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Research Paper

Analysis of the Asymmetric Effect of Exchange and Bank Facility Rates on Labor Productivity in Iran: NARDL Approach

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ABSTRACT

One of the most critical indicators of one-factor productivity is the labor productivity index. This index has various and broad applications in the dimensions of economic policy. On the one hand, the labor productivity index determines per capita income levels and living standards. On the other hand, efficiency combined with other factors such as capital stock can make technical changes. The issue of how monetary and exchange rate variables affect labor productivity has been of particular importance in recent international studies. Due to the importance of the issue, this study investigates the asymmetric effect of exchange rate and bank facility rates on labor productivity in Iran in 1971-2018. The results of model estimation by self-explanatory method with nonlinear autoregressive distributed lag (NARDL) indicate that in the short and long run, the effect of free-market exchange rates and bank lending rates on labor productivity is asymmetric so that reductions in exchange rates have a significant direct effect on labor productivity and increases are not significant. In addition, increases in bank lending rates have a direct effect and reductions have an adverse effect on labor productivity.

1 Introduction

Productivity indicates the relationship between outputs and inputs in the production process. Improving productivity can affect the main economic, social, and political phenomena in society. In fact, productivity can affect many economic variables at the micro and macro levels, such as value-added, production, employment, and inflation. In addition, improving productivity can affect the competitiveness of a country's economy at the international level. Almost all developed and prosperous developing countries have made many investments to enhance productivity at the national and regional levels and owe their increasing growth and development to the proper attention and attitude to this issue. In Iran, during the 2000s, improving the productivity of production factors was gradually put on the agenda in the medium and long-term planning system. The issue of productivity was first considered in the country's second five-year economic, social, political and cultural program in the years after the imposed war and the form of Note 35. In the third economic development plan of Iran, there is no specific goal for productivity. In the fourth

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program of economic development of the country, special attention was paid to the issue of productivity, and certain quantitative goals were considered for its promotion. In this regard, targeting the growth of different products, especially labor productivity, continued in the fifth and sixth five-year development plans.

Therefore, the issue of productivity in general, and labor productivity in particular, has always been the concern of the country's economic policymakers for helping the sustainable growth of Iran's economy. So far, many studies have been conducted on the effects of monetary and exchange rate variables on labor market indicators, such as employment in the country. For example, Emami and Maleki [11] measured actual exchange rate fluctuations in 1964-2008 using the generalized autoregressive conditional heteroskedasticity (GARCH) model. Then, using the ordinary least squares method, they evaluated the effect of actual exchange rate fluctuations on Iran's employment. In addition, many studies have been conducted on the factors affecting productivity in terms of labor productivity, capital, and total factors in the Iran's economy. However, not many studies have been conducted to evaluate the effects of positive and negative shocks of monetary and exchange rate variables on labor productivity. Therefore, in the present study, the asymmetric effects of the free exchange rate and the bank facility rate have been evaluated in the form of a self-explanatory pattern with nonlinear distribution intervals (NARDL).

The structure of the present study consists of five sections. The second part reviews conducted studies and empirical writings on the asymmetric effects of monetary and exchange policies on the labor market. The third section deals with theoretical foundations. In the fourth section, the research methodology, including model, data, econometric methodology, experimental results of the study, and statistical analysis, are reviewed. In the final section, the summary and conclusion are presented.

2 Research Background

2.1 Internal Studies

In a study, Kazeruni and Rostami [23], investigated the asymmetric effects of exchange rate fluctuations on actual production in Iran in 1951-2002. The results show that the effects of positive and negative shocks and predicted and unpredictable exchange rates are asymmetric, and negative exchange rate shocks have a greater impact on actual product than positive shocks. Tavakoli and Sayah [36], examined the effect of exchange rate on the country's economic activities using annual data in 1950-2007. With the help of econometric method, the system of quasi-related equations is estimated. The results of positive and negative shocks and the application of fiscal and monetary policies show that the impact of the increase in the exchange rate on the level of household expenditures and the level of exports is significant. With the rise in the exchange rate (devaluation of the country's currency), non-oil exports react negatively, and household expenditures positively. The country's imports do not show a significant impact on exchange rate fluctuations. The effect of government expenses on imports is positive and has a more significant impact than implementing monetary expansion policy. Also, exchange rate fluctuations have an insignificant effect on the country's actual production and private investment.

In a study, Komijani and Ebrahimi [22], investigated the effect of exchange rate fluctuations on labor productivity growth in developing countries in 1980-2010 using the GMM dynamic panel method. The results show that the effect of exchange rate fluctuations on labor productivity growth at the level of low financial development is negative. From a level of financial development upwards, the effect of exchange rate fluctuations on labor productivity growth is positive. In a study, Jalaei et al. [19], examined the effect of exchange rate shocks on investment and employment in Iran in 2007, using computable general equilibrium models. The results show that the increase in the exchange rate in the agricultural, industrial

and mining sectors, along with the decrease in production, also reduces employment, and in the service, oil, and gas sectors, decreases it, and in the agricultural, industrial, and mining sectors, increases these two variables. Therefore, positive exchange rate shocks can increase employment.

