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Relationship between Real Effective Exchange Rate and Labor Productivity: Empirical Evidence

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Abstract: Labor productivity is one of the indicators that reveal a country's economic development, human resource quality, availability of infrastructure and technology, among others. Improvement in organizational productivity is also dependent on labor productivity. The current study attempts to study the relationship between labor productivity and the Real Effective Exchange Rate in the selected countries. The sample included Australia, Brazil, Bulgaria, Canada, China, Iceland, Japan, Malaysia, South Africa, and the USA. With the aid of statistical techniques, the study found that productivity and exchange rate are correlated with varying degrees of strength and the nature of the relationship varies from country to country. The study concludes with important directions for future investigations.

Keywords: Real Effective Exchange Rate; Labor Productivity; Correlation; Regression

1. Introduction

Economic growth has several indicators that can be used to determine the economic condition inside a country's economy. For instance, growth in real Gross Domestic Product, increase in Human Development index, etc. Unfortunately, there is one indicator that is often overlooked – Labor productivity – despite its ability to show how well the labor performs inside the economy. Furthermore, it can show the availability of the facility, technology, etc. Labor productivity is affected by several factors, such as technical, organizational, geographic, social, and structural (Fedulova *et al.*, 2019; Choudhry, 2009). These factors will show an overall economic condition that the country experience, which will help us consider the development of the people inside the country.

Labor productivity has several influencing factors that could contribute to its growth (Choudhry, 2009). For instance, location, cultural beliefs, international influence, and incentives. Also, the currency exchange rate is another factor connected with labor productivity (Jeanneney & Hua, 2011). Moreover, it is believed that international currency exchange influence may have both positive and negative impacts on the growth of labor productivity depending on the country and its policies. For instance, foreign direct investment is considered to be an important determinant that could affect a country's economic system (IMF, 2006). Do countries with similar income levels exhibit similarities when it comes to the relationship between labor productivity and exchange rate? The current study attempts to look for its answer by revisiting the relationship between real effective exchange rate and labor productivity for different countries using a statistical approach.

The rest of the study is organized as follows: the second section is the review of relevant literature, followed by research methodology section. The fourth will be on data, results, and discussion, and the fifth section will conclude the study with recommendations and limitations.

2. Literature Review

2.1 Real Effective Exchange Rate

The currency exchange rate is the rate at which one national currency will be exchanged for another. It is also regarded as the value of one country's currency against another country's currency (O'Sullivan & Sheffrin, 2003). Unfortunately, it is unstable and sensitive to market conditions. Therefore, to reduce its instability, a measurement was taken into consideration of the domestic and external inflation rates; these measures vary depending on the regime preferred in a given country. The relationship between the domestic goods and services and the prices of these goods and services in external markets is called the Real Effective Exchange Rate (REER) (Campbell, 2012).

Since then, REER has become an important indicator that can be used to measure the competitiveness of one country's economy. REER takes the relative price of the same goods in the domestic market then compare it with product in a different region (Özkan, 2003). In other words, REER is estimated by calculating the basket of goods in one economy followed by its comparison with a similar basket of goods in another economy. Therefore, while representing the actual value of the currency, it is obtained through the weighted average of the nominal effective exchange rate (Sebastian *et al.*, 2014),

$$REER = \prod_{i=1}^{n} \left[\left(\frac{e}{e_i} \right) \left(\frac{P}{P_i} \right) \right] w_i$$

Where,

e : the exchange rate of home currency
e_i : the exchange rate of foreign currency in indexed form
w_i : weight attached to foreign currency/country. Total sum equals 1.
P : wholesale price index
P_i : Consumer price index
n : number of countries/currencies in the index other than the home country

2.2 Labor Productivity

Labor productivity is an economic indicator that shows economic growth, domestic competitiveness, living standards in one economy (ILO, n.d.). Meanwhile, labor productivity can also imply the number of goods or services produced per hour of labor in a period of time. Labor productivity (L) can by counted as the GDP (G) per total hours worked (H) such as (Ohanian, 2012).

