.8529887	7
0.0251924	0.0078812	0.0446335	0.0698885	0.8524045	8
0.0256259	0.0078767	0.0446154	0.0699356	0.8519464	9
0.0257793	0.0078768	0.0446782	0.0699254	0.8517403	10

Table 5 shows the variance decomposition of *lfs* (sustainability). According to this table, the relative share of the fluctuations of sustainability in its changes in period one is 100%, and other factors are ineffective. The percentage of sustainability changes in future periods gradually decreases to 85% in the 10th period. With this amount, the largest share of sustainability changes in the 10th period is also explained by itself. In the second period, exports have the largest share in explaining sustainability changes. The share of this variable increases slightly in future periods and reaches 4% in the 10th period. Oil revenue has the least power to explain changes in sustainability in the second period. Over time, this share increased to 25% in the 10th period. Further, in the second period, taxes have the most significant power to explain sustainability after exports. In the following periods, this amount exceeds the share of exports and reaches 69% in the 10th period.

5. Conclusions and suggestions

The primary purpose of this study was to design a model for examining exchange rate shock affecting the financial sustainability of export-oriented companies. In this study, the impacts of exchange rates, taxes, oil revenues, and exports on the financial sustainability of 19 groups of export-oriented companies were studied according to ISIC classification and were estimated through the PVAR model using the GMM from 2008 to 2019.

In line with the above objective, the static test of variables was done at first. Then, the information criteria of Akaike (AIC), Schwarz, and Hannan Quinn (HQIC) were used to estimate the optimal lag of the model. The results showed that the optimal interruption of the model was two.

In the next step, the GMM panel var model was estimated, which showed that most of the model coefficients were significant. The results of model stability indicated that the specific values of this model were located inside the unit circle, so the model was stable.

Finally, the results were interpreted using the impulse response function and variance decomposition. The results obtained from the impulse response function also showed that the impulse effect, in the size of a standard deviation, in the exchange rate, taxes, and oil revenues on the variable of financial sustainability was initially negative, moved in a positive direction over time, and was neutralized after several periods. Nevertheless, in the size of a standard deviation, the export impulse effect on the financial sustainability variable was initially positive, moved in a negative direction over time, and neutralized after a few periods. What was quite apparent was that the response of all variables to an impulse, the size of a standard deviation, moved to zero over time, which showed that the model was convergent.

Furthermore, according to the results of variance decomposition, it could be stated that the exchange rate

impact on financial sustainability was much more than the effect of sustainability on the exchange rate. This was because exchange rate shocks had more explanatory power for financial sustainability shocks. The results indicated that the impact of exchange rate shocks on the components of financial sustainability was significant. Therefore, the primary hypothesis of the research, the overall effect of exchange rate shocks on the financial sustainability of export-oriented companies, was confirmed.

In a comparison of the results of the present study with others, our findings were in line with the results of studies conducted by Ruth (2021), Budiono (2017), Jalaee, Mir, and Rahimipoor (2016), and Botha and Jaco (2017); however, they were not in the same direction as those of Raee, Hasanzade, and Bayazidi (2017), and P.Uche, Iliemena, and Happiness (2020).

To summarize, because managing and neutralizing the impacts of exchange rate fluctuations, oil revenues, and taxes on the financial sustainability of export-oriented companies were beyond the control of the firm's managers, it was recommended that managers should focus on managing the effects of export fluctuations on their company's financial sustainability and on adopting appropriate strategies to stabilize the company's sales and exports in the face of economic turmoil, caused by fluctuations in the variables. Moreover, to be safe from fluctuations caused by currency shocks, investors should invest in different industry groups to reduce the risk of abnormal fluctuations.

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