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Analyzing Factor Abundance and Export Competitiveness: Testing the Heckscher-Ohlin Trade Theorem in the Philippines-US International Trade Patterns

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***Abstract*: This study assesses the predictive accuracy of the Heckscher-Ohlin (H-O) trade theorem in the context of US-Philippines trade dynamics. Despite the H-O theorem's assertion that countries export goods in accordance with their abundant factors, our empirical analysis reveals a consistent negative correlation between labor and exports in both nations. This finding aligns with Leontief's Paradox, indicating a departure from conventional economic theories. The identification of this paradox prompts a reevaluation of established models to foster a more nuanced understanding of the multifaceted factors influencing international trade. In light of these insights, recognizing the enduring relevance of the H-O theorem as a foundational framework, it becomes essential to complement it with a comprehensive approach for analyzing the intricate interplay of factors shaping trade relationships between nations. This acknowledgement enriches our understanding of trade dynamics, acknowledging both the merits and limitations of theoretical frameworks in capturing the evolving nature of International Trade.**

***Keywords*: Heckscher-Ohlin, International trade, Leontief's paradox.**

1. Introduction

There is a strong association between international trade and sustainable development. (Belloumi & Alshehry, 2020) Several studies and reports also support the statement that international trade can contribute to sustainable development. For example, The World Bank and the World Trade Organization (2015) has recognized the potential of trade to promote sustainable development. The organizations' report highlights how trade can contribute to poverty reduction, promote inclusive economic growth, and foster sustainable development. Similarly, a report also co-published by The World Bank and the World Trade O rganization (2018) pointed out the positive relationship between international trade and poverty reduction. The report argues that trade can generate economic growth, create jobs, and increase access to goods and services, all of which can contribute to reducing poverty.

One economic theory that can shed light on the matter at hand is the Heckscher-Ohlin Trade Theorem, as it is one of the basic general equilibrium theories in economics (Bernhofen & Brown, 2016). In the early 20th century, economists Eli Heckscher and Bertil Ohlin formulated a theorem suggesting that nations ought to specialize in manufacturing and exporting goods that utilize their plentiful factors of production. Conversely, they should import goods that rely on their scarce factors of production (Ikechukwu et al, 2022).

Despite being developed nearly a century ago, the Heckscher-Ohlin Trade Theorem remains a relevant and widely used framework for understanding the patterns and potential benefits of international trade. One reason for its continued relevance is that it helps explain the role of comparative advantage in determining trade flows, which is a fundamental principle of economics. For instance, the study conducted by Bernhofen and Brown in 2016, provides empirical evidence that supports the continued validity of the Heckscher-Ohlin Trade Theorem as a logical tool for analyzing certain trade patterns. According to them, the theorem still holds up well as they were not able to reject the hypothesis in any of the sample years. This is also supported by Bilas and Bošnjak's (2015) study, where they concluded that the international pattern of trade between Croatia and other European Union member countries is still in accordance with the assumed pattern of the Heckscher-Ohlin theorem.

Although the Heckscher-Ohlin trade theory is frequently used to explain patterns of international trade, little research has been done to precisely assess its applicability to the trade relationship between the Philippines and the US. While some studies have investigated the applicability of the Heckscher-Ohlin trade theory to other trade relationships, such as the trade-relationship between the Philippines and Japan (Preciados & Zabala, 2019) and the patterns of trade between the U.S. and China (Clements, 2007), the dynamics of the trade relationship between the Philippines and the US have not been thoroughly

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Table 1
Share of Major Philippine Trade Partners (2009-2018), adopted from DTI's report titled: FACT FILE 2019: A Decade of Trade in the Philippines

	Exports			Imports	
	2009	2018		2009	2018
China (and Hong Kong)	57.71	55.30	China (and Hong Kong)	33.20	56.31
USA	5.74	6.31	USA	3.54	6.00
Japan	4.97	4.88	Japan	2.39	4.06
Singapore	1.96	3.01	Singapore	1.93	3.27
Thailand	0.94	1.99	Thailand	1.63	2.76

examined through the lens of this theory. This creates a substantial research gap that this paper will fill.

The United States and the Philippines have a notable and longstanding trading connection that has gotten stronger through time. The Philippines is the 31st largest goods trading partner of the United States, with a total of $23.4 billion in goods exported in 2020 (Office of the United States Trade Representative, 2021). On the other hand, the United States is the Philippines' 2nd largest export market, accounting for 14.2% of its total exports, while having a 30.5% growth rate within the last five years (The Observatory of Economic Complexity, 2021). This is also backed by the Philippines Department of Trade and Industry's (DTI) decade report which shows the USA as the 2nd biggest trade partner on both imports and exports of the Philippines (2019), as seen on the table 1.