Ebrahimi et al. [10], investigated the asymmetric effects of real exchange rate fluctuations on private-sector consumption in Iran in 2016-2017, using the NARDL approach. The results show that the consumption behavior of the private sector is a function of the fluctuations and uncertainties of the real exchange rate rather than being influenced by its absolute level. Also, the level of real exchange rate fluctuations (decrease and increase) has a different effect on private-sector consumption. The effect of positive and negative shocks of real exchange rate fluctuations on private sector consumption in the short run is symmetric and in the long run is asymmetric.

Moradi et al. [25], studied the impact of the growth of bank facilities on economic growth and investment in Iran using the autoregression model with panel data and data from the four economic sectors of industry and mining, agriculture, services, and housing in the period of 1358-1395. The results indicate that if a shock is imposed in the growth changes of the remaining bank facilities as a standard deviation, it will increase the value-added growth, and its effect will be neutralized after ten periods. The shock effect in the growth changes of bank facilities on investment growth often appears late and will be neutralized after ten periods. The analysis of variance showed that about 14% of the growth changes in value-added is explained by the remaining growth of bank facilities, which this effect reaches 32% at the end of the tenth period.

Eidi et al. [9], investigated the asymmetric effects of the exchange rate on Iran's money demand function despite household religious expenditure using NARDL with quarterly data in 1997-2017. The results of the boundary tests indicate the existence of a long-term relationship between the research variables. Also, GDP, interest rates, and religious household expenditures have positive and significant effects, and negative exchange rate changes indicate a significant effect. On the other hand, positive exchange rate changes are insignificant.

2.2 Foreign Studies

Aghion et al. [1], examined exchange rate fluctuations and productivity growth using the GMM method and data from 83 countries from 1960-2000. The results showed that real exchange rate fluctuations could significantly impact the long-term productivity growth rate, but this impact depends on the country's financial development. For countries with relatively low levels of financial development, exchange rate fluctuations generally reduce growth, while financially advanced countries have no significant effect.

Alexandro et al. [4], examined employment, exchange rates, and labor market difficulties in 23 low-tech and high-tech OECD countries. The results show that employment in low-tech sectors is very open for trade. Countries with flexible labor markets are sensitive to exchange rate fluctuations.

Guillaumont Jeanneney and Hua [15], examined the effect of real exchange rates on labor productivity in China. This study was conducted in 2007-2008 in 29 provinces of China using an econometric model. The results show that the increase in the real exchange rate has a positive effect on the growth of labor productivity. In contrast, according to the Balassa-Samuelson effect, the growth of productivity tends to increase the fact price. In addition, the desired effect is stronger in inland provinces than in coastal provinces, and it helps to minimize the distance between inland and coastal provinces.

Faleiros et al. [14], evaluated the impact of exchange rates and labor productivity on imports in the Brazilian manufacturing sector in 17 manufacturing sectors in the period 1996-2011 using the GMM method. The results indicate that both the exchange rate and labor productivity variables explain the import influence

factor. However, human resources productivity has the most negative impact on the market share of imported goods. Bergeaud et al. [8], examined the circular relationship between productivity growth and exact interest rates on data from 17 OECD countries. The researchers used the simulation to examine the effect of temporary interest shock. Given that productivity is the main factor of potential production and affects interest rates, the level of interest rates determines the expected return on investment projects and, therefore, the productivity required for investment. The results show that without a technology shock, this relationship is balanced when productivity growth and interest rates are both low.

Azenui and Rada [5], examined the growth of labor productivity in sub-Saharan Africa (34 of the 49 least developed countries) in 1991-2018. This study has the following two objectives. The first goal is to identify sectoral contributions to labor productivity growth. The second goal is to assess the relationship between total productivity growth and its sectoral components enhancing economic growth. The results suggest that global integration benefits growth in sectors and increases structural change in sub-Saharan Africa.

3 Theoretical Foundations

Increasing GDP is one of the indicators of improving living standards, which will require more use of production inputs. Due to limited resources (production inputs) and environmental impacts caused by more use of production resources, increasing economic growth can be provided by improving the productivity of production factors. In this regard, considering the decisive role of productivity in countries' economic growth and development, the preparation of productivity indicators has been considered. One of the most critical indicators of one-factor productivity is the labor productivity index. This index has various and broad applications in the dimensions of economic policy. On the one hand, the labor productivity index determines per capita income levels and living standards. On the other hand, can make technical changes through efficiency combined with other factors such as capital stock. However, labor productivity alone cannot reflect all the personal capacities of the labor force as an important factor in the production process.

Productivity measurement methods have an extensive and diverse literature from the dimensions of economic theories; productivity measurement is rooted in the theories of Tinbergen [37], and Solow [35]. These two researchers have proposed productivity indicators from the perspective of production functions and related them to economic growth analysis. Later, productivity measurement took on a wider dimension based on the studies of Jorgenson and Griliches [20], and Griliches [16].