$$L = \frac{G}{H}$$

Whereas the total hours worked can be obtained from the product of hours worked per worker (h) and employment (E) divided by the size of productive age (16-64 years) population P,

$$H = h * \frac{E}{P}$$

Labor productivity indicates the growth of the country's economic condition and living standards. It could be observed on high variability and dynamism, Factors of changes in labor productivity are the reasons for the change in its level. They are classified into several factors; Material and technical, Organizational, Regional economic, Social, Structural factors (Fedulova *et al.*, 2019). Furthermore, when labor productivity in one country increases, it shows the development of labor quality in that country. As the labor productivity formula shows, it is highly affected by the diversity in goods and services, technology, education, among others.

2.3 Relation Between REER and Labor Productivity

Labor productivity calculation comes from GDP that is divided by total hours worked. From this formula, we can conclude; higher GDP and lower working hours will increase the labor productivity

inside a country. By increasing the amount of transactional value inside the country, the development of infrastructure will follow. However, in poorer countries, some of them have neither enough capital nor qualified human resource to grow their economy (Fedulova *et al.*, 2019). Therefore, they can rely on foreign investors rather than borrowing money from an economic entity. However, to attract investment, a country must improve its macroeconomic situation (Boghean & State, 2015). Moreover, by setting an optimum currency exchange rate and removing trade barriers, investors can also be attracted. The changes in exchange rate impact investors' confidence in the profitability prospects in the country and economic growth. Later, by investing in productivity-enhancing technologies and infrastructures, the labor productivity level can be improved.

3. Research Methodology

3.1 Sample and data collection

Our sample contained ten countries, some of which were high-income economies while others were middle-income economies. High-income economies are the economies whose income range is above $12,536 and include Australia, Canada, Iceland, Japan, and the USA. Middle-income economies are the economies whose income range is $4,046 ~ $12,535 and include Brazil, Bulgaria, China, Malaysia, and South Africa. This classification is being done by Worldbank (2020).

The data for "Labor Productivity" was collected from OWID (2021), and data for "Real Effective Exchange Rate" was collected from Worldbank (2021). The time scale of the data was from 2004 to 2017.

3.2 Data Analysis Techniques

Pearson's correlational analysis will be used to find the correlation between Real Effective Exchange Rate and labor productivity. In Pearson's correlational analysis, there are several degrees of correlation. There is a perfect correlation if the test value is equal to ± 1, High degree of correlation with range ± 0.5 - ± 0.99, Moderate degree ± 0.3 - ± 0.49, Low degree if the value was lower than ± 0.29, No correlation if the value is equal 0 (SS, 2021). The formula for Pearson's correlation coefficient is (Glen, 2021a)

$$r = \frac{n(\sum xy) - (\sum x) - (\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$$

Also, linear regression analysis will be performed to estimate the relationship between the two variables. It is given by (Glen, 2021b),

$$y = a + bx$$

$$a = \frac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n(\sum x^2) - (\sum x)^2}$$

$$b = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

R^2, also called r^2, will be estimated as

$$r^2 = \left(\frac{n(\sum xy) - (\sum x) - (\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}\right)^2$$

4. Results and discussion

In this section, the changes that the currency exchange rate brings to the labor productivity ratio with constant GDP from 2011 will be observed. Thus, we will notice the change in labor productivity without the growth in GPD and could focus on the smaller impact of the currency exchange rate on the shift in labor productivity. Firstly, high-income economies will be discussed and then the middle-high-income economies.

