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THE RELATIONSHIP BETWEEN LABOR PRODUCTIVITY AND EXCHANGE RATE: A PANEL DATA ANALYSIS

Emek Verimliliği Döviz Kuru İlişkisi: Bir Panel Veri Analizi

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ABSTRACT

The aim of this study is to contribute to the determinants of the exchange rate, which has emerged as an important problem especially for developing countries in recent years. For this purpose, relationship between the exchange rate and labor productivity has been tested using the panel data method. The scope and shortcomings of theoretical approaches have been summarized such as Purchasing Power Parity, Interest Rate Parity, Fisher Effect and Unbiased Rate Theory as well as Balassa Samuelson Effect which emphasize the relationship between exchange rate and labor productivity. The relationship between exchange rate and labor productivity has been examined in three groups as developed, developing and all countries. Although it has been proved econometrically that the exchange rate is influenced by labor productivity and the variables move together in all groups, the strongest relationship has been identified in developing countries.

Keywords: World Economy, Exchange Rate, Labor Productivity

Jel Codes: F31, J24

ÖZET

Bu çalışmanın amacı özellikle son birkaç yılda gelişmekte olan ülkeler için önemli bir problem olarak yeniden baş gösteren döviz kurunun belirleyicilerine katkı sağlamaktır. Bu amaçla döviz kuru ile emek verimliliği arasında uzun dönemli bir ilişkisinin varlığı panel veri yöntemiyle test edilmiştir. Satın alma Gücü Paritesi, Faiz Paritesi, Fisher Etkisi gibi yaklaşımların yanı Balassa-Samuelson Hipotezi gibi döviz kuru ile emek verimliliği arasında ilişki kuran kuramsal yaklaşımların kapsamı ve eksiklikleri özetlenmiştir. Daha sonra döviz kuru ile emek verimliliği arasındaki ilişki panel veri yöntemiyle gelişmiş, gelişmekte olan ve tüm ülkeler olmak üzere üç grupta incelenmiştir. Bütün gruplarda döviz kurunun emek verimliliğinden etkilendiği ve bu iki değişkenin birlikte hareket ettiği ekonometrik olarak ispat edilmiş olsa da en güçlü ilişki gelişmekte olan ülkelerde tespit edilmiştir.

Anahtar Kelimeler: Dünya Ekonomisi, Döviz Kuru, Emek Verimliliği

Jel Kodları: F31, J24

1. INTRODUCTİON

Exchange rate is one of the basic indicator/prices that affect and determines the behavior of economic decision-making agents. The exchange rate, which can be defined as the ratio of different countries' national currencies to each other, can affect many other variables as well as can be affected many others. Due to the impact on economic decision-making behavior and the potential to influence national economies, there is an extensive literature on exchange rates.

It is possible to summarize the literature on exchange rates under two groups. As you will see on the following pages while the methods used in both groups are very similar, the time series and variables can differ each other. The first group of studies focus on determiners of exchange rates. In these studies, the main question is how the exchange rates are priced and which variables are important. The second group of studies focused on the relationship between exchange rate and other important macroeconomics indicators such as growth, inflation, balance of payments, investment and unemployment, and try to determine the degree of this relationship in order to show why exchange rate is important. The relationship examined by this paper could take place in the scope of first group.

However empirical studies try to explain the exchange rate fluctuations, which is a nominal variable, with another variables. The most widely used variables are inflation, interest rate, balance of payment and budget deficit. In addition, there are many studies testing these factors which are difficult to measure but have an impact on the exchange rate such as speculation and political stability. We intent to keep away us from the agglomeration and distraction attention to different aspect.

It's commonplace that to check the existing theories with empirical studies. But some studies can be experimental. In other words, they try to reveal the relation unnoticed or underrated before. To that end, we propound in this paper a different question. Whether the relationship between labor productivity and exchange rate is the main question in this paper.

2. LEADİNG THEORİES OF EXCHANGE RATE

Before look over the exchange rate studies it is necessary to look at how the exchange rate fluctuations are explained theoretically. At the first glance there are four theories of exchange rate. These below mentioned theories are Purchasing Power Parity (PPP), Interest Parity, Fisher Effect and lastly Unbiased Rate Theory.

2.1. Purchasing Power Parity

The origin of alternative approaches of Purchasing Power Parity is the Law of One Price (LOOP). The LOOP is the basis of the Purchasing Power Parity. According to the LOOP, in a world where transportation costs between different markets are considered to be "zero" and there are no practices preventing trade, two different goods, which are not different in terms of benefit, should be sold at the same prices in different markets. (Gibson & Thirlwall, 1992, p. 60)

Theoretically, long-term changes in exchange rates are explained by the PPP. But there are two sorts of PPP. One of them is Absolute PPP (APPP) which is based on the principal of same product prices. And the other type of PPP is Relative PPP (RPPP)which is based on the principal of inflation rate.

Generally, the Purchasing Power Parity has important assumptions like whatever theoretical knowledge. The first assumption of PPP is that there is not any cost to move a commodity spatial. In other words, there are not freight costs for transportation. In addition to zero transportation cost, there are not any transaction costs for converting currencies each other. Every currency can be easily converted to another currency. This is the second assumption of PPP. The last assumption is that there is not any restrain on trade between countries such as quota and tariffs (MacDonald, 2007, p. 42).