In terms of estimating and approximation models based on productivity indicators, one of the main methods is using econometric methodology with parametric methods. The econometric methodology is used to measure the productivity of observations related to data quantities and outputs. This method has been widely used in productivity studies, especially labor productivity, in academic and experimental studies. The main advantage of econometric methodology as a parametric method compared to non-parametric methods such as the growth accounting method and numerical accounting is testability and potential capacities. However, productivity measurement by the econometric method faces the limitations of insufficient observations.

The labor productivity index in terms of GDP and the number of employees in the whole economy is accessible through the production function. So that the labor productivity is obtained from the ratio of GDP to the number of employees in the total economy. This index is available in production functions, such as the Cobb-Douglas function, directly through conversions in the presence of capital stock variables. Therefore, in a function based on labor input and capital stock, the labor productivity function can be used for econometric estimates. However, labor productivity can be affected by other variables outside of production functions. This can also be generalized using the generalized form of the Cobb-Douglas

function, whose independent variables go beyond traditional factors of production such as labor and capital stock. In the literature on economic growth theories, the effect of exchange rates and exchange regimes on production has always been the focus of macroeconomic research. In the influence of exchange rates and exchange regimes on the level of production during the years 1929 to 1973, the Keynesian school's view on the fact that exchange rate did not interfere in the fate of economic stimulus policies was accepted by most economists. However, from 1973 onwards, with the establishment of floating exchange rate regimes on the one hand and the rise of the World Trade Organization on the other, these policies and their impact on the real sector of the economy faced serious doubts. In open economies with a high degree of trade openness, exchange rates and exchange regimes play a significant role in the production and economic growth. This role is performed through the foreign trade channel. So that on the one hand, the exchange rate affects the import of production inputs, and on the other hand, it affects that part of export products [27]. Therefore, exchange rate fluctuations and their positive and negative shocks on the level of production, especially in countries that suffer from currency instability, can be significant. Therefore, currency shocks can also affect labor productivity as a potential capacity in the production function and methods of measuring productivity.

In terms of theoretical foundations, the causal relationship from productivity to exchange rates is explained by Balassa [6], [32]. But for the opposite direction of causality, which is the effect of the exchange rate on productivity, there is no consensus on the theoretical foundations of the international economic literature. Nevertheless, there are a large number of experimental studies on this subject, with different findings. In general, exchange rate fluctuations, whether increased or decreased, are considered harmful to growth. But other studies find a variety of relationships between such inconsistencies and productivity and thus growth. Overall, although empirical studies are far from convincing, the specific suggestions they make about the channels through which exchange rate fluctuations can affect growth are significant [28].

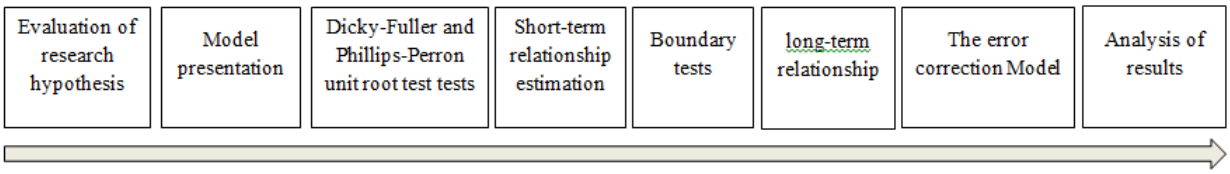
The theoretical foundations of the positive relationship between productivity growth and exact interest rates go back to the 1928 cryptocurrency saving and investment model. Although this model is relatively simple, it is one of the main foundations of macroeconomic theory [31], and has even been used in recent research to study interest rate trends. The causal relationship from potential growth to long-term exact interest rates has standard literature. Many empirical studies have shown even considering the role of other factors in the long-term equilibrium of interest rates, decrease in productivity, and potential growth in falling interest rates in the early 1980s. [7], [12], [2]. The inverse causal relationship from long-term interest rates to productivity, resulting in GDP growth, has recently received widespread attention. Some researchers have presented the negative impact of higher interest rates on productivity growth due to difficult financial conditions. Various theoretical models show how facility constraints can lead to innovation and reduce costs. Empirically, this relationship has been confirmed in several articles. [3], [2], [24], [21], [30].

