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Research Paper

The Effect of Real Exchange Rate Volatility on Productivity Growth in Iran With The Role of Financial Development

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Abstract

One of the most important items to select exchange system is to study the effect of Exchange rate volatility on real sector of economy especially on productivity growth. But exchange rate volatility and different exchange systems have different effects on country's economic system the selection of exchange system is dependent on the condition of the country. Thus, this paper evaluates the effect of exchange rate volatility on productivity growth in Iran with regard to financial development and the data are collected from World Bank during 1979- 2014. By stationarity Phillips-perron test, stationarity of variables is evaluated. Then co- integration and long-run relationship were examined by Johansen and Julius test. Using vector error correction model, short-run volatilities of variables were evaluated in long-run equilibrium path. The results showed that exchange rate volatility had negative relationship with productivity growth and the effect of financial development on productivity growth was positive and significant. Also, the effect of reciprocal exchange rate volatility and financial development on productivity growth was negative and smaller than the effect of exchange rate volatility in extent.

Keywords: Productivity Growth, Exchange Rate Volatility, Financial Development, Johansen and Julius test.

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1- Introduction

The choice of exchange rate system is of great importance especially in developing countries. As the majority of commercial trade and international funding is performed using money of industrial countries rather than country currency, these countries should assume selection of exchange rate with major money volatility in the world and considering the existing conditions, they must make the best decision (Mussa, et al, 2000).

Different exchange systems might affect the economy performance via exchange rate volatilities. The economists do not agree on the most important conditions affecting the relationship between exchange rate volatility and economy performance. Some economists consider the relationship between economy and global capital and the amount of openness economy as important issues. Some studies as those done by Mussa, et al, (2000) and Yeyati & Sturzenegger (2003) showed that conditions like the economic development level of countries, skill and communication development with global economy were effective on the relationship between exchange rate volatilities and real sector including productivity and its growth. The organization of exchange rate volatilities is correlated with these conditions. Aghion, et .al. (2009) presented financial development as an important factor influencing the relationship between exchange rate volatilities, economic growth and productivity growth.

Following the study of Aghion, et al, (2009), this paper evaluates the role of financial development in relationship between exchange rate volatilities and labor force productivity growth (economic growth) in Iran during 1979-2014. Based on the hypotheses of the study, it is expected that exchange rate volatilities has negative impact on labor productivity growth in Iran economy and the effect of reciprocal exchange rate volatilities and financial development on productivity growth is negative

2-Theoretical Basics

2-1 The effect of exchange rate volatilities on real sector

The extensive studies regarding the relationship between different exchange systems and real sector of economy have shown different results. Some of the studies including Baxter, M., Stockman (1989) found that exchange system could not have significant and systematic impact on real sector of economy and commercial cycles. Some studies empirically showed the low impact of different exchange systems on economic growth. For example, Ghosh et al. (2003) state that ‘‘perhaps the best one can say is that the growth performance of pegged regimes is no worse than that of floating regimes’’.

Other studies argued that the effect of exchange rate volatilities or different exchange rate systems under different conditions is different. In other words, Given these studies, exchange rate volatility or flexible exchange rate systems are not desirable or undesirable in all conditions and they are changed based on other conditions. For example, Levy-Yeyati, E., Sturzenegger (2003) found that less floating exchange rate systems with low flexibility in developing countries reduce economic growth and increase production volatilities but in industrial countries, exchange system has no significant impact on growth. Razin & Rubinstein (2006) found that the effect of different exchange rate system could have direct effect on economic growth in short-term. The important factor in exchange rate volatilities, performance and the selection of exchange system is the nature of economy shocks. The countries under currency shocks take benefit of pegged exchange rate. Money supply is adapted automatically with the change in monetary demand without having any impact on real sector. On the other hand, the countries exposed to internal real shocks perform better with floating exchange rate system as they let the relative prices move for re-allocation of resources to respond to the shocks (Hausmann, et al, 1999).

Another factor regarding to the performance of exchange rate volatilities and exchange rate system is the relationship of countries with global capital market and economy openness. Husain et al. (2005) found that in the countries less exposed to international capital market, fixed exchange rate system could be an important instrument for stability of credit monetary policies and it is led to stable investment and improvement of long-run growth aspects. Among emerging markets-developing countries joining global financial market and the advanced economies, there is no relationship between economy performance, exchange rate system and exchange rate volatilities. For emerging markets, fixed exchange rate is problematic while the selection of fixed exchange rate has some credit advantages and creates some financial crisis risks. One aspect of the effect of exchange rate volatilities and exchange systems on real sector is the effect of exchange rate volatilities on uncertainty of foreign trade. The increase of exchange rate volatilities and consequently the increase of relative price volatilities by non-stabilized economic conditions and that of inflation have negative effect on trade and investment and this leads to growth reduction. De Grave & Schnable (2008) presented two factors in risk elimination arising from exchange rate volatility and reduction of exchange rate risk costs as some reasons for increasing exchange rate stability and economic growth. Against these reasons emphasizing on the positive relationship between exchange rate stabilization and economic growth, De Grave & Schnable present other reasons showing the negative relationship between fixed exchange rate system and economic growth. De grave & Schnable state that under flexible exchange rates, countries economy is adjusted easily against real shocks (Khatayi and Mosavinik, 2008). On the other hand, exchange rate volatilities in long-run might face the reaction of financial markets and cover their risk. This leads to negative effect mitigation. The increase of exchange rate volatilities creates uncertainty in price and exchange rate. The uncertainty of price can have negative impact on real sector of economy. The reason for the negative effect of exchange rate volatilities and uncertainty is that the uncertainty in price causes the resources allocation mechanism is not considered well in economy. Consequently, inefficient investment is made. This has negative impact on economy performance. Baldwin (1989), in his analysis of European Monetary Union, argued that a single currency might have growth effects on Europe by reducing the exchange rate premium on capital within Europe.