Under above mentioned assumptions APPP states that identical and similar goods should have same prices in the different countries. In this circumstance the price of a good should be such that, the ratio of prices of the goods is the exchange rate between currencies of the countries. If price of a good falls, based on the assumptions, the good which sold at lower price will be transported to the country where price is high, or vice versa. However, obviously, APPP exclude the non-tradable goods which cannot be transported like services. So, it has evolved RPPP which other version of PPP approach.

As it motioned before, the RPPP approach is based on inflation. When inflation rate of a country (ex. A) is higher than the other country (ex. B), prices of goods will increase in "A" faster than "B". But when we remember that identical and similar goods should have same prices in every country, currency of "A" will deprecate with respect to currency of "B". Therefore, exchange rate is determined on the basis of inflation differential under the RPPP. The differences of inflation rate will determine the exchange rate deprecation. Clearly, the link established under the RPPP is unilateral. In a word, the exchange rate value is result of differential of inflation rate. However, many empirical studies have indicated that exchange rate is one of the main determinants of inflation. Consequently, theoretical claims of PPP have remained controversial although it explains pieces of reality with accommodate non- tradable goods (P.Taylor & Sarno, 2002).

2.2. Interest Rate Parity

Another approach to explain exchange rates is Interest Rate Parity (IRP) theory. The approach focuses on short-term changes of exchange rate, widely used in exchange rate estimation models and closely related to the degree of integration of global financial markets.

The IRP examines the relationship between domestic and international interest rates, spot foreign exchange and futures markets. Zero transaction costs, full mobility of capital and investor who can invest financial securities in both national currency and foreign currency are the assumptions of IRP. Under the

assumptions the theory states that exchange rate of the currencies is determined by the interest rates of countries.

Two different prices (interest rate) of an asset both at home and abroad at the same time leads to profit opportunities for investors. Interest rate differences between the countries affects the arbitrage process of the investors in the free market. These investors, who are called arbitrators, make profit by buy the economic asset from the low-price market and sell it in the high price market. As a result of the arbitrage process, prices rise in the low-priced market while fall in the high-priced market. Ultimately the prices of financial assets are equalized in the two markets.

IRP general assumes that exchange rates synchronously adjust to changes in relative interest rates between two currencies so as to eliminate arbitrage opportunities. That is, the returns of financial instruments such as bonds of different countries will be equalized by the arbitrage of market agents. The value of the exchange rate will be determined by the returns of the national currencies in their countries. The difference between the returns of two identical bonds traded in different national currencies will show itself at the value of the exchange rate. (Hubbard & O'Brien, 2012, s. 239-240).

In the circumstance, if two different countries have same risk level, maturity, no transaction and information cost, no restrictions on the international mobility of capital there will no differences financial assets of the countries. This is called also “Covered Interest Rate Parity”.

2.3. Fisher Effect (Uncovered Interest Rate Parity)

However, the main feature of arbitrage is that the riskless investment. But, when the funds are invested in another country, there is a risk that may arise due to possible exchange rate changes. The investors should take precautions to eliminate the currency risk for arbitrage. The most common way is to use futures markets. In other words, the investor must secure itself with futures market while investing in a foreign currency bond instrument in foreign currency.

Fischer Effect or Uncovered Interest Rate Parity (UIRP) state that the forward rate and the expected spot rate are identical because, even without covering exchange rate risk in the forward market, actions of market participants will make them equal. If forward rate is greater than the expected spot rate everyone sells dollars forward and the forward rate will fall until it becomes equal to the expected spot rate. At this point, profit opportunities disappear. On the contrary everyone buys dollars forward, the forward rate will rise until it becomes equal to the expected spot rate. At this point, profit opportunities disappear.

Starting from this point of view, Rowland says that the interest difference between the two countries is equal to the expected change in the exchange rate (Rowland, 2002). It is expected that the value of the currencies of the countries will change according to the interest differences and value of the currency of the country with high interest rate will decrease in the extent of nominal interest rate difference. In other words, under the UIRP condition, the domestic interest rate equals the sum of the foreign interest rate and the expected exchange rate change.