4 Study Model and Estimation Method

In this section, the research model and method are presented. The research steps are briefly presented in the form of a flowchart (1). Determining total behavior and employment depends on the assumptions that apply to economic enterprises. There are several methods for deriving the labor demand function, each depending on the specific situation. Theoretical foundations are divided based on the following assumptions: 1- In which market the firm is present (competitive or non-competitive) 2- It is a function of multi-factor production 3- The model is static or dynamic, of course, it is possible that in some models these items are integrated, i.e., it is a combination of market type and the number of factors. Therefore, in microeconomic

theory, for the demand function, it is assumed that firms, given their short-term, medium-term, and long-term periods, demand inputs that maximize profits [38].

flowchart (1): Research steps



Suppose the production function matches the three inputs L, K, and M (labor, capital, and import) as Q = f = (L, k, M), and the problem statement should be considered as the same cost function C = wL + rk + sM, assuming the cost is constant. Such that r, w, and s are the prices of labor inputs, capital, and imports, respectively. Now, with the help of the objective function and the constraint equation, we extract the values of the inputs

$$max\ Q;\ f\ (L,K,M) \tag{1}$$

$$s.t.\bar{C} = wL + rK + sM \tag{2}$$

$$Z = f(L,K,M) + \ \lambda[\bar{c} - wL - rK - sM] \tag{3}$$

$$Z_L = \frac{\sigma Z}{\sigma L} = mP_L - \lambda w = 0 \tag{4}$$

$$Z_K = \frac{\sigma Z}{\sigma K} = mP_K - \lambda r = 0 \tag{5}$$

$$Z_\lambda = \frac{\sigma Z}{\sigma \lambda} = \bar{c} - wL - rK - sM = 0 \tag{6}$$

In this step, by solving the above simultaneous equations with three unknowns, we obtain the values of L, K and M.

$$\frac{MP_L}{w} = \frac{MP_K}{r} = \frac{MP_M}{s} = \lambda$$
$$\bar{C} = wL + rK + sM \tag{7}$$

Based on the above relations, the input demand functions are obtained as follows:

$$L^* = L\ (w,r,s,Q)$$
$$K^* = K\ (w,r,s,Q)$$
$$M^* = M\ (w,r,s,Q) \tag{8}$$
$$\lambda^* = \lambda\ (w,r,s,Q$$

Where L *, K *, and M * represent the demand functions with conditional inputs, which are a function of the input prices (w, r, s) and the amount of output.

Apart from the methods of deriving the labor demand function from the optimization path, the determination of the labor demand function based on exogenous variables (a special conceptual method) has also been used. The views of classical, neoclassical, Keynesian, New Keynesian economists, theories

of the real business cycle, the natural rate of unemployment in the labor market show that nominal and real wages, productivity, technology, expectations, changes in imported raw materials, taxes, and changes in people taste towards work and leisure the factors affecting the balance of the labor market and the equilibrium amounts of wages and employment. In some studies, in extracting the equations of labor and wage demand, an approach different from the optimization problem was taken, so that "Allen H. Thomas" based on the studies of "Blanchard and Summers" considers the changes in wages and employment as factors influencing changes in labor demand. Caroline van Rich Jam focuses on the structural factors influencing labor demand. "Reza Moghadam" and "Caroline Van Rich Jam" determine the wage equation based on the "Blanchard and Summers" model and the "Nickel" model, and according to the "internal-external wage" model, introduce labor demand as a function of the previous period demand real wage and productivity [22].

According to the theoretical foundations and empirical background, the models used in experimental research in productivity are very diverse. The present study focuses on the asymmetric effect of exchange rates and bank facility rates on labor productivity in Iran. The proposed model is based on the Cobb-Douglas function, which has been recognized as the best function in terms of compliance with economic conditions due to the appropriateness of its functional form and the smooth internal relations of its variables. In the initial case, the Cobb Douglas function is as follows.

$$Q=A\ L^{\alpha}\ K^{\beta} \tag{9}$$

Where Q (production), L (labor input) and K (capital stock input) are known as standard inputs in the production function [18]. According to the aim of the present study investigating the effect of monetary and exchange rate variables on labor productivity, two variables of R (bank facility rate) and X (free market exchange rate) are added in the generalized form of Cobb Douglas production function as follows. In addition, by adding the error component, the mathematical form of the function is transformed into a regression model.

$$Q=\ A\ L^{\alpha}\ K^{\beta}\ R^{\gamma}\ X^{\Theta}\ e^{u} \tag{10}$$

The final form of the logarithmic, linear model is as follows. Where AP is labor productivity, K is capital stock, L is labor, X is the free-market exchange rate, R is bank facility rate, and ε is the disruption component. All variables are in logarithmic form, and index t represents the period (year).

$$LnAP_t = \alpha_1 + \alpha_2 LnK_t + \alpha_3 LnL_t + \alpha_4 LnX_t + \alpha_5 LnR_t + \varepsilon_t \tag{11}$$

According to the primary purpose of this study which is to analyze the asymmetric effect of exchange rate and bank system facility rate on labor productivity in Iran, NARDL was used, which was first developed by Shin et al. [33]. According to the studies of Pesaran et al. [29], and in this long-term model (11), the error correction (EC) form can be written as equation (12), and through this short-term and long-term effects can be simultaneously observed, and the results of the approach and the boundary test can be examined. The short-term coefficients in Equation (12) are related to the first-order difference variables, which are obtained by normalizing the coefficients of the intermittent variables (λ_2 to λ_5) on λ_1 and the long-term coefficients in Equation (11). Using the F-statistic in the boundary test approach, the validity of long-term coefficients can be obtained to test the hypothesis H_0: λ_1 = λ_2 = λ_3 = λ_4 = λ_5 = 0. Rejection of the H0 hypothesis indicates a long-term relationship.