2-2 The impact of financial development on the relationship between exchange rate volatilities and real sector

An effective factor on the relationship between exchange rate volatilities (or exchange rate system) and real sector is financial development of countries. Mussa, et al., (2000) referred to the inverse relationship between exchange rate volatilities and growth rate of low financial development countries and stated that the lack of developed financial system in most developing countries, lack of financial infrastructures to support the relative depth of foreign exchange markets and its volatilities have caused these countries could not provide acceptable stability in the case of lack of formal guidance of exchange rate. The solution presented by this study regarding the weak financial development is a fixed exchange rate system.

There are two mechanisms through which the developed financial sector can reduce the negative impact of exchange rate volatilities. First, the higher degree of financial sector development could find the effective way of transferring the risks of exchange rate volatilities. Merton & Bodie (1995) emphasized that one of the main tasks of financial system is to provide suitable conditions for trade prosperity, and safeguard trade against risk, distribution and collection of risk. Thus, one of the duties of financial developed markets is to reduce the effect of exchange rate volatilities on trade, real sector and economic growth. The second mechanism mitigating the effect of uncertainty arising from exchange rate volatilities in financial developed sectors is that higher levels of financial development can provide better access to fund enterprises. They can resist against the effects of exchange rate volatilities. Recently, Chati (2005) and Dakal and Rio (2007) showed that liquidity restriction created by financial development level of exporting country plays an important role in determining the export level (Chit & Judge, 2009). In countries with high financial development, the negative effect of exchange rate volatilities and flexible exchange rate systems are reduced with through these mechanisms. As exchange rate volatilities and floating exchange rate systems can prevent negative impact of real shocks (Alogokoufis, 1994), we might say that in the countries with developed financial levels, exchange rate volatilities and floating exchange rate systems can have positive effect. If the effect of financial development level on the relationship between exchange rate volatilities in a country is emerged at the enterprise level of a country and it is assumed that the enterprises are exposed to liquidity shocks, they should borrow to survive in the market. The borrowing capacity of enterprises is a function of their current income and this factor is defined by financial development. The higher the financial development, the higher is its coefficient. For enterprises working at international level, internal price and income of enterprises are affected by exchange rate. By Appreciation of exchange rate, current revenue of enterprises is reduced and their ability to borrow for survival against liquidity shocks can be reduced. Despite the financial and liquidity problems in enterprises, innovation of enterprises as dependent upon the liquidity flow in enterprises is reduced. The exchange rate reduction has inverse impact. The lower the financial development coefficient (borrowing capacity to income ratio) and the lower the financial development of country, the higher the exposure of enterprises to innovation volatilities and higher growth volatilities of labor force productivity (Aghion, et .al. (2009). Thus, low financial development in countries causes exchange rate volatilities impose strong liquidity shocks on enterprises and this leads to volatilities and negative impact on labor force productivity.

3- Review of Literature

Different empirical studies with different approaches have been conducted to examine the relationship between exchange rate volatilities and exchange rate system with real sector of economy including economic growth and productivity growth. One of the main papers is the study of Baxter and Stockman (1989) and Ghosh et al. (2003). They did not find any strong relationship between exchange rate volatilities and real sector, however they stated that in fixed exchange systems with lower volatility, exchange rate of economic growth is not worse than floating exchange systems and high exchange volatilities. Different studies considering the effect of exchange volatilities on trade and neutralizing the impact of shocks on economy, found different relations between exchange rate volatilities and real sector.[1] For example, Husain et al. (2005) using the classifications in financial system found that pegged exchange rate regimes with low level of exchange volatilities are useful for developing countries with low participation in international capital market.

However, for developing countries merging into global financial markets (emerging countries) and advanced countries, the result of the study of Baxter and Stockman (1989) are achieved in which no strong relationship between economic performance and exchange rate regime and exchange rate volatilities. These studies along with the relations of exchange volatilities and exchange rate regime/system with economy real sector, given the impact of financial development on this relationship that was examined for the first time by Aghion et al. (2006) achieved functional results. This paper refers to the contrast between the exchange rate volatilities, financial development level, natural shocks of macro-economy and its impact on labor force productivity growth. The

[1]. Some of studies are considered in this regard: (Levy.Yeyati & Sturzenegger (2003), Belke & Setzer(2003) Dubas et al (2005) , Razin & Rubinstein(2006), De Grauwe & Schnabl(2008),.

main hypotheses of the study showed that exchange rate volatilities reduced labor force productivity growth. This effect was so strong in the countries with weak capital market where financial shocks are the main sources of volatilities. The hypothesis was tested in this paper by Generalized Method of Moments (GMM) method and the statistics on 83 countries during 1960-2000. It is showed that exchange rate volatilities in the countries with low financial development had negative impact on labor force productivity growth. While a theoretical model was presented at enterprise level in other section of present study which is indicative of the role played by financial development in exchange rate volatilities and productivity growth of workforce, the model was examined using the data of 28 manufacturing sector in 27 countries in 1970-2000, and the results predicated the model.