Moreover, throughout the past few years, there have been huge economic changes in both the Philippines and the US, primarily as a result of the COVID-19 pandemic's impact. The patterns of trade between the two countries have probably changed as a result of these changes, which may have implications for the application and validity of the Heckscher-Ohlin trade theory in this context. For instance, according to the International Monetary Fund (IMF), the pandemic has disrupted global supply chains and trade flows, leading to changes in the availability and cost of inputs and outputs for various industries (2021). Investigating how these changes have altered the patterns of trade between the Philippines and the US and determining if they still conform to the prediction of the Heckscher-Ohlin trade theory would also be very informative.

By filling in these research gaps, this paper will contribute to a deeper understanding and will advance knowledge on the applicability and validity of Heckscher-Ohlin trade theory in the context of the trade relationship between the Philippines and the United States. It will also shed light on how trade patterns between the Philippines and the United States have changed over the past few years, with the ultimate goal of providing insights into the benefits of international trade for sustainable development in both of the countries.

2. Literature Review

A. An Overview on Heckscher-Ohlin Model

Gumpert (2015) states that the Heckscher-Ohlin Model is an economic theory focusing on international trade since 1933. Multiple economists tested this theory, including Wassily W. Leontief, known for his Leontief Paradox. According to Cavusoglu, Leontief (1947) used the Input-Output Model and evaluated 200 industries grouped into 50 sectors (2018). This led to the discovery that 30% of the imports were more labor intensive than the exports in the U.S. Clearly, the United States, a capital-abundant country, was importing goods that required capital-intensive production and exporting commodities that required a lot of labor-intensive output. (Ito et al, 2016). Contrary to earlier theories of international trade which assume that countries will specialize in and export commodities that they can produce more cheaply than rival countries, referred to as a comparative advantage (Kurtishi-Kastrari, 2013). This suggests that a country abundant in capital, such as the United States, would be expected to export goods that are intensive in capital and import goods that are intensive in labor from countries where prices are comparatively lower. (Paraskevopoulou et al, 2016). Despite the findings of Wassily Leontief, the Heckscher-Ohlin model continued to stand out as a significant and influential contribution to the field. This is because economists still recognized that the endowments of various countries influence trade (Shetty, 2014).

In addition, the Heckscher-Ohlin Model is a 2x2x2 model which states that there are identical technological advances existing in different countries (Guo, 2015). Trade between two countries takes place when two countries have different levels of economic development (Lai & Bujang, 2016). There should be constant returns to scales for both countries and goods are within perfect competitive markets to satisfy the H-O theorem (Estrada, 2021). Also, both countries produce commodities with incomplete specialization in this model (Suzuki & Doi, 2019). Changes in international trade occasionally have the potential to affect production patterns or the areas where commodities are produced. (Jones, 2014). Also, convergence does not exist in H-O theorem's factor price equalization (Sen, 2015).

B. Criticisms on the Heckscher-Ohlin Model

Moreover, according to the study by Aahana, the theorem exclusively concentrates on the factor proportions and intensities within countries' trade patterns, overlooking additional factors like economies of scale, transportation expenses, and external economies. (2018). It is also built on the assumption of fixed factors of production, identical production function, and full employment, which does not apply to a dynamic market structure (Salvatore, 2016). Further, transport costs and transport intensity affect the final output of production which will result in the geographic specialization zones which the H-O model lacks (Venables & Limão, 2002). The Heckscher-Ohlin Model also claims that there are no discrepancy levels between factor endowment ratios and can be precisely measured. However, variations in the factor endowment exist in the real world, which poses a challenge for determining trade patterns and comparing and estimating costs (Mumuni, 2000).

C. Empirical Studies on Heckscher-Ohlin Model

The study Lemuel Preciados and Al Rae Zabala (2019) composed of various variables. The first variable they utilized was the natural logarithm of the Philippine's commodities exported to Japan in a specific year. The value of commodities exported from the Philippines to Japan is determined by this variable, which is a crucial sign of the two countries' trade relations. The second and third variables are the natural logarithm of labor supply (Labor Force, individuals/year) and capital supply (Gross Fixed Capital Formation, in US) in the Philippines in a year, correspondingly. The aforementioned variables are a true indication of abundance of capital and labor resources in the Philippines, which are vital components that influence a country's ability to compete internationally.