Table 1. Statistical analysis of high-income economies

Countries	Regression Equation	R^2	Pearson's Correlation coefficient
Australia	y = 21.45 + 0.3025x	0.3996	0.6321
Chile	y = 18.254 + 0.036x	0.0015	0.0385
Iceland	y = 60.801 - 0.1136x	0.4468	-0.6684
Japan	y = 50.216 - 0.1124x	0.6234	-0.7895
USA	y = 70.673 - 0.0872x	0.0359	-0.1895
y = labor productivity, x = Real Effective Exchange Rate			

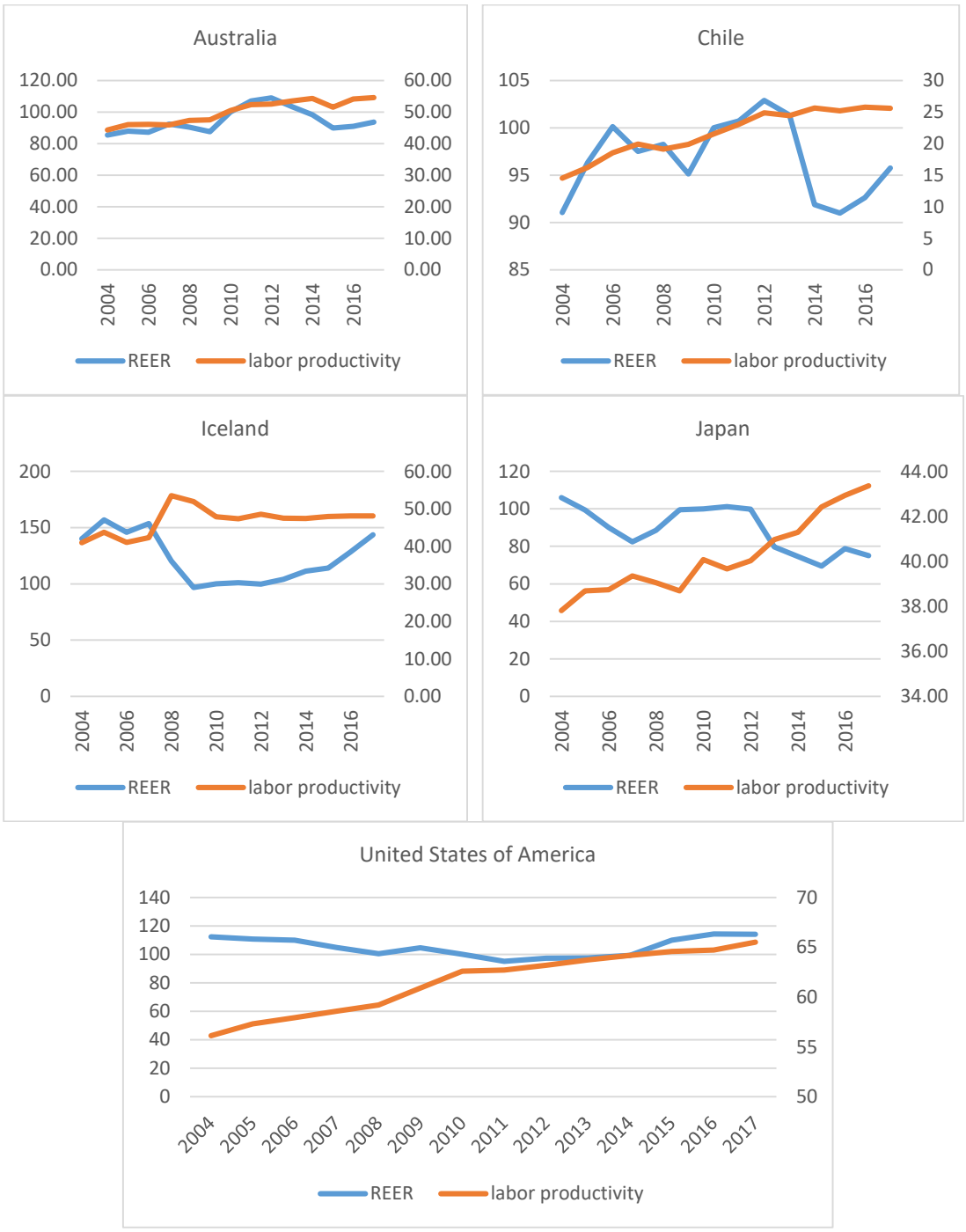

Figure 1. Labor productivity and REER of high-income economies

4.1 High Income Economies

The data analysis revealed different degrees of correlation among different countries' REER and labor productivity. Moreover, these differences in correlation between each country occurred due to differences in each country's economic policies and practices.