The study of Chit & Judge (2009) empirically evaluated the role of development of financial sector in the effect of exchange rate volatilities on export of five countries of Eastern Asia by GMM. This study tested the non-linear effect of exchange rate volatilities on export. The results show that the effect of exchange rate volatilities depends upon the financial development level; it means that the export of economies with low financial development is mostly affected by the effect of exchange rate volatilities. The political reasoning of this study is that fixed exchange rate systems in countries with low financial development has positive impact on growth. The floating exchange rate systems absorb real shocks but can have inverse effect on export and growth. In local studies, Kazeruni and Rostami (2007) evaluated the asymmetrical effects of exchange rate volatilities on real production in Iran. The results of evaluating the effect of predicted and unpredicted shocks of exchange rate and positive and negative shocks of exchange rate showed that there were asymmetrical effects of exchange rate shocks. Negative shocks of exchange rate affected real production more than its positive shocks. Aghion et al, (2009) evaluated the effect of exchange rate volatilities on productivity growth based on financial development level by panel data. The results showed that exchange rate volatilities had significant impact on productivity growth. The amount of this effect depends upon the financial development level of the country. The higher the financial development level, the lower is the effect of exchange rate volatilities on productivity growth. Diallo (2015) evaluated the real exchange rate volatilities on total productivity growth by panel data of 24 developed countries and 50 developing countries and he applied threshold effect estimation method and non-structural variable regression during 1975-2004. The results showed that in developed countries, the effect of exchange rate volatilities on total productivity growth was negative. This effect was negative and higher in developing countries. He showed that the higher the financial development of countries, the lower is the effect of exchange rate volatilities on total productivity growth.

Also, Khatayi and Mosavinik (2008) evaluated the relationship between exchange rate volatilities and economic growth by considering the role of financial development using the data of 69 countries by panel data method. The result of study showed that without considering financial development, the effect of exchange rate volatility on economic growth was negative. By considering the financial development level, this effect was negative in low level of financial development and by increase of financial development level from threshold level, the effect of exchange rate volatilities on economic growth is positive.

Parhizkari et al, (2014) evaluated the effect of exchange rate instability on value-added of agriculture sector in Iran using GARCH and ARDL method during 1978-2011. The results showed that the effect of exchange rate volatilities on value added of agriculture sector was negative.

Zamani and Basharabadi (2014) evaluated the effect of exchange rate volatilities on trading of agriculture products in Iran by Garch, vector error correction and Johansen methods. The results showed that exchange rate volatilities had negative impact on export of agriculture sector in long-run. Also, the exchange rate volatilities in long-term had positive impact on import of agriculture sector, however these effects were negative in short-run.

4- Introduction of variables and model

The model of Levine et al. (2000) presented the empirical evidences for the positive relationship between financial development and economic growth in countries. In present study, the mentioned model and study of Aghion et al, (2009) evaluating the effect of exchange rate volatilities on real sector are used. In addition to the effect of exchange rate volatilities, whose relation with real sector was reviewed in Theoretical Basics, the present study has used Levine et al. to study the effect of financial development on growth. Using other control variables in this paper, the mutual effect of financial development in exchange rate volatilities has been considered in the model. The reason for introducing the reciprocal effect of financial development and exchange rate volatilities was explained in the theoretical basics, is that exchange rate volatilities have double effect. The positive effect of exchange volatilities is to reduce the effect of real shocks on economy and it has positive effect on real sector. On the other hand, the exchange rate volatilities in the countries exposed to liquidity shocks have negative effect with increasing shocks. The countries with high financial development can control the liquidity shocks and prevent the negative effect of exchange rate volatilities. It is expected that the effect of exchange rate volatilities is positive in these countries. In the countries with low financial development, the negative effect of exchange rate volatilities and reciprocal relationship of exchange rate and financial development is considered as effective factor on production growth and labor force productivity growth. Thus, production growth or labor force productivity growth is a function of following factors:

$$GY_t = f(ER_t, FD_t, FD_t * ER_t, Z_t) \quad (1)$$

In these equations, variables are defined and computed as follows:

GY: The growth of labor productivity is calculated by dividing GDP by the number of working people. Like other common studies, the statistics of real per capita GDP for working people is used to measure labor productivity.

ER: It indicates effective real exchange rate volatilities index as achieved by the study of Dollar (1992) as follows:

$$LRER_t = \alpha + \beta_t d_t + \gamma \ln(Y_t) + \varepsilon_t \quad (2)$$

LRET is logarithm of the real effective exchange rate, d variable of time, and Y per capita production of country. Explanation of the relationship between Y and effective real exchange rate is based on Balassa (1964), who argues that labor productivity growth in developed countries is in trade sector and according to Balassa-Samuelson, higher productivity growth in tradable goods compared to non-tradable goods leads to the increase of real exchange rate. The residuals of this estimation are the exchange rate volatilities of its equilibrium value and we consider it as the first index for effective real exchange rate volatilities.

$$ER_t = (LRER_t - \widehat{LRER}_t) \quad (3)$$

FD: it is financial development index. Logarithm of internal credit in private sector is a percent of GDP. This index refers to the financial resources provided for private sector via loan, securities and credit transfer. The more the financial resources in private sector, the higher is the financial sector development.