2.4. Unbiased Rate Theory

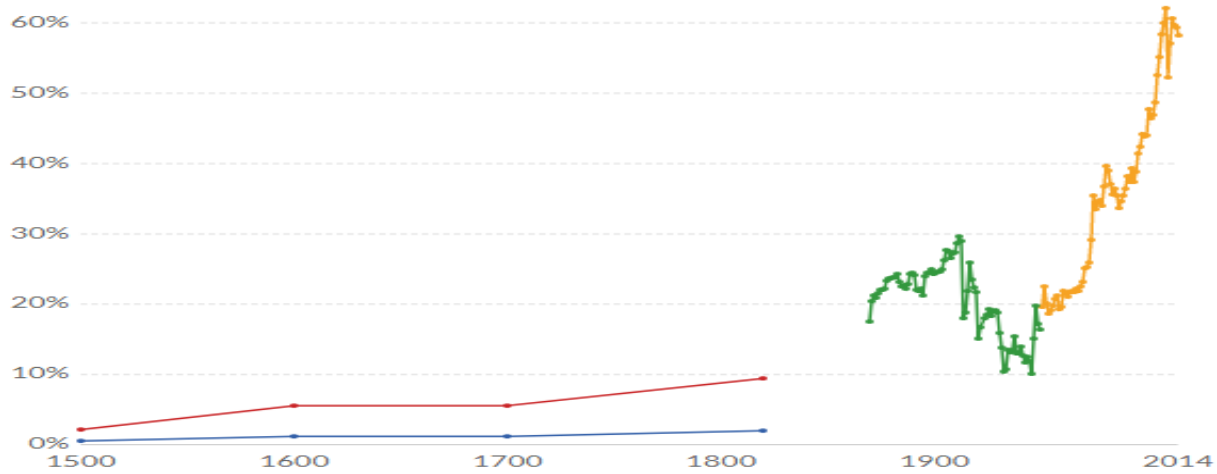
The theory is a contribution to interest related exchange rate theories. As seen above there is a point of contention about forward and future value an of instrument. The contribution of the Unbiased Rate Theory (URT) is right here.

The URT is based on the assumptions that investors are both rational and risk neutral and capital is freely mobile (Razzak, 2002). URT also known as Forward Parity is the theory proposing that forward rates are unbiased estimator of future spot rate. Unbiased forward rates mean forward rates of an instrument will be equal to the anticipated price of an instrument on a certain date or expiry date. Because the forward rate “fully reflect” available information about the exchange rate expectation. Thus, is usually viewed as an unbiased predictor of future spot rate. (Chiang , 1988)

It is clearly understood from these theories that the mutual values of the countries’ currencies have explained in the short and long term. The APPP approach which based on the LOOP states that in the long run, exchange rates are go up in price to equal exchange prices for tradable goods. The RPPP approach corresponds to the modification of the APPP approach with non-tradable goods. So, it’s clear that in both approaches, the mutual value of the currencies has determined as a result of the effective price mechanism.

On the other hand, the approaches developed on the axis of IRP seem to try to explain the changes in exchange rates based on the deep integration of financial markets today. Accordingly, the mutual value of the currencies of the countries corresponds to the differences in returns from financial assets. The reciprocal value of national currencies is the reflection of differences in the return on financial assets in countries or more directly on interest rates.

Thus, these approaches, which can be grouped in two groups, are incomplete as they overlook an important feature of today's economic structure. As seen in the graphic below, exchange has become an important variable in today's economic structure.



Graphic: Total of Imports and Exports, 1500-2014
Source: Marrini, S., Global Value Chain and Transformation of Global Trade,

As can be seen from the graphic above, foreign trade became an important feature of the world economy in the twentieth and twenty first centuries. This have triggered empirical and theoretical studies on the relationship between exchange and exchange rate. The theoretical approach that examines the relationship between exchange rate and exchange is known as the Balassa and Samuelson Hypothesis in the literature.

2.5. Balassa Samuelson Effect

Balassa and Samuelson effect bases deprecation or appreciation of exchange rate on the productivity differences of production factors which used in traded and non-traded sectors. According to the hypothesis, the sectors whose products traded are exposed to global competition, so their productivity is higher. If productivity is high in a sector, the efficiency of the factors used in the production process is high in that sector. High productivity means an increase at the earnings of the factors. For example, wages increase under the assumption that labor is the only production factor. However, the price of the tradable products stays stationary due to international competition while wages increases because of higher productivity. Labor which is work for in non-tradable sectors tends to move to the tradable sector due to higher wages inside the country. To restrain the movement, wages increase in the non-tradable sectors. However, after a while, wage increases are reflected to the price of the products by the employers and the price of the non-tradable products increase. The relationships can be shown in formal form with the following equations;

$$P_T^X = P_T^Y \qquad (1)$$

$P_T^{\dot{I}}$, represents increase rate of tradable product price in i country. So, the mean of first equation is that increase rate of tradable products price is equal in the countries X and Y. Increase rate of non-tradable products price, however, would not be equal as follow.

$$P_{NT}^X \neq P_{NT}^Y \qquad (2)$$

If worker become more productive then firms consent to pay more for worker. That is, wages will increase. If wage increases are not accompanied by productivity, however, firms would compensate the wage increases by mark up.

$$P_T^X = W_T^X - LP_T^X \quad (3)$$

$$P_T^Y = W_T^Y - LP_T^Y \quad (4)$$

$$P_{NT}^X = W_{NT}^X - LP_{NT}^X \quad (5)$$

$$P_{NT}^Y = W_{NT}^Y - LP_{NT}^Y \quad (6)$$

$W_Z^{\dot{I}}$, represents increase rate of wages in sector Z in country İ, and $LP_Z^{\dot{I}}$ represents increase rate of labor productivity in sector Z in country İ at the 3,4,5 and 6 equations. But, because of mobility, we need to remember that the wages are tend to equal inside country. This is shown at the 7 and 8 equations.