The results revealed that REER could have both negative and positive relationships with labor productivity. The effect may vary from country to country. Australia and Chile are having a positive correlation between REER and labor productivity, while Iceland, Japan, and the USA reported a negative correlation, as shown in Table 1. Australian labor productivity is classified as a high degree of correlation, as can be seen from the first panel in Figure 1. The possible cause of this phenomenon occurs because Australia's economic sector is different from Chile's. The Australian economy is transforming from a mining exports-intensive industry to a non-mining economy such as manufacturing, services, and tourism (Firstcapital, 2013). Thus, it is heading to high-quality economic development. Also, as Australia's relationship with its trade partners varies, REER is likely to get affected. Meanwhile, Chile's economy is still relying on natural resources' export (CIA, 2021). Furthermore, the lower value of the currency could contribute to an increase in the price of tradable goods, thus increasing profit and enhancing economic growth (Morvillier, 2020). Therefore, although REER value change in Chile will only slightly affect its labor productivity because their infrastructure and facility required to increase it have already been created. Thus, causing their labor productivity and REER to have little correlation.

In the given period, Iceland experienced a negative correlation between REER and Labor productivity. In the calculation to obtain labor productivity, we are required to use GDP divided by the total hour worked (Ohanian, 2012). Because we used constant GDP, it will create a phenomenon where their labor productivity will remain relatively stable at around $50 since 2010. On the other hand, REER is increasing from year to year as their economy becomes stronger due to increased purchasing power, as shown in the third panel of Figure 1.

Japan also experienced a negative correlation between REER and Labor productivity. According to the Pearson's correlation test, Japan has a -0.78 value this was due to Japan's economic structure. By 2017, 30.1% of their GDP is attributed to their industrial sector (CIA, 2021). Thus, as the REER value decreases, it is shown to improve their labor productivity by a large margin. This occurs because the decrease in REER created a condition where its currency becomes more valuable and competitive. Because higher REER implies more expensive exports (IMF, 2021), it is not a good indicator for a country that heavily relies on industrial exports.

Meanwhile, in the USA, whose 80.2% of economy relying on services, around 70% of its GDP comes from internal consumption (UNCTAD, 2021). Thus, resulting in an economy that is highly independent and resilient. Therefore, resulting in a very low correlation between REER and labor productivity.

4.2 Middle-High-Income Economies

In this section, the first group that will be discussed is the one that revealed a positive correlation between REER and labor productivity, and the second group comprises the countries revealing negative correlation.

All three countries that have experienced a positive correlation between labor productivity and REER are mainly the industrial countries from the developing world. What sets apart the industrialized developing countries from their much-developed counterparts is the drastic changes in economic policies and productive structures, which are potentially affected by REER (Jeanneney & Hua, 2011). Furthermore, the optimization of REER in these countries was intended to control industrial production and capital intensity which also affects foreign direct investment that is crucial to the country's growth and development. Thus, Pearson's correlation test has only revealed the historical truth. Moreover, it is important to note that the effect that occurs in each country will also act differently based on the size of the economy. For instance, the Chinese economy showed the most extreme scenario where REER was highly correlated with the economy labor productivity. One may attribute this extraordinary behavior to the role of state planning in economic development. Also, we know that China's economy highly relies on processing trade and exports (Javed *et al.*, 2021). Neverthless, as discussed earlier in the case of Japan, higher REER may result in more expensive export.