FR: * ER = FD: This variable indicates the mutual effect of exchange rate volatilities and financial development. As it was explained, it is expected that higher financial development reduces the negative effect of exchange rate volatilities and has positive reciprocal effect.

Z: This is except all the variables in Equation (1) and we denote some of other variables with Z and it refers to the set of control variables for labor productivity growth as defined:

$$Z = [LT, LG, LINF, LCAP] \quad (4)$$

LT: It is the degree of economy openness as defined by the logarithm of total export and import to GDP. It is expected that higher interaction with world's economy and the use of global trade advantage has positive effect on production growth.

LG: The government volume degree as defined by logarithm of spending of government to GDP. The expenditures of government can have double effect, on one hand, government consuming can have positive effect on education and health and on the other hand the increase of government spending can lead to inefficient assignment of government development resources.

LINF: Instability index of logarithm price as defined by inflation rate plus 100 (inflation rate+100). Inflation instability has negative effect on growth. This index evaluates the instability effect of inflation and the change in index growth of prices on production growth.

LCAP: Logarithm of growth fixed capital to GDP of capital as one of the inputs of production. It is natural that capital changes have important effects on production changes and labor productivity.

The data of above variables are extracted from world development index (WDI) and it is for the most complete and available period 1979-2014 and D indicates the first differential of variables.

5- Research Method

5-1 Cointegration

To evaluate the causal relationship between two variables, causal models are used. The most well-known causality test in econometric literature is Granger causality test. Granger (1986) believe that future cannot be the cause of the past and states that if current y is predicted by past values of x carefully compared to the case in which past x is not used, x is Granger cause of Y. Bivariate form of Granger causality model is as follows:

Given the common trend in most macro-economy time series, same directional movement is seen in these series. If non-stationary time series are used in estimation of model coefficients, a spurious regression is created because in the variables with this trend, it is observed that even when there is no significant economic relationship among them, and it shows strong correlation (Nofersti, 1999).

Most economic theories like money quantity theory and consumption theory are based on long-run relationship between the variables. Although stationarity condition of time series variables of a long-run relationship can be provided via differentiation, to keep long run data regarding the level of variables, we cannot do anything special.

Here, Cointegration estimates regression without the fear of its spurious nature based on time series variables level (NoferSti, 1999).

Cointegration definition

If time series are stationary after d times difference, it has d unit root and it is said Cointegration is of d or I(d) rank. If two time series X_t and Y_t are both I(d), any linear composition of these two time series is I(d), if there are constant coefficients as α, β as regression disturbance term $U_t = Y_t - a - \beta X_t$ has Cointegration rank lower than d, for example, I(d-b) and ((b>0), according to Engle and Granger (1987), X_t and Y_t are Cointegration of order (d,b). Thus, if X_t and Y_t are both Cointegration of rank I(1) and $U_t \approx (0)$, two co-integrated time series are of rank CI(1,1). This definition is generalized to more than two time series (Noferti, 1999). After the evaluation of the fact that error terms of regression equation are stationary, we can use common econometric methods to estimate parameters by time series and use F, t statistics in statistical inferences.

Cointegration tests

Various methods have been proposed for Cointegration test. One of these methods includes Engle, Granger, Cointegration Regression Durbin - Watson Test (CRDW), Autoregressive Distributed Lag (ARDL) and Johansen &Juselius. Here, there is a brief explanation of Johansen & Juselius Cointegration.

Johansen & Juselius Cointegration test

Given the shortcomings of Engle-Granger method, Johansen & Juselius Cointegration test has some advantages solving the shortcomings of Engle-Granger method. This method can evaluate the long-run relationship among some variables and define directly the number of long-run relations. Additionally, Johansen &Juselius method is based on the Maximum Likelihood (ML). Johansen &Juselius (1990) presented maximum likelihood method as one of the most common Cointegration methods. This method evaluates the long-run equilibrium relationship among some economic time series variables and it is turned into a basic instrument to estimate economic models of time series. In this method, estimation of Cointegration vectors (coefficients of long-run equilibrium relationship) among variables is done by vector autoregression model (VAR) among the variables.

The relationship between VAR model and Cointegration provides Cointegration vectors of VAR coefficient. The mentioned method is based on the following error correction model:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \mu_0 + \mu_1 t + u_t t = 1, \dots \dots, T \qquad (5)$$

Where, Z_t is a vector of p current variables of model. Γ and Π are matrices of coefficients, μ_0 , μ_1 are vector of constant coefficients and time series, Δ indicates difference operator and u_t is Gaussian error with zero mean and constant variance. The matrix of Π coefficients or matrix of effect provide information on long-run relationship. The above vector error correction consists of three cases:

1-If Π rank is full, then z_t is stationary and achieving spurious regression is not achieved. The best method is estimation of VAR model based on the level of variables.