$$W_T^X = W_{NT}^X \quad (7)$$

$$W_T^Y = W_{NT}^Y \quad (8)$$

After the descriptions we need to link up with labor productivity and exchange rate. Exchange rate is ratio of price indexes of the two different country (in our example X and Y). So;

$$ER = P^X - P^Y = [(1-\alpha^X)P_T^X - \alpha^X P_{NT}^X] - [(1-\alpha^Y)P_T^Y - \alpha^Y P_{NT}^Y] \quad (9)$$

ER is depreciation or appreciation of exchange rate. $P^{\dot{I}}$ represents price index in the country İ and $\alpha^{\dot{I}}$ is weightiness of non-tradable goods in price index. When we combine the 1, 7, 8 and 9 we achieve to Balassa and Samuelson equation in the last instance.

$$BS = \alpha^X GAP^X - \alpha^Y GAP^Y \quad (10)$$

$$GAP^{\dot{I}} = LP_T^{\dot{I}} - LP_{NT}^{\dot{I}} \quad (11)$$

After these specification Balassa (1964) and Samuelson (1964) effect shows that productivity gap between the tradable and non-tradable sectors results exchange rate deprecation or appreciation (Tille, Stoffels, & Gorbachev, 2001).

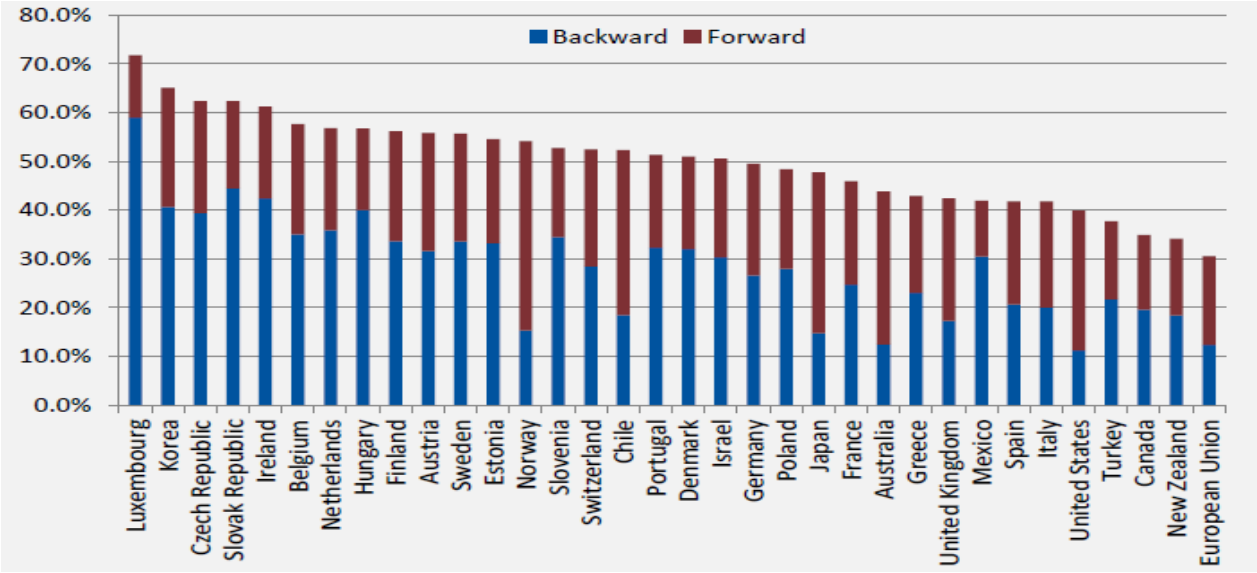
It's clear that BS hypothesis explains the changes in the exchange rate with the productivity difference between the sectors within the country. In other words, it establishes a relationship between the production structure and the exchange rate. İn this regard The BS Hypothesis is different from the Purchasing Power Parity, Interest Rate Parity, Fisher Effect and Unbiased Rate Theory described in the previous titles.

The BS Hypothesis is based on two sectors that are exposed to global competition (tradable) at the one side and do not feel any competitive pressure (non-tradable) at the other side. However, the number of sectors and activities that have not subjected to the global competitive pressure is very few due to the globalization process and the removal of foreign trade barriers after the 1980s and 1990s. Therefore, the two categories seem inconsistent today.

Its not so important whether sectors subjected global competition or not. More importantly, there have been a change in the production organization in the world economy after the 1990s. The production structures of national economies have intertwined and the weight of intermediate goods has increased rapidly in world trade today. Its mean that countries which want to export goods have to import first. For example, the following statements were cited from the report published by the WTO in 2018 (World Trade Organization, 2018);

> *Economies and sectors are interconnected. Supply and production chains have gained importance internationally. For this reason, trade of intermediate input has become an important variable observed in world trade.*

In addition to these statements, the need for import before production and export can be seen through the quantitative data shown in the table below.



Graphic: Foreign İnputs (Backward Participation) and Domestically Produced Inputs Used in Third Countries's Export (Forward Participation) as a Share of Gross Export (%)
Source: European Central Bank Working Paper Series, 2014

As it can be seen from the table, countries need imported inputs in their production and exports. This need has increased with production relations established as a result of advancing communication and transportation opportunities. There is no doubt that production and export depend primarily on imported inputs, indicating the need for foreign exchange.