$$\Delta LnAP_t = \omega_1 + \sum_{i=1}^{n_1} \omega_{2i}\, \Delta LnAP_t - 1 + \sum_{i=0}^{n_2} \omega_{3i}\, \Delta LnK_{t-i} + \sum_{i=0}^{n_3} \omega_{4i}\, \Delta L_{t-i} + \sum_{i=0}^{n_4} \omega_{5i}\, \Delta LnX_{t-i} + \sum_{i=0}^{n_5} \omega_{6i}\, \Delta LnR_{t-i} + \lambda_1 LnAP_{t-1} + \lambda_2 LnK_{t-1} + \lambda_3 L_{t-1} + \lambda_4 X_{t-1} + \lambda_5 R_{t-1} + \varepsilon_t \quad (12)$$

Critical values of this test are presented by Pesaran et al. [29]. In the boundary test, two critical values are determined. In the boundary test, it is assumed that the critical value for the upper bound is all the variables of the pattern I(1), and for the lower bound, all the variables are assumed to be I(0). Critical values are measured with upper and lower bounds. If the statistic is higher than the upper bound value, it indicates a cointegration relationship. If it is lower than the value of the lower bound, the cointegration is rejected. If the F-statistic is calculated between the values of the two boundaries, the cointegration test is ineffective.

To investigate the asymmetric effects of exchange rate and bank facility rate on labor productivity based on studies by Shin et al. [34], the exchange rate variable and bank facility rate are divided into positive and negative components.

$$LnX = LnX_0 + LnX_t^+ + LnX_t^- \quad (13)$$

$$LnR = LnR_0 + LnR_t^+ + LnR_t^- \quad (14)$$

Where (LnX_t^+ و LnR_t^+) and (LnX_t^- و LnR_t^-) are respectively the partial process of positive changes and the total, partial process of negative changes in the LnX and LnR variables. These four components are defined as the partial accumulation of changes in Rt and Xt as follows:

$$LnX_t^+ = \sum_{j=1}^{t} \Delta LnX_j^+ = \sum_{j=1}^{t} max(\Delta LnX_j, 0)$$
$$LnX_t^- = \sum_{j=1}^{t} \Delta LnX_j^- = \sum_{j=1}^{t} min(\Delta LnX_j, 0) \quad (15)$$

$$LnR_t^+ = \sum_{j=1}^{t} \Delta LnR_j^+ = \sum_{j=1}^{t} max(\Delta LnR_j, 0)$$
$$LnR_t^- = \sum_{j=1}^{t} \Delta LnR_j^- = \sum_{j=1}^{t} min(\Delta LnR_j, 0) \quad (16)$$

Using Equations 11, 13, 14, 15, and 16, the following equation can be obtained:

$$LnAP_t = \beta_0 + \beta_1 LnK_t + \beta_2 LnL_t + \beta_3 LnX_t^- + \beta_4 LnX_t^+ + \beta_5 LnR_t^- + \beta_6 LnR_t^+ + \varepsilon_t \quad (17)$$

Equation (17) is the function equation of Iran's labor productivity in the long run, which the NARDL estimates with nonlinear effects of exchange rates and bank facility rates.

$$\begin{aligned}\Delta \mathrm{LnAP_t} = \varphi_1 &+ \sum_{i=1}^{n_1} \varphi_{2i}\, \Delta \mathrm{LnAP_{t-i}} + \sum_{i=0}^{n_2} \varphi_{3i}\, \Delta \mathrm{LnK_{t-i}} + \sum_{i=0}^{n_3} \varphi_{4i}\, \Delta \mathrm{L_{t-i}} \\ &+ \sum_{i=0}^{n_4} \varphi_{5i}\, \Delta \mathrm{LnX^-_{t-i}} + \sum_{i=0}^{n_5} \varphi_{6i}\, \Delta \mathrm{LnX^+_{t-i}} + \sum_{i=0}^{n_6} \varphi_{7i}\, \Delta \mathrm{LnR^-_{t-i}} \\ &+ \sum_{i=0}^{n_7} \varphi_{8i}\, \Delta \mathrm{LnR^+_{t-i}} + \theta_1 \mathrm{LnAP_{t-1}} + \theta_2 \mathrm{LnK_{t-1}} + \theta_3 \mathrm{LnL_{t-1}} \\ &+ \theta_4 \mathrm{LnX^-_{t-1}} + \theta_5 \mathrm{LnX^+_{t-1}} + \theta_6 \mathrm{LnR^-_{t-1}} + \theta_7 \mathrm{LnR^+_{t-1}}\end{aligned} \tag{18}$$

The above equation is a NARDL that can investigate the asymmetric effects of monetary policy (bank facility rate) and exchange rate policy (informal exchange rate) on Iran's labor market (labor productivity) in the short and long term. As in Equation (12), φ_1 to φ_8 coefficients represent short-term coefficients and θ_1 to θ_7 coefficients represent long-term coefficients. By estimating the equation (17) and normalizing the estimated coefficients, and dividing the coefficients θ_2 to θ_7 by θ_1, the long-term coefficients of Equation (18) are obtained. To interpret the pattern (17), after estimating the pattern by NARDL method and performing the diagnostic test, the variance heterogeneity test, the normality of the residuals, and the stability test, the boundary test [29], should be used to verify the existence and confirm the long-run relationship between dependent and independent variables. Therefore, the F statistic is calculated, and critical values are compared and examined at significant levels.