2-If Π rank is zero, no long-run information is achieved, it means that no linear combination among Z_t variables is found to be I(0). Thus, the suitable model of VAR model is based on the difference of first rank of variables (it means that variables are not co-integrated).

3-If Π rank is positive, r is lower than p (p is the coefficients in model) and α, β matrices with dimensions (p, r) as βα Z = II are presented. Thus, β consists of the coefficients of r different Cointegration vectors presenting fixed $\dot{\beta} Z_t$. Even if Z_t is not stationary, α is the short-run speed of adjusting coefficients in equations system (Johansen, 1995).

The test of determining the number of convergence vectors:

Johansen method attempts to estimate VAR model of equation (20.5) and the residuals are used to compute two statistics of likelihood ratio (LR) to determine unique Z_t Cointegration vectors. The first test in which H0 is that Π rank is less or equal to Cointegration vector is called trace test. It is as follows:

$$\text{Trace} = -T \sum_{i=r+1}^{p} \text{Ln}(1 - \hat{\lambda}_i) \qquad (6)$$

For (r=0,1,...,k-1), test statistics (λ_{Trace}) is computed and its value is compared with the presented critical value. If the test statistics value is greater than its critical value, null hypothesis of r cointegration vector against hypothesis of more than r co-integration vectors, is rejected. When null hypothesis of r cointegration vector is supported that test statistics value is smaller than its critical value.

The statistics of second test is Maximum eigen-values test with null hypothesis of exactly r cointegration vectors in Z_t as follows:

$$\lambda_{max} = -T \text{Ln}(1 - \hat{\lambda}_{r+1}) \qquad (7)$$

If the computed value of λ_{max} is more than its critical value, null hypothesis of r Cointegration vectors against hypothesis 1 of r+1 co-integration vectors is rejected. R Cointegration vectors are supported if the statistics value of test is smaller than its critical value. The distribution of these two tests is not based on common chi-square distribution. The critical values of above likelihood ratio tests are achieved by numerical simulations (Johansen, S., Juselius, 1990; Osterwald-Lenum, 1992).

Trend Determination

In Johansen- Juselius Cointegration test, the existence or non-existence of time trend is important in time series. After determining time trend, it should be defined that deterministic variables of intercept and trend are considered in co-integration vectors or in short-run error correction model. Including intercept in short-run error correction model as based on difference of first rank of variables, means considering trend in Cointegration vectors. To evaluate the existence or non-existence of intercept and time trend, the following vector error correction model with two time lags is considered.

$$\Delta Z_t = \beta_1 \Delta Z_{t-1} + \alpha \acute{\beta} Z_{t-2} + u_t \qquad (8)$$

Where, α is $k \times k$ matrix of long-run non-equilibrium adjustment speed terms, β is $k \times k$ matrix of long-run relations coefficients and u_t vector $k \times 1$ dedicated to equations disturbance terms. If the intercept and time trend in short-run model and co-integration vectors are considered, we have the following equation:

$$\Delta Y_t = \beta_1 \Delta Y_{t-1} + [\acute{\beta} \quad \mu_1 \quad \delta_1] \begin{bmatrix} Y_{t-2} \\ 1 \\ t \end{bmatrix} + \mu_2 + \delta_2 t + U_t \qquad (9)$$

Where, μ_1 , δ_1 are $k \times 1$ intercept vectors and time trend long-run relations and μ_2, $k \times 1$ areδ_2 vectors of intercept and time trend short-run relations (Nofersti, 1999). There are five cases regarding intercept and time trend:

1- If $\delta_1 = \mu_1 = \mu_2 = \delta_2 = 0$ (No intercepts and no trends), it means that intercept and time trend are not in long-run and short-run relations. In real world, such thing is impossible and intercept should be considered in the model.

2- If $\delta_1 = \mu_2 = \delta_2 = 0$ (Restricted intercepts and no trends). In this case, in short-run model, there is no intercept and trend ($\mu_2 = \delta_2 = 0$) and there is no trend in long-run relationship ($\delta_1 = 0$). Thus, only restricted long-run relations have intercept.

3- If $\delta_1 = \delta_2 = 0$ (Unrestricted intercepts and no trends). Thus, there is no time trend in short-run model and only there is intercept. This intercept causes that long-run relations have trend but because $\delta_1 = 0$, it is assumed that long-run relations intercept is remained by intercept of short-run relations. Indeed, when the above mentioned model being estimated, μ_1, μ_2 , are combined and forms an intercept for short-run model.

4- If $\delta_2 = 0$ (Unrestricted intercepts and restricted trends), there is no time trend in short-run model. It means that for long-run relations, there is no quadratic time trend but as there is no $\delta_1 = 0$, we consider time trend for long-run relations. It is when we have a linear growth in long-run relations but model variables cannot explain it. In other words, there is an unclear exogenous growth (e.g. technology improvement) in long-run relations and it should be considered in our model. The long-run relations are restricted to have time trend.

5- If δ_1, δ_2 μ_1, μ_2, are not zero (Unrestricted intercepts and trends). In such a case, due to time trend in short-run model, the long-run relations have quadratic time trend. Therefore, such case is impossible in economic statistics mainly when the variables logarithm is used in the model because it is not logical we consider an increasing or decreasing growth for an economic variable.