At this point, it is the first thing spring to mind that a cause and effect relation can be established between the need for foreign exchange and the share of countries' imports in production and exports. When such a relationship is established, if the share of imports in production and exports is high, the need for foreign exchange will be high. In this case, the value of national currency against foreign currencies will be influenced by the need for imports as well as these theories and hypothesis. So, if the need for imports is high, national currency will depreciate against foreign currencies.

However, when we look at the table above, we see that a significant portion of the value exported by developed countries such as Luxembourg and Korea include imported value. The reality leads us to the question of how efficiently the imported intermediate goods and raw materials are used by countries.

Which country uses raw materials or intermediate goods imported from international markets more efficiently? It would be more appropriate to ask this question in relation to foreign exchange. Which country produces more value added with a certain amount foreign currency? The answer of these questions points to an important variable that determines the need for foreign exchange and the mutual value of a country's currency: Productivity.

3. LABOR PRODUCTİVİTY

The link between productivity of each production factor and exchange rates needs to be tested. But this study is limited to labor productivity. Labor productivity represents the total volume of output produced per unit of labor during a given time period. A labor productivity data providing general information about the efficiency and quality of human capital in the production process for a given economic and social context, including other complementary inputs and innovations used in production (ILO, 2019).

Labor productivity is an important measure of economic performance. Mostly, forces behind labor productivity are described especially the accumulation of capital (machinery and equipment), organizational improvements as well as physical and institutional infrastructures, improved health and skills of workers and the generation of new technology (ILO, 2019).

Differences in labor productivity affect investment, gross and per capita income and income distribution in today's highly integrated economic structure. (Englander & Gurney, 1994). Because, the amount of investment, direction of investment or income level will be affected by the labor productivity of countries. For example, the investor tries to solve the problem while he/she evaluate investment opportunity: the

amount of raw material or intermediate goods purchased from international markets with 100 dollars can be used more efficiently in which country? So, labor productivity differences will also affect the exchange rates as it determines the foreign exchange requirement for any country.

The dependence of production and exports on imports indicates the need for foreign exchange and the demand for foreign exchange determines the mutual value of the national currency. In terms of labor productivity, if labor productivity is the same in all countries, the mutual price of the national currencies will be determined by the absolute amount of needed imports. However, differences in productivity are likely to affect the amount of needed imports and hence the mutual value of national currencies. Thus, the cause affect relationship between labor productivity and exchange rates becomes an important question.

As we will see in the next section, when we look at the literature, exchange rate studies have focused on topics such as manufacturing industry, foreign deficit, budget deficit, foreign trade volume and so on. In this study, the main objective is to contribute to the literature by examining the relationship between labor productivity and the value of mutual currencies of countries.

4. LİTERATURE REVİEW

Studies on the pricing of the exchange rate are quite much. In a study conducted by Calderon and Kubota (2018), covering the years 1974-2013 and 82 countries, it has been shown that exchange rate fluctuations are greatly affected by trade in the manufacturing industry (César & Kubota, 2018). Khin et.al. (2017) conducted a study in Malaysia for the years 2010-2016 and showed a positive and short-term relationship between Consumer Price Index and Money Supply and Exchange Rate (Khin, Yee, Seng, Wan, & Xian, 2017). Adusei and Gaypong's (2017) study using Ghana's data from 1975 to 2014 showed that there is a significant relationship between exchange rate and inflation, balance of payment deficit, money supply, growth rate and external debt (Adusei & Gyapong, 2017).

According to the results of Hassan et.al (2017) using the data of Nigeria in 1989-2015 quarterly, net foreign assets and interest rates are significant in explaining the volatility in exchange rate (Hassan, Abubakar, & Dantama, 2017). According to the study conducted by Alagidede and İbrahim (2017) using data from Ghana between 1980 and 2013, the output level is the most important variable in the exchange rate pricing in the short term (Alagidede & Ibrahim, 2017). According to Cevik et.al. (2016) study covering 115 countries and 1996-2011, it was found that the national currencies of developing countries showed more volatility (Cevik, Harris, & Yilmaz, 2015).

A study by Oaikhenan and Aigheyisi (2015) using Nigeria's data between 1970 and 2013 revealed that government spending and interest rates were the most important determinants of the exchange rate (Oaikhenan & Aigheyisi, 2015). In the studies conducted by Grydaki and Fontas (2011) using the data of Latin American countries between 1979 and 2009, it was revealed that the changes in money supply and inflation rate were the most important reasons for the volatility in exchange rates (Grydaki & Fontas, 2010). In the study conducted by Asiama and Kumah (2010) using the data of African countries between 1980 and 2008, oil prices and openness were found to be the most important determinants of exchange rates (Asiama & Kumah, 2010). Calderon and Kubota's (2009) study of 82 countries and 1975-2005 revealed that productivity shocks are important variables that explain the volatility of exchange rates as well as unexpected changes in monetary and fiscal policies (Calderon & Kubota, 2009).