The next variables that were utilized are also the natural logarithm of labor supply (Labor Force, persons/year) and capital supply (Gross Fixed Capital Formation, in US) in Japan in a specific year. Another significant aspect that may have an impact on trade competitiveness is the accessibility of labor and capital resources in Japan, which is measured by these factors. Generally, these variables must be utilized in order to fully comprehend the trade relations between the Philippines and Japan as well as the factors that affect both countries' ability to trade.

There are also other empirical and theoretical studies to validate the Heckscher-Ohlin Model at the degree trade in goods (Baldwin & Robert-Nicoud, 2014). The Heckscher-Ohlin Model and the performance of cocoa products in Nigeria revealed that the Nigerian cocoa production is positively impacted by trade openness, exports, and domestic consumption (Verter, 2016). According to another study Ugbor et al., Heckscher-Ohlin's theory was contradicted by Nigeria's production and trade patterns since the country has an abundance of labor but imports labor-intensive products and exports capital-intensive goods. (2015). A study on the US-Mexico trade stated that the H-O model can be reformulated to be more dynamic and fitting in the changing times (Schmidt & Kulkarni, 2014).

Also, Schott allows for factor intensity reversal to demonstrate how a commodity can be labor intensive or capital intensive through the method of production (2003). If a commodity is produced by human labor in a developing country, then it's considered labor intensive, whereas if a good is produced in a developed country, then it's capital intensive. (Clark & Kulkarni, 2009) stated that other variations in the H-O model which took into account different factor prices between industries as the effects of imperfect mobility produced the best results.

Additionally, there are other variations of H-O models that prove its relevance until today. According to Yoshihara & Kurose, the Heckscher-Ohlin-Samuelson model claims it is necessary to have an international trade theory that does not depend on the factor price equalization to overcome the difficulties of capital issues (2016). A study on Empirical Test of the Single- and Multiple-Cone Heckscher–Ohlin Model revealed that the change from the single-cone to multiple-cone equilibrium prompted the changes in the capital intensities and economic resources (Suzuki, 2016).

The findings from the aforementioned studies prompted the researchers to incorporate an econometric approach to test the validity of the Heckscher-Ohlin Trade Theorem on The Pattern of International Trade between the Philippines and US.

There are varying degrees of support for the validity of the Heckscher-Ohlin trade theorem in different trade relationships, with some criticizing it for oversimplifying trade patterns by focusing solely on factor proportions, assuming fixed factors of production (Aahana, 2018) and identical production functions, neglecting other variables such as transportation expenses and economies of scale (Salvatore, 2016), and not accounting for variations in factor endowment ratios (Mumuni, 2000). However, there are still empirical and theoretical studies that continue to validate the Heckscher-Ohlin theory, such as the trade relationship between the Philippines and Japan (Preciados and Zabala, 2019), performance of cocoa products in Nigeria (Verter, 2016), and the US-Mexico trade (Schmidt & Kulkarni, 2014).

D. Theoretical Framework

This study's empirical model was based on the study by Bilas and Bosnjak (2015) and the theoretical framework as well as conceptual framework was adapted and modified from the study of Preciados and Zabala (2019). It must be firstly noted that Heckscher-Ohlin Trade Theorem has three major assumptions (Preciados & Zabala, 2019).

The first assumption is that the countries involved in trade should differ in factor abundance. For example, if country A is presumed to have an abundance of capital, country B should be presumed to have an abundance of labor. In light of this, there are two methods for determining factor abundance:

$$(K/L)A > (K/L)B$$

where K is Capital, L is Labor, A is Country A, and B is Country B.

This Factor Ratio equation indicates that the capital-labor ratio is greater in country A than in country B, signifying a higher abundance of capital in country A compared to country B.

$$(P_K/P_L)A < (P_K/P_L)$$

where P_K is Price of Capital, P_L is Price of Labor, A is Country A, and B is Country B.

This Factor Price Ratio equation indicates that if country A's factor price ratio is lower than that of country B's, then country A is said to have an abundance of capital. Thus, capital in this example is comparatively more affordable in Country A than B.

The next assumption is that commodities are categorized in terms of their factor intensity. When a country has two factors and two commodities, one of the commodities will require comparatively more of one component than the other, and so it can be rated according to its capital-labor ratio. A good can therefore be either labor-intensive or capital-intensive (Ikechukwu et al., 2022). Which we can identify by:

$$(K/L)X > (K/L)Y$$

where K is Capital, L is Labor, X is Good X, and Y is Good Y. And lastly, the third assumption is that free trade exists between the two countries.