Johansen (1995) states introducing deterministic variables in model is done simultaneously with determining the rank of Π matrix, it means that the above five models are estimated from the most restricted case (first model) to the most unrestricted case (fifth model). Then, hypothesis of lack of Cointegration vector (r=0) is tested in them. If according to critical values of trace test or maximum eigenvalue, this hypothesis is rejected, in the second stage, null hypothesis r=1 is tested for these five cases until null hypothesis being accepted. Thus, the numbers of co-integration vectors along with their model being determined concurrently.

Co-integration advantages

Co-integration theory is of great importance/considerable from three aspects. First, co-integration indicates a long-run and equilibrium relation among non-stationary time series variables. It means that as the components of a vector of variables can have mean, variance and covariance of time, the linear relationship among these variables has no dependence on time. Second, co-integration indicates a significant relationship among the variables and this removes the problem of insignificant relations. In other words, the regressions rejected by non-stationary variables, are significant if the variables are co-integrated with each other. Finally, co-integrated variables have an error correction model, explaining short-run and long-run relationship among these variables. Thus, using common VAR if the variables are co-integrated can ignore the long-run models relations among the variables.

5-2 Vector error correction model (VECM)

Vector error correction model (VECM) is a restricted vector autoregressive model (VAR) being applied for non-stationary and co-integrated time series. If after performing co-integration test, we recognized that there is one or some co-integrated vectors among the existing variables, so

VECM will be the best method for estimation. This method adjusts variables short-run changes and equilibrium deviation.
ECM model is defined for the above variables as follow:

$$\Delta Y_t = \alpha \Delta X_t + \gamma (Y_{t-1} - \beta X_{t-1}) + \varepsilon_t \qquad (10)$$

As/because/since ΔX_t , both are I (0) and stationary with the assumption that error term has ΔY_tstochastic white noise process and the above model has interpretable results if two variables being co-integrated with (1,-β) vector because in this case, $(Y_{t-1} - \beta X_{t-1})$ variable, that is U_{t-1}, will be I(0) and due to stationary of variables, the model is estimable using OLS.
In the above model, ΔX_t explains short-run disturbances for Y, however correction term, U_{t-1}, reflects adjustment to the stable condition. If the error correction term is statistically significant, it indicates what share of non-equilibrium in Y variable in the previous period is corrected in the current period. In other words, shows adjustment speed.
The above simple model is generalized easily to include a bivariate lag:

$$A(L)Y_t = B(L)Y_t + \gamma (y_{t-1} - \beta X_{t-1}) + \varepsilon_t \qquad (11)$$

Where, A(L) , B(L) are lag operators and like the previous case, the disturbance term has white noise process. To estimate an error correction model, we must have co-integration coefficients in (β). Normally, these coefficients are estimated by co-integration regression equation using OLS estimator.

6- Research Findings

6-1 Variables stationary

In econometrics, for being ensured of non-spurious, the most important issue is the evaluation of the methods. Mostly, non-stationary of variables or stochastic time series leads to estimated spurious regression. To be ensured of applied variables stationary in the model, unit root tests can be used. There are two famous tests including Augmented Dickey-Fuller and Philips – Perron in this regard. Despite the close similarity of these two tests findings, critical values by Dickey-Fuller (1979) are not valid in case of limit distribution. To avoid auto-correlation problem of regression error terms, two methods of Philips – Perron (1988) are used to test stationary of variables/variables stationary. In this method, it is assumed that when disturbance terms are not distributed independently and similarly, limit distribution is included. The results of Philips-Perron unit root test are shown in Table 1.

Table 1: The results of variables stationarity by Philips-Perron (PP) test in the level

Variable	Test process	Prob	P P statistics	Critical values			Stationarity condition
				10%	5%	1%	
GY	With intercept and trend	0.34	-2.48	-3.20	-3.54	-4.24	Non-stationary
ER	With intercept and trend	0.48	-2.20	-3.20	-3.54	-4.24	Non-stationary
FD	With intercept and trend	0.64	-1.89	-3.20	-3.54	-4.24	Non-stationary
FR	With intercept and trend	0.46	-2.22	-3.20	-3.54	-4.24	Non-stationary
LT	With intercept and trend	0.32	-2.51	-3.20	-3.54	-4.24	Non-stationary
LG	With intercept and trend	0.22	-2.76	-3.20	-3.54	-4.24	Non-stationary
LIFN	With intercept and trend	0.21	-3.16	-3.20	-3.54	-4.24	Non-stationary
LCAP	With intercept and trend	0.42	-2.87	-3.20	-3.54	-4.24	Non-stationary

Source: Study findings

The results of Table 1 show that all variables are non-stationary at the level and de-trending the variables cannot make the variables stationary and this is the reason for random nature of trend in unit root regression equation. Detrending time series variables has received much attention by econometric economists recently. The economists consider detrending the variables as acceptable if the trend is deterministic for time series and are ensured of its non-stochastic nature. If the trend is stochastic, it misleads the estimations of unit root test and it cannot be used. Thus, only when the trend is deterministic, it is used. Thus, none of variables are stationary with detrending at the level and the trend in unit root equation is stochastic. To determine cointegration degree of variables, Philips –Perron test is performed in first rank difference of variables. As shown in Table 2, all variables are stationary with one differentiation, it means co-integrated of first rank I (1).