5 Experimental Data and Results

In the present study, the statistical population is data related to capital stock, labor force, free market exchange rate (informal), and bank facility rates in Iran. This information has been extracted as time-series data from the Central Bank and the Statistics Center of Iran. For static analysis, the Dickey-Fuller and Phillips-Perron tests were used for the logarithm of productivity variables (AP), labor force (L), capital stock (K), bank facility rate (R), positive bank facility rate shock (R +), negative bank facility rate shock (R-), free-market exchange rate (X), positive free-market exchange rate shock (X +), negative free market rate shock (X-). The results of the variables studied using these two tests are given in the table below.

Investigation of the results of Dickey-Fuller and Phillips-Perron test indicates that only the productivity variable (AP) is at the static level and the other variables used in this study are not at the static level and are static with one-time differentiation, so the variables are also the sum of on degree I(1). According to the static results of the variables and the fact that the variables are I(0) and I(1), the NARDL has the advantage of applying to the variables in the first-order difference. Therefore, according to the obtained results, the NARDL approach can be used. The results of estimating the asymmetric effect of exchange rate and bank facility rate in the research model are presented in Table 2. To analyze the asymmetric effects, the exchange rate is divided into two series of EX^+ and EX^- and the rate of bank facilities is divided into two series of R^+ and R^-. To select the best pattern, the AIC criterion is used and the interval of (3, 2, 0, 0, 1, 3 and 2) was selected as the optimal interval. The maximum interval length allowed for variables is considered to be 3.

The estimated coefficients of the short-run nonlinear model show that the effect of increases and decreases in the exchange rate on labor productivity is both symptomatically and significantly different. As the results show, the two series EX^+ and EX^- (increases and decreases in the exchange rate) are uninterrupted. So that, a one percent decrease in the free exchange rate increases labor productivity by 0.95 percent. However, increases in the free exchange rate do not have a significant effect on labor productivity.

Table 1: Results of the generalized Dicky-Fuller and Phillips-Perron tests

Variable	Generalized Dicky-Fuller test				Phillips-Perron test			
	In the level of		In first-order difference		In the level of		In first-order difference	
	Test statistic	Level of Possibility	Test statistic	Level of Possibility	Test statistic	Level of Possibility	Test statistic	Level of Possibility
LAP	-2/9281	0/0002	-	-	-2/9281	0/0005	-	-
LK	-2/9297	0/8071	-2/9297	0/0223	-2/9281	0/0734	-2/9297	0/0145
LL	-2/9237	0/6585	-2/9251	0/0001	-2/9237	0/6585	-2/9251	0/0001
LEX	-2/9237	0/9881	-2/9251	0/0001	-2/9237	0/9827	-2/9251	0/0002
LEX^+	-2/9251	0/9762	-2/9266	0/0002	-2/9251	0/9762	-2/9266	0/0002
LEX^-	-2/9251	0/8061	-2/9266	0/0001	-2/9251	0/8061	-2/9266	0/0001
LR	-2/9266	0/6803	-2/9281	0/0000	-2/9266	0/6344	-2/9281	0/0000
LR^+	-2/9281	0/9032	-2/9297	0/0000	-2/9281	0/9067	-2/9297	0/0000
LR^-	-2/9297	0/9035	-2/9297	0/000	-2/9281	0/9344	-2/9297	0/0000

Resource: Research findings

Table 2: Results of short-term relationship estimation

Level of Possibility	**Statistic t**	**Coefficient**	**Explanatory variable**
0/0221	2/4395	0/3161	LAP(-1)
0/0005	-3/9867	-0/4774	LAP(-2)
0/0456	2/1044	1/2473	LK
0/5336	-0/6313	-0/5481	LK(-1)
0/5436	0/6157	0/4259	LK(-2)
0/0013	-3/6242	-1/9377	LK(-3)
0/0069	2/9438	1/6858	LL
0/1388	-1/5290	-0/7983	LL(-1)
0/1276	-1/5759	-0/7983	LEX^+
0/0599	1/9713	0/9548	LEX^-
0/0093	2/8177	0/1738	LR+
0/1406	-1/5217	-0/1263	$LR^+(-1)$
0/0517	2/0435	0/1510	$LR^+(-2)$
0/0035	-3/2234	-0/4355	LR^-
0/0223	2/4353	0/3828	$LR^-(-1)$
0/1079	-1/6673	-0/2662	$LR^-(-2)$
0/0803	-1/8227	-0/2385	$LR^-(-3)$
Amount of sum of coefficients (standard deviation)	Level of Possibility	F Statistic	Wald test for sum of coefficients
0/14	0/0000	45/86	
R^2=0/9689	R=0/9478	X^2_{AC}=-3/7416	X^2sc=-3/0044