Table 2. Statistical analysis of middle-high-income economies

Countries	Regression Equation	R^2	Pearson's Correlation coefficient
Brazil	y = 6.4853 + 0.0947x	0.1675	0.4093
Bulgaria	y = - 6.0799 + 0.2576x	0.4132	0.6428
China	y = - 6.3256 + 0.1333x	0.9145	0.9562
Malaysia	y = 26.037 - 0.0744x	0.0276	-0.1662
South Africa	y = 20.409 - 0.042x	0.2107	-0.4590
y = labor productivity, x = Real Effective Exchange Rate			

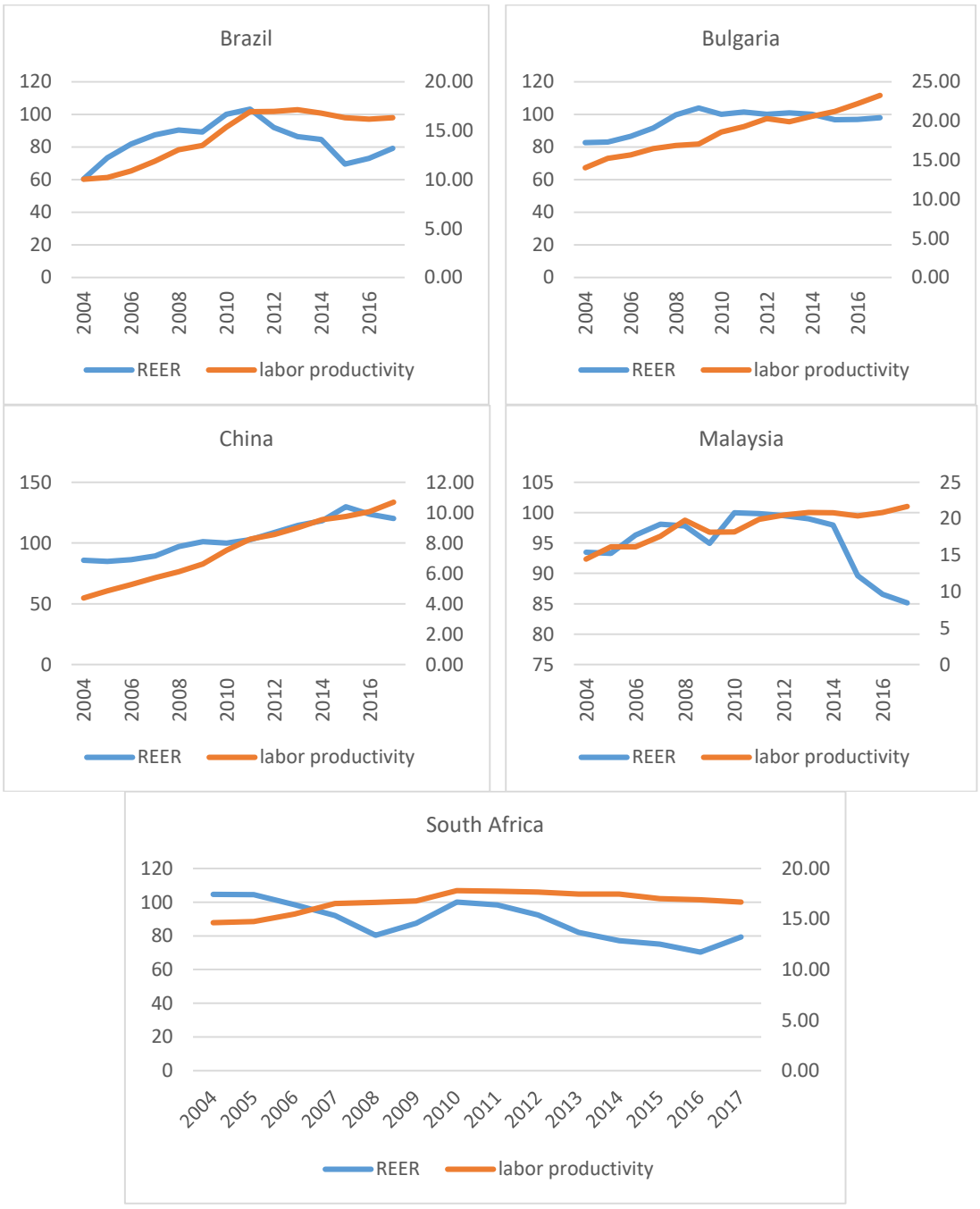

Figure 2. Labor productivity and REER of middle-high-income economies

However, the positive developments that these developing countries experienced outweigh the loss that higher REER may have bought to their economies. Because higher REER can also indicate that the country might be experiencing stable policymaking, their economic outlook healthier and attractive for the investors (Yousaf *et al.*, 2011) thus, the behavior exhibited by China is not strange but interesting.