Isard and Symansky (1996) found evidence to support the SB hypothesis. They used 30 years data of APEC (Asian Pacific Economic Corporation) countries and found that the tradable good prices the key factor on exchange rates (Isard & Symansky, 1996). Lee and Tang (2003) studied twelve OECD countries exchange data and Total Factor Productivity (TFP). They found that TPF and exchange rate don't move together in long run. But when they used labor productivity instead of TPF the long run relationship between the two were positive (Lee & Tang, 2003). Similarly, Canzoneri, Cumby and Diba (1999) tested the relationship between productivity and exchange rate. They found the two variables are cointegrated in long run (Canzoneri, Cumby, & Diba, 1999). On the otherwise, Chinn and Johnston (1999) tested the SB hypothesis and found little evidence to prove the relationship between productivity and exchange rate (Chinn & Johnston, 1999).

5. DATA SET AND METHODOLOGY

The aim of this study is to examine the relationship between average labor productivity and exchange rates for 165 countries based on 2004-2014 data. The countries have been divided into two groups as developed and developing countries. For exchange rate data, all countries' US Dollar exchange rate have been used and taken from Unctad.Stat.

Average labor productivity has been calculated according to ILO. ILO's method has computed labor productivity as follow (ILO, 2019);

$$Labor\ Productivity = \frac{GDP\ at\ constat\ prices}{Number\ of\ employed\ persons}$$

So, the labor productivity data have been obtained by division the annual gross domestic product of the countries by the number of annual employments. And the data have been taken from the Pen World Table data base.

The stationary levels of the variables can affect the reliability of the results of econometric models which to be applied. Therefore, whether the variables stationary or not is vitally in econometric analysis. In this context, the stationary state of the variables has been analyzed by Im, Pesaran and Shin (2003) (IPS) panel unit root analysis in the study. PS (2003) panel unit root test gives more reliable results in cases where cross-sectional size is larger than time dimension (IM, Pesanan, & Shin, 2003). This is why the test type have been chosen.

The IPS (2003) test is an extended version of ADF unit root test which was developed for time series for heterogeneous panel unit root analysis. Stationarity is tested separately for each section and the average of these test statistics gives the test statistics of the panel.

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + X_{it}\delta + \varepsilon_{it} \qquad (1)$$

$H_0 = a_i = 0_i$ means that each section is rooted, whereas in $H_1 = a_i \leq 0$ hypothesis, at least one section is unit rootless in the panel root tests Im, Pesaran and Shin (IPS, 2003).

Pedroni cointegration analysis has been used for the long-term relationship between the variables. There are seven test statistics, four of which are in-group and three between groups in Pedroni cointegration analysis,. (Pedroni, Critical Values For Cointegration Tests in Heterogeneous Panels With Multiple Regressors, 1999) Three of the intra-group test statistics consist of non-parametric tests. The first test is variance ratio type, the second Phillips Peron and the third statistic are similar to PP (t) statistic. The fourth statistic is a parametric statistic similar to Augmented Dickey Fuller (ADF) (t). Cointegration tests are based on group averages approach in the between groups statistics. The first of the three tests in the group is similar to the PP (rho) statistics, while the other two is similar to the PP (t) and ADF (t) statistics (Güvenek & Alptekin, 2010).

	Grup istatistikleri	**Panel istatistikleri**
1. ρ istatistiği	$TN^{-\frac{1}{2}}\tilde{Z}_{\tilde{\rho}N,T^{-1}} \equiv TN^{-\frac{1}{2}}\sum_{i=1}^{N}\frac{\sum_{t=1}^{T}(\hat{u}_{it-1}\Delta\hat{u}_{it}-\hat{\lambda}_i)}{(\sum_{t=1}^{T}(\hat{u}_{it-1}^2))^{-1}}$	$T\sqrt{N}Z_{\tilde{\rho}NT-1} \equiv T\sqrt{N}\frac{\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{u}_{it-1}\Delta\hat{u}_{it}-\hat{\lambda}_i)}{(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{u}_{it-1}^2)}$
2. t istatistiği (parametrik olmayan):	$N^{-\frac{1}{2}}\tilde{Z}_{tN,T} \equiv N^{-\frac{1}{2}}\sum_{i=1}^{N}\frac{\sum_{t=1}^{T}(\hat{u}_{it-1}\Delta\hat{u}_{it}-\hat{\lambda}_i)}{(\hat{\sigma}_i^2\sum_{t=1}^{T}(\hat{u}_{it-1}^2))^{\frac{1}{2}}}$	$Z_{tNT} \equiv \frac{\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{u}_{it-1}\Delta\hat{u}_{it}-\hat{\lambda}_i)}{\sqrt{(\bar{\sigma}_{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{u}_{it-1}^2)}}$
3. t istatistiği (parametrik):	$N^{-\frac{1}{2}}\tilde{Z}^*_{tN,T} \equiv N^{-\frac{1}{2}}\sum_{i=1}^{N}\frac{\sum_{t=1}^{T}(\hat{u}^*_{it-1}\Delta\hat{u}^*_{it})}{(\sum_{t=1}^{T}(\hat{s}_i^{*2}\hat{u}_{it-1}^{*2}))^{-\frac{1}{2}}}$	$Z^*_{tNT} \equiv \frac{\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{u}^*_{it-1}\Delta\hat{u}^*_{it})}{\sqrt{(\bar{s}_{NT}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{u}_{it-1}^2)}}$
4. v istatistiği		$T^2N^3Z_{\hat{e}NT} \equiv T^2N^{\frac{3}{2}}\frac{1}{(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{u}_{it-1}^2)}$