Resource: Research findings

Thus the effect of exchange rates on labor productivity is asymmetric. In the case of bank facility rates, increases in bank facility rates in total (according to the wald test) directly affect labor productivity. Thus, with a one percent increase in the rate of bank facilities, labor productivity increases by 0.20 percent. On the other hand, reductions in the rate of bank facilities in the sum of intervals (according to the wald test)

have an adverse effect on labor productivity. Accordingly, in general, with a one percent decrease in the rate of bank facilities, labor productivity increases by 0.54 percent. In NARDL, it is also necessary to ensure a long-term relationship, and boundary tests will help to ensure this. As the results of the boundary test in Table 3 show, the value of the test statistic is 12.77, which is greater than the lower and upper bound presented by Peasaran and Shin [13] at the possible level of one percent. Accordingly, the existence of a long-run relationship between increases and decreases in free exchange rates, increases, and decreases in bank facility rates, capital stock, and employment with labor productivity is not ruled out.

Table 3: Boundary tests in the asymmetric estimation

Level of Error	Boundary 2	Boundary 1	Test statistic
1%	3/99	2/88	12/7702
%5	3/28	2/27	
%10	2/94	1/99	

Resource: Research findings

Now, according to the confirmation made in the boundary test that there is a long-term relationship between the variables in the research model, the long-term relationship can be estimated. Estimation obtained from long-term relationship estimates are presented in Table 4.

Table 4: Results of the long-term relationship

Level of Possibility	**Statistic t**	**Coefficient**	**Explanatory variable**
0/0000	-5/1865	-0/6997	LK
0/0014	23/6042	0/7642	LL
0/1686	-1/4177	-0/0454	LEX_POS
0/0514	2/0456	0/8221	LEX_NEG
0/0031	3/2726	0/1709	LR_POS
0/0001	-4/6246	-0/4800	LR_NEG
0/2386	-1/2074	-3/3946	C

Resource: Research findings

Estimating the long-term nonlinear pattern is in line with the results obtained from the short-term nonlinear pattern. Increases in the free exchange rate in the long term, as in the short term, do not significantly affect labor productivity. In this regard, reductions in the free exchange rate in the long-term, as in the short-term, will increase labor productivity. Thus, a one percent decrease in the free exchange rate leads to a 0.82 percent increase in labor productivity. Therefore, in the long term, the free exchange rate has an asymmetric effect on labor productivity. On the other hand, increases in bank facility rates show a direct and significant effect on labor productivity. So that, a one percent increase in the rate of bank facilities will cause a 0.17 percent increase in labor productivity. On the other hand, reductions in bank facility rates have a significant inverse effect on labor productivity. Thus, in total, with a one percent decrease in the rate of bank facilities, labor productivity increases by 0.48 percent.

Table 5: Results of estimating the error correction Model

Level of Possibility	**Statistic t**	**Coefficient**	**Explanatory variable**
0/0000	5/6252	0/4774	DLAP(-1)
0/0046	3/1090	1/2473	D(LK)
0/0017	3/5151	1/5118	D(LK(-1))
0/0001	4/8641	1/9377	D(L(K(-2))
0/0000	7/0460	1/6858	D(LL)
0/0015	3/5724	0/1738	D(LR_POS)
0/0078	-2/8944	-0/1510	D(LR_POS(-1))
0/0000	-5/0532	-0/4355	D(LR_NEG)
0/0000	5/7667	0/5047	D(LR_NEG(-1))
0/0136	2/6543	0/2385	DLR_NEG(-2))
0/0000	-11/4353	-1/1613	CointEq(-1)*
Amount of sum of coefficients (standard deviation)	Level of Possibility	F Statistic	Wald test for sum of coefficients
0/0882			
R^2=0.9209	R=0/8962	X^2_{AC}=-4/0672	X^2sc=-3/6167

Resource: Research findings

Estimated coefficients have been used to evaluate the stability. Given that the estimated values are between two critical values of 5%, the null hypothesis that the estimated model is stable cannot be rejected. The results of these two tests are shown in Figures 1 and 2.