Although considered a developing country, the Malaysian economy is highly diversified and advanced compared to the other developing country in the region and is one of the most competitive economies in the world, with the rank of 27th (Schwab, 2018). Moreover, the economic growth that Malaysia experiences are less likely to slow down anytime soon. Morvillier (2020) showed that undervaluation of one's currency could cause an increase in the overall price, and in turn, increases profit margins, thus encouraging investments, and as a result, positively influence economic growth. It is a good sign for the overall economy in the long run. The Malaysian situation, as shown in the fourth panel of Figure 2, can be a manifestation of this cycle of positive effects in Malaysia.

Different from the other countries on our list, the South African economy is still highly relying on mineral exports. Thus, the South African economy needs to have a low value of REER to increase the volume of an exported resource. Since the increase in REER may also contribute to higher prices and more expensive products (IMF, 2021), South Africa's economy can perform better by keeping its REER low. However, from the above findings, a question comes to mind that why even within one group of countries, the relations between REER and labor productivity are inconsistent? We know that the socio-economical needs vary from one country to another, and so do the priorities of the policy-makers in these countries therefore, it is very reasonable to believe that a framework comprising only two factors is insufficient to report consistent relationships among different countries. A multivariate framework, guided by large historic data, is needed in the future to better answer this question.

5. Conclusion and recommendations

Labor productivity can help us determine the economic and technological conditions within an economy. Higher labor productivity value can show the quality of labor, availability of infrastructure, competitiveness inside the country. Furthermore, according to the current study's findings, we can conclude that labor productivity correlates with the Real Effective Exchange Rate (REER). Moreover, each country may have a different degree and type of correlation because each country has a unique source of income, economic drivers, technologies and quality of labor. At this stage it is difficult to propose a conclusive generalized hypothesis.

It is important for policymakers to optimize the REER based on the needs and capabilities. As it can both positively and negatively affect the growth of labor productivity, hence monitoring and controlling REER can be difficult and if not handled correctly, it can adversely affect labor productivity. Therefore, managing REER is extremely important for overall economic growth.

In the current study, we could not obtain the labor productivity data with dynamic GDP thus, we resorted to constant GDP-based labor productivity. In future studies, the actual GDP value for each year can be considered. Also, why different countries showed different degrees of correlation and different types of relationships (direct/inverse) are some questions needed to be answered in the future. Also, because of the limited data, low-income economies were not studied, thus leaving behind a space for future investigators. The study involved only two variables, in the future, more variables can be considered before making any generalized assumption.

References

Boghean, C., & State, M. (2015). The Relation between Foreign Direct Investments (FDI) and Labour Productivity in the European Union Countries. *Procedia Economics and Finance*, *32*(15), 278–285. https://doi.org/10.1016/s2212-5671(15)01392-1

Campbell, K. (2012). *Foreign Exchange Market*. Encyclopedia of Business inToday's World. SAGE Publications https://doi.org/10.4135/9781412964289.n403

Choudhry, M. T. (2009). *Determinants of Labor Productivity: An Empirical Investigation of Productivity Divergence*. CiteSeerˣ. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.614.8306

CIA. (2021). *Chile*. The World Factbook. https://www.cia.gov/the-world-factbook/countries/chile/#economy

Fedulova, I., Voronkova, O., Zhuravlev, P., & Gerasimova, E. (2019). Labor Productivity And Its Role In The Sustainable Development Of Economy : On The Example Of A Region. *Entrepreneurship and Sustainability Issues*, *7*(2), 1059-1073,7 (2), 1059–1073. https://doi.org/10.9770/jesi.2019.7.2(19)

Firstcapital. (2013). *Financial Year 2012-2013 –Australia's changing economy*. Sydney: First Capital Financial Planning Pty Ltd. http://firstcapital.com.au/wp-content/uploads/2013/07/July-Snapshot-2013.pdf