Source: (Selim, Purtaş, & Uysal, 2014)

Pedroni (2000) FMOLS estimator has been used to estimate long-term coefficients between variables. The major advantage of the FMOLS estimator is that it provides both consistent and effective long-term estimates by correcting both endogeneity and auto-correlation. Panel FMOLS estimator is expressed as $\beta_{GFM} = N^{-1} \sum_{i=1}^{N} \beta_{FMi}$. The time series of equation (1) for each country is derived from the FMOLS estimate in this equation (Pedroni, 2001). The following model has been used for FMOLS forecasting.

$$Exc_{it} = a_0 + \beta_1 Apl_{it} + Dummy_{2008} + e_{it} \qquad (2)$$

Exc represents the exchange rate, Apl represents the average labor productivity and Dummy2008 represents the 2008 global crisis at the above model.

6. FINDINGS

Stationarity of exchange rate (Exc) and average labor productivity data is reported in Table 1.

Table.1 IPS Panel Unit Root Test Results

			Exchange Rate	Average Labor Productivity
Developing Countries	I (0)	Prob.	0.491	1.000
		Ist.	-0.021	9.331
	I(I)	Prob.	0.000***	0.000***
		Ist.	-12.024	-20.002
Developed Countries	I (0)	Prob.	0.398	0.106
		Ist.	-0.256	-1.246
	I(I)	Prob.	0.000***	0.000***
		Ist.	-6.036	-8.130
All Countries	I (0)	Prob.	0.449	1.000
		Ist.	-0.127	9.092
	I(I)	Prob.	0.000***	0.000***
		Ist.	-13.454	-22.452

Note: *** Indicate level of variables stationarity at %1 significance

According to the results of Table 1, H_O hypothesis has been accepted for both exchange rate and average labor productivity. In other words, it is determined that the variables are unit rooted at the level value. But the variables become stable at first difference. In this context, it is provided to be stable at the first difference level, which is an important prerequisite of cointegration analysis.

Table.2 Relationship between Exchange Rate and Average Labor Productivity in Developing Countries

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	**Prob.**	**Weighted Statistic**	**Prob.**
Panel v-Statistic	18.47760	0.0000	1.774570	0.0380**
Panel rho-Statistic	5.132673	1.0000	-0.221972	0.4122
Panel PP-Statistic	11.72472	1.0000	-3.530054	0.0002***
Panel ADF-Statistic	1.226438	0.8900	-6.896449	0.0000***
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	4.472324	1.0000		
Group PP-Statistic	-1.766346	0.0387**		
Group ADF-Statistic	-8.134533	0.0000***		

Not: ***,** Indicate statistical significance cointegration at 1% and at 5%, respectively.

Productivity problems is one of the main challenges of developing countries. Table 2 shows that, there is long-term relationship between exchange rates and average labor productivity at the five seventh test statistics. In other words, exchange rate and average labor productivity moves together in the long run in developing countries. Because of there is co-integration in the model, the next step is to estimate the co-integration coefficients.

Table. 3 F-MOLS Estimator Results for Developing and Under developed Countries

	Coefficient	Std. Error	t-Statistic	Prob.
APL	-0.006517	0.002417	-2.696259	0.0071***
Dummy	-82.11098	35.16274	-2.335170	0.0197*
R-squared	0.982954	Mean dependent var		684.2479
Adjusted R-squared	0.979838	S.D. dependent var		2256.433
S.E. of regression	320.4004	Sum squared resid		1.54E+08
Long-run variance	130419.5			

Note: ***,* Indicate statistical significance at the 1%,and 10% level, respectively.

Co-integration coefficients of developing countries is seen at the Table 3. According to Table 3, a marginal increase in average labor productivity results a decrease in the exchange rate by 0.006. Moreover, the exchange rate continued to decrease due to the increase in average labor productivity in the 2008 global crisis. The result shows that labor productivity is one of the key factors to effect exchange rate.

Table. 4 Relationship between Exchange Rate and Average Labor Productivity for Developed Countries

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	**Prob.**	**Weighted Statistic**	**Prob.**
Panel v-Statistic	3.187756	0.0007	0.223178	0.4117
Panel rho-Statistic	0.631174	0.7360	-0.445114	0.3281
Panel PP-Statistic	-0.404632	0.3429	-3.478832	0.000***
Panel ADF-Statistic	-7.034379	0.0000	-3.790111	0.000***
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	1.807629	0.9647		
Group PP-Statistic	-3.157580	0.0008***		
Group ADF-Statistic	-4.786947	0.0000***		

Note: ***,** Indicate statistical significance cointegration at 1% and at 5%, respectively.