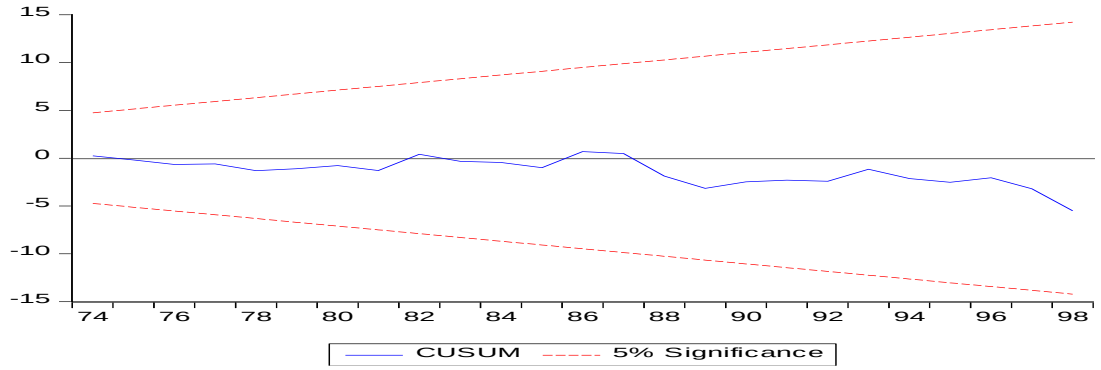


Fig. 1: Results of test 1

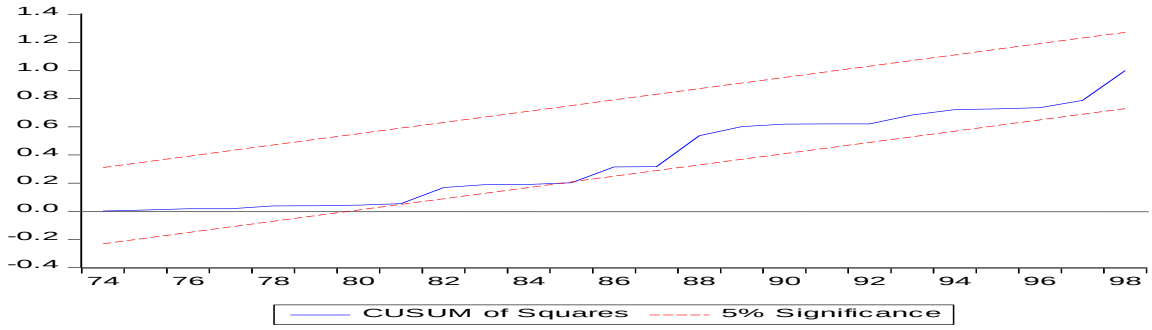


Fig. 2: Results of test 2

CUSUM and CUSUMSQ tests were performed to evaluate pattern recognition tests and ensure no problem. The results of these tests showed that the pattern is stable. The productivity index indicates the relationship between outputs and inputs in the production process and can fundamentally impact economic, social, and political phenomena. Labor productivity is one of the productivity indicators that are of great importance in terms of production, employment, and competitiveness in micro and macro dimensions. In the laws of the fourth, fifth, and sixth development plans in the years after the imposed war, it has always been emphasized that part of the quantitative goals of economic growth should be dedicated to the growth of the productivity index. The share of productivity growth in economic growth during these programs is considered to be about 33%, and obviously, the growth of labor productivity plays an important role in its realization. In this study, the effects of exchange rates and bank facilities on labor productivity in Iran for 1971-2019 have been investigated using the NARDL method. The overall purpose of the present study was to evaluate the asymmetric effect of exchange rate and bank facility rates on labor productivity. Asymmetric estimates of exchange rates and bank facility rates on labor productivity in the short term show that only the effect of a decrease in the exchange rate is significant and has a direct effect. Hence it has an asymmetric effect on labor productivity. In addition, increases in bank facility rates have a direct effect, and reductions have an adverse effect on labor productivity. Accordingly, bank facility rates have an asymmetric effect on labor productivity in the short term. In the long term, the results are the same as in the short term. Thus, only reductions in the exchange rate directly affect labor productivity, and increases are not significant. In addition, increases in bank facility rates have a direct and significant effect, and decreases have a significant inverse effect on labor productivity.

When discussing the functions of monetary and exchange rate variables and the impact of their fluctuations on macroeconomics, the focus is mainly on issues such as inflation rates and output. However, monetary and exchange rate fluctuations can indirectly affect production and even inflation by affecting labor productivity, improving the productivity of all factors of production in general, and labor productivity in particular play an important role in the competitiveness of Iran's economy at the international level. Therefore, improving productivity can lead to increased production and export capabilities of Iran's economy. In this regard, it is recommended that monetary and exchange rate policymakers, by creating relative stability in monetary and exchange rate variables, make it possible for productivity, as a very important factor in production, to be effective in increasing and sustaining the growth of the country's economy, while helping to stabilize the macroeconomic environment.

6 Conclusion

This study investigates the asymmetric effect of exchange rate and bank facility rates on labor productivity in Iran in 1971-2018. The results of model estimation by self-explanatory method with nonlinear autoregressive distributed lag (NARDL) indicate that in the short and long run, the effect of free-market exchange rates and bank lending rates on labor productivity is asymmetric so that reductions in exchange rates have a significant direct effect on labor productivity and increases are not significant. In addition, increases in bank lending rates have a direct effect and reductions have an adverse effect on labor productivity.

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