Glen, S. (2021a). *Correlation Coefficient: Simple Definition, Formula, Easy Calculation Steps*. Statistics How To. https://www.statisticshowto.com/probability-and-statistics/correlation-coefficient-formula/

Glen, S. (2021b). *Linear Regression: Simple Steps, Video. Find Equation, Coefficient, Slope*. Statistics How To. https://www.statisticshowto.com/probability-and-statistics/regression-analysis/find-a-linear-regression-equation/

ILO. (n.d.). *Labour productivity*. International Labour Organization. Retrieved on April 23, 2021 from https://ilostat.ilo.org/topics/labour-productivity/

IMF. (2006). *World Economic Outlook: Financial Systems and Economic Cycles*. International Monetary Fund. http://imf-ieo.org/external/pubs/ft/reo/2009/apd/eng/areo1009.pdf

IMF. (2021). *What is real effective exchange rate (REER)?*. International Monetary Fund. https://datahelp.imf.org/knowledgebase/articles/537472-what-is-real-effective-exchange-rate-reer

Javed, S. A., Bo, Y., Tao, L., & Dong, W. (2021). The'Dual Circulatio' Development Model of China: Background and Insights. *Rajagiri Management Journal*. https://doi.org/10.1108/RAMJ-03-2021-0016

Jeanneney, S. G, & Hua, P. (2011). How does real exchange rate influence labour productivity in China? *China Economic Review*, *22*(4), 628–645. https://doi.org/10.1016/j.chieco.2010.04.008

Morvillier, F. (2020). Do currency undervaluations affect the impact of inflation on growth?. *Economic Modelling*, *84*, 275–292. https://doi.org/10.1016/j.econmod.2019.04.018O'Sullivan, A., & Sheffrin, S. M. (2003). *Economics: Principles in action*. New Jersey: Prentice Hall.

Ohanian, L. E. (2012). Aggregate hours worked in OECD countries: New measurement and implications for business cycles. *Journal of Monetary Economics*, *59*(1), 40-56. https://doi.org/10.1016/j.jmoneco.2011.11.005

OWID. (2021). *Productivity per hour worked*. Our World in Data. https://ourworldindata.org/grapher/labor-productivity-per-hour-pennworldtable

Özkan, F. (2003). *Denge Reel Kur Hesaplama Yöntemleri ve Reel Kur Dengesizliğinin Ölçülmesi: Türk Lirası Üzerine Bir Çalışma*. Ankara: Türkiye Cumhuriyet Merkez Bankası. http://www3.tcmb.gov.tr/kutuphane/TURKCE/tezler/fundaozkan.pdf

Schwab, K. (2018). *The Global Competitiveness Report 2018*. Switzerland: World Economic Forum.

Sebastian, A., Sharma, U., Sonna, T., & Joshi, H. (2014). *Impact of Real Exchange Rate Volatility on Use-Based Industrial Production in India*. WPS(DEPR) 05/2014, Department of Economic and Policy Research, Reserve Bank of India. https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/WP05150514F.PDF

SS. (2021). *Pearson's Correlation Coefficient*. Statistics Solutions. https://www.statisticssolutions.com/free-resources/directory-of-statistical-analyses/pearsons-correlation-coefficient/

UNCTAD. (2021). *Beyond 20/20 WDS - Table view - Gross domestic product: GDP by type of expenditure, VA by kind of economic activity, total and shares, annual*. Switzerland: United Nations Conference on Trade and Development. http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=95

Worldbank. (2020). *World Bank Country and Lending Groups*. The World Bank. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

Worldbank. (2021). *Real effective exchange rate index*. The World Bank. https://data.worldbank.org/indicator/PX.REX.REER

Yousaf, U., Naqvi, F. N., Nasir, A., Bhutta, N. A., & Haider, A. (2011). Impact of foreign direct investment on economic growth of Pakistan. *European Journal of Economics, Finance and Administrative Sciences*, *4*(32), 95–100. https://doi.org/10.21058/gjecs.2019.42004