The other important part of the study is to examine the relationship between labor productivity and exchange rates. Table 4 presents this relationship. The results of Table 4 are compatible with Table 2 which results of developing countries is presented. Four seventh test statistics shows that there is long-run relationship between exchange rates and average labor productivity in developed countries. In other words, exchange rate and average labor productivity move together in the long run among developed countries. Because of there is co-integration in the model, its necessary that to estimate the co-integration coefficients. The coefficients provide degree of the relationship determined in the model.

Table. 5 F-MOLS Estimator Results for Developed Countries

	Coefficient	Std. Error	t-Statistic	Prob.
APL	-0.000335	0.000186	-1.797356	0.0733*
Dummy	8.280338	3.878107	2.135150	0.0336**
R-squared	0.991888	Mean dependent var		51.14462
Adjusted R-squared	0.990375	S.D. dependent var		210.2601
S.E. of regression	20.62786	Sum squared resid		125525.0
Long-run variance	330.6245			

Note: **,* Indicate statistical significance cointegration at 5% and at 10%, respectively.

According to the results of Table 5, a marginal increase in average labor productivity in developed countries results a decrease of 0.003 in exchange rate. Its means that exchange rate is fewer influenced by the labor productivity gains compared with developing countries. When we considering dummy variable however, despite the increase in average labor productivity during the 2008 global crisis, exchange rates increased. This is the most important difference between the developed and developing countries. But still, the result indicate that labor productivity is an important determinant on exchange rate in both developed countries.

Shortly and precisely, after these results we can say there is a long run relationship between labor productivity and exchange rate despite degree differences. Labor productivity and exchange rate relationship is more powerful in the developing countries. The relationship is so powerful that it sustained in 2008 when global crisis broke out. When it comes to developed countries, however, the relationship is weakening. As its seen, labor productivity and exchange rate relationship lose its power in developed

countries. In addition, the relationship even reversed in the crisis year 2008. The last job is to suppose all countries as if a single country. This is examined in the following tables.

Table.6 Relation between Exchange Rate and Average Labor Productivity for All Countries

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	**Prob.**	**Weighted Statistic**	**Prob.**
Panel v-Statistic	20.40896	0.0000	1.679316	0.0465**
Panel rho-Statistic	5.668646	1.0000	-0.402391	0.3437
Panel PP-Statistic	12.95057	1.0000	-4.659063	0.0000***
Panel ADF-Statistic	1.335864	0.9092	-7.811365	0.0000***
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	4.816359	1.0000		
Group PP-Statistic	-2.942452	0.0016****		
Group ADF-Statistic	-9.430639	0.0000***		

Note: ***,** Indicate statistical significance cointegration at 1% and at 5%, respectively

Even if we consider all countries like a single country the result doesn't change. According to the results of Table 6, 5 of 7 test statistics shows that there is a long-term relationship between exchange rates and average labor productivity. In other words, the exchange rate and average labor productivity in 165 countries have been moving together in the long run. The determination of co-integration is not enough to evaluate. Thus, we need to estimate the co-integration coefficients.

Table. 7 F-MOLS Estimator Results for Model 3

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
APL	-0.005946	0.002318	-2.565292	0.0104**
DUMMY	-66.05549	29.95557	-2.205115	0.0276**
R-squared	0.983186	Mean dependent var		579.9686
Adjusted R-squared	0.980115	S.D. dependent var		2077.235
S.E. of regression	292.9193	Sum squared resid		1.55E+08
Long-run variance	115265.8			

Note: **,* Indicate the significance of coefficients at significance level %5 and 10% respectively

Table 6 shows the coefficients of co-integrated variables. According to the results of Table 6, a marginal increase in average labor productivity in 165 countries results a decrease of 0.005 in exchange rate. The result, that is powerful of relationship, coverage developing countries. But in the crisis year, the result for all countries coverage developed countries. Despite the increase in average labor productivity during the 2008 global crisis, exchange rates increased.

7. CONCLUSİON

The aim of this study is to contribute to the determinants of the exchange rate, which is a challenge for developing countries in recent years. Thus, the relationship between the exchange rate and labor productivity has been tested using the panel data method. Labor productivity influences the exchange rate in the long run both in developing and developed countries according to the results of the tests. Developed countries are less influenced by labor productivity when compared to the developing countries. Firstly, this may be explained as the developed countries had reached their limits in productivity gains in their historical process. Secondly, there has been a flow of capital from the developed countries to other geographies since the 1970s. Production centers have shifted from west to east and from north to south in this process. And the developed countries have become financial centers. But this also means that labor intensive activities have shifted to east and north in the process. Because of these two reasons, it is not surprising that the increase in labor productivity has a weak impact on the exchange rate in developed countries.

On the other hand, the impact of labor productivity on the exchange rate is clearly higher in developing countries. When compared with developed countries, productivity increases gained in developing countries results substantial decreases on the exchange rate. This may guide policy implementations. Giving priority to policies that increase labor productivity will positively affect the foreign exchange need through the production structure dependent on imported inputs in developing countries which affected by external shocks. Possible gains in labor productivity will decrease the impact of negative external shocks in the developing countries.

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