Table 2: The results of variables stationary evaluation by Philips-Perron (PP) test in the first difference

Variable	Test process	Prob	P P statistics	Critical values			Stationarity condition
				10%	5%	1%	
DGY	With intercept and trend	0.00	-4.74	-3.21	-3.55	-4.25	Stationary
DER	With intercept and trend	0.04	-4.57	-3.21	-3.55	-4.25	Stationary
DFD	With intercept and trend	0.00	-4.83	-3.21	-3.55	-4.25	Stationary
DFR	With intercept and trend	0.10	-3.23	-3.21	-3.55	-4.25	Stationary
DLT	With intercept and trend	0.01	-4.44	-3.21	-3.55	-4.25	Stationary
DLG	With intercept and trend	0.00	-6.65	-3.21	-3.55	-4.25	Stationary
DLIFN	With intercept and trend	0.00	-10.93	-3.21	-3.55	-4.25	Stationary
DLCAP	With intercept and trend	0.00	-11.22	-3.21	-3.55	4.25-	Stationary

*D denotes first rank difference
Source: Study Finding

6-2 The co-integration analysis of estimated variables of model

In most economic time series variables, the same directional movement is observed due to a common trend in most of them. Generally, economic variables whose statistical features (e.g. mean and variance) are based on time are called non-stationary variables. The estimation of regression model by non-stationary variables is called spurious regression because referring to the results of such model leads to misleading results. One way to avoid spurious regression is to differentiate and use the difference of variables in the model but such model doesn't present any information about long-run relationship of variables. Under such conditions, we can resort to cointegration methods and estimate the required model based on the level of variables. The results of stationarity test of variables show that variables are stationary with once differencing. To analyze cointegration among the model variables, we can use Johansen and Juselius cointegration test.

Determination of optimal lag in VAR model

The first issue in vector auto-regressive models is determining the length of lag. To determine optimal lag, Schwarz-Bayesian, Akaike or Hannan-Quinn criteria are used. In the present study as the data are annual, Schwarz-Bayesian criterion is used because more lags are considered. After entering the variables in VAR system, it was observed that Schwarz-Bayesian criterion had the maximum lag in lag 2. Thus, lag length 2 is selected. The results of optimal lag selection are shown in Table 3.

Table 3: Determine optimal lag in VAR model

Lag	LogL	LR	FPE	AIC	SBC	HQ
0	-32.46	NA	1.49E-09	2.38	2.73	2.50
1	142.3	256.99	2.45e-12*	-4.14	1.46	-3.03
2	214.99	72.70	2.92E-12	-4.65	-0.90	-2.56

Source: Study findings

Johansen cointegration test and evaluation of the long-run relations of variables

To estimate the long-run equilibrium relations among the variables, maximum likelihood of Johansen is used. This test considers various assumptions of definite trend in data in terms of existence and non-existence of intercept and linear or non-linear trend. Finally, the presence of restricted intercept without time trend (second case of cointegration test) is supported. The optimal lag of this test is the optimal lag in VAR model, lag 2. Table 4 shows maximum eigenvalue and the trace test to estimate the number of cointegration vectors. The results of Johansen and Juselius cointegration test in Table 4 show that the existence of a co-integrated vector among the variables is supported. Thus, the results of cointegration test show a long-run equilibrium among model's variables.

Table 4: The results of Johansen and Juselius cointegration test

p-value	Critical values	Maximum eigenvalue test	p-value	Critical values	Trace test	H0
0.01*	28.58	33.61	0.02*	54.07	57.26	r=0
0.52	22.29	13.47	0.48	35.19	23.65	1≥ r
0.79	15.89	5.93	0.62	20.26	10.18	2≥ r

R: The number of cointegration vector. It shows cointegration relation among the variables at the level 5%.Source: Study findings

After determining the number of co-integrated vectors, it is required to normalize the co-integrated vector based on the variable of productivity growth. This is achieved by dividing all estimated parameters in unrestricted co-integrated vector by the required variable coefficient.

Table 5: The results of co-integrating vector estimation and long-run relationship of variables

Normalized co-integrated vector		Unrestricted co-integrated vector coefficient	Variable
T statistics	Coefficient		
-	1.00	2.88	GY
-91.64	-1.36	-3.92	ER
-15.57	1.07	3.08	FD
-26.85	-0.69	-2.00	FR
-18.02	1.43	4.12	LT
-32.25	-2.57	-7.41	LG
-34.81	-1.31	-3.78	LINF
-28.78	0.77	2.23	LCAP
-5.29	8.88	25.61	C

It shows significance at the level 5%.Source: Study findings

Table 5 illustrates a long-run equilibrium relationship among the model variables and this relationship is identified in terms of GY variable as follows:

$$GY = 8.9 - 1.4ER + 1.1FD - 0.7FR + 1.4LT - 2.6LG - 1.31LINF + 0.77LCAP \quad (12)$$

Long-run model results show that all study variables are significant at 5% level. The findings of long-run equilibrium (12) relationship as semi-logarithmic and the results show that 1% increase of exchange rate volatilities reduce labor productivity growth to 1.36.

6-3 The vector error correction model and evaluation of short-run relations of variables

There is a close relationship between co-integration and error correction models based on Granger theorem, corresponding to each economic long-run relationship, there must be a short-run relationship as error correction mechanism to achieve long-run equilibrium. This concept was presented for the first time by Philips (1957). The vector error correction is a restricted vector autoregressive model (RVAR) designed for co-integrated non-stationary series. This model restricts endogenous variables long-run behavior to approach the co-integrated relations via dynamic short-run adjustment. In other words, this model shows the adjustment of variables to non-equilibrium in short run to achieve a long-run equilibrium relationship. In vector error correction model, the co-integrated term is called error correction term because deviation from long-term equilibrium is corrected via a series of partial short-term adjustments. The error correction term coefficient defines the speed of short-run adjustment to long-term in case of volatility. Thus, error correction models associate variables short-term volatilities to their long-term equilibrium values. Estimation results of short-run vector error correction model are shown in Table 6.

Table 6: The estimation results of vector error correction model

SD	T statistics	Coefficient	Variable
-1.40	-0.24	-0.34	D(GY(-1))
-0.68	-0.23	-0.16	D(GY(-2))
1.05	-60.88	64.00	D(ER(-1))
-1.13	-64.22	-72.73	D(ER(-2))
0.54	-14.97	8.14	D(FD(-1))
-1.04	-15.01	-15.65	D(FD(-2))
-0.98	-18.49	-18.12	D(FR(-1))
1.07	-19.56	20.85	D(FR(-2))
1.98	-0.29	0.55	D(LT(-1))
-0.45	-0.26	-0.12	D(LT(-2))
0.93	-16.68	15.49	D(LG(-1))
1.35	-17.98	24.28	D(LG(-2))
-1.40	-17.13	-24.02	D(LINF(-1))
-1.24	-16.28	-20.25	D(LINF(-2))
-0.85	-8.32	-7.03	D(LCAP(-1))
1.56	-5.79	9.05	D(LCAP(-2))
1.48	-6.93	0.16	ECM(-1)

Significance at 5% level.
Source: Study findings

The results of short-term model in Table 6 show that error correction term is significant at 5% level and it shows that about 16% of deviations of labor productivity growth variable from the long-run equilibrium value is adjusted after a period of time. Thus, adjustment term coefficient shows relatively appropriate adjustment speed of convergence to long-term equilibrium.

6-4 Diagnostic tests

After being ensured of estimated non-spurious nature, classic assumptions are investigated. This evaluation causes that estimations being tested according to/regard to the classic assumptions of the best linear unbiased estimator (BLUE). To do this, classic assumptions are evaluated. Variance Heteroskedasticity problems lead to the increase of estimated coefficient variance of intercept and variance of other estimated independent variables is affected and estimation is not efficient. To evaluate/investigate variance Heteroskedasticity of residuals, Breusch-Pagan and Glejser tests are used and the results of E-views software output are shown in Tables 7, 8.

Table 7: The results of Breusch-Pagan test to determine variance Heteroskedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.48	Prob. F(7,34)	0.11
Obs*R-squared	22.75	Prob. Chi-Square(7)	0.12
Scaled explained SS	47.14	Prob. Chi-Square(7)	0.00

Source: Study findings

Table 8: The results of Glejser test to determine variance Heteroskedasticity

Heteroskedasticity Test: Glejser			
F-statistic	1.26	Prob. F(7,34)	0.23
Obs*R-squared	19.84	Prob. Chi-Square(7)	0.23
Scaled explained SS	24.19	Prob. Chi-Square(7)	0.09

Source: Study findings

As shown, the above mentioned tests finding show that fitted model residuals have false variance of standard error and results. According to econometric issues, auto-correlation in residuals leads to homogenous estimation. To avoid such error, Breusch- Godfrey test is used. The results of Breusch- Godfrey test are shown in Table 9.

Table 9: The results of Breusch- Godfrey test to evaluate auto-correlation

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.14	Prob. F(2,33)	0.17
Obs*R-squared	3.62	Prob. Chi-Square(2)	0.12

Source: Study findings

In Breusch- Godfrey test, null hypothesis regarding to non-auto correlation is supported based on the existing likelihood in table and auto-correlation in residuals of equation is rejected

7- Conclusion

One of the most important items to select exchange rate systems is the evaluation of the effect of exchange rate volatilities on real sector of economy namely productivity growth. The different exchange systems and exchange rate volatilities have different effects on economic system of our country and the economists don't agree regarding the best exchange system and it depends on the conditions of the country. This study evaluates the exchange rate volatilities on productivity growth of country by considering financial development index and collecting data from World Bank during 1979-2014. At first, by Philips-Perron test, the stationarity of variables is estimated and then using Johansen, Juselius, the cointegration relationship between variables and their long-run relationship are considered. Finally, using vector error correction model, we investigate short-run volatilities of variables in long-run equilibrium path. The results showed that exchange rate volatilities had negative relationship with productivity growth and the effect of financial development on productivity growth was positive. Also, the effect of reciprocal/mutual relationship of exchange rate volatility and financial development factor on productivity growth was negative and smaller than the effect of exchange rate volatilities. According to study findings, the policy makers should consider the effect of exchange rate volatilities on real sector namely productivity growth to select a good exchange rate system in country. In policy making, we should consider the level of financial development of the country and its direct and indirect effect on productivity growth (via the channel of adjusting exchange rate

8- References

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