3. Research Method

This paper has utilized and implemented the approach and techniques used in the study conducted by Preciados and Zabala in 2019. In other words, the methodology followed in this research is based on the methods and procedures established in Preciados and Zabala's paper.

A. Factor Abundance Index

The following formula will be used to determine what factor are the countries abundant at:

$$\frac{Share\ of\ Supply\ of\ Effective\ Factor}{Share\ of\ World\ GDP}$$

According to Preciados & Zabala, if the value is greater than 1, the country is abundant in that factor (2019). If it is confirmed that the country has an abundance of a particular factor, this study will use the test developed by Leontief in 1947, the Input-Output (I-O) analysis.

B. Statistical Tests

1) Unit Root Test

When analyzing time series models, the presence of a unit root in a stochastic process might present difficulties for statistical inference. The study will use the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to address this problem. A time series is considered non-stationary when the null hypothesis is true, implying the existence of a unit root. However, the null hypothesis is rejected, demonstrating the stationarity of the time series if there is strong evidence that a unit root is absent.

Without constant and trend:

$$\Delta Y_t = \delta Y_{(t-1)} + U_t$$

With constant:

$$\Delta Y_t = \alpha + \delta Y_{(t-1)} + U_t$$

With constant and trend:

$$\Delta Y_t = \alpha + \beta T + \delta Y_{(t-1)} + U_t$$

2) Co-integration Analysis

To examine the long-term relationship between variables, the study will employ the Unrestricted Cointegration Rank Test (Trace). Additionally, Pairwise Granger Causality Tests will be conducted to analyze the causal relationships between individual variables.

C. Econometric Model for H-O in Explaining Export Performance

To explore the impact of factor abundance on trading dynamics between the Philippines and the US, a regression model has been formulated. The objective is to ascertain the existence of a meaningful relationship between these two variables, and statistical tests will be employed for data analysis. The regression equation is as follows:

$$Log(EXP_{PHUS})_T = \beta_0 + \beta_1 logPHLaborSupply_t + \beta_2 logPHCapital\ Supply_t + \beta_3 logUSLaborSupply_t + \beta_4 logUS\ CapitalSupply_t + \varepsilon$$

where $Log(EXP_{PHUS})_T$ is the logarithmic value of the merchandise exports that the Philippines sends to the US within a specific year. $logPHLaborSupply_t$ is the logarithmic value of the labor supply in the Philippines during a specific year, which will be measured in terms of the number of people who are part of the labor force. $logPHCapital\ Supply_t$ is the logarithmic value of the capital supply in the Philippines during a particular year, which will be measured by the Gross Fixed Capital Formation. $logUSLaborSupply_t$ is the logarithmic value of the labor supply in the US during a specific year, which will be measured in terms of the number of people who are part of the labor force. $logUS\ CapitalSupply_t$ is the logarithmic value of the capital supply in the US during a particular year, which will be measured by the Gross Fixed Capital Formation.

The empirical model used in this study was primarily adopted from the work of Preciados & Zabala (2019), which in turn was based on the research conducted by Bilas and Bosnjak (2015), as well as the frameworks established by Hufbauer (1970), Balassa (1979), and Nyahoho (2010). The key variables in the model are the total labor force and total capital, which are central to the theory of the Heckscher-Ohlin model. This model suggests that a country's exports are likely to increase significantly if it has an abundance of these factors, as first predicted by Leontief (1947).

4. Results and Discussion

Table 2
Gross fixed capital formation

Gross Fixed Capital Formation (in Trillions)				Share of World GDP	
Year	**World**	**US**	**Philippines**	**US**	**Philippines**
2005	11.279	2.990	0.019	19.03%	0.55%
2010	15.598	2.756	0.042	16.68%	0.59%
2015	19.799	3.722	0.068	16.25%	0.66%

Table 2 shows the capital supply in the United States, the Philippines, and the rest of the world. The information makes it abundantly evident that the United States invests in and has a greater supply of capital than the Philippines.

The test results shown in Table 3 are the capital abundance of the United States and the Philippines. The capital abundance ratio suggests that a ratio of more than one means a country's capital supply is abundant. The results illustrate how the United States has a ratio of more than one, meaning its capital is

abundant, from the years mentioned above. The Philippines, nonetheless, possesses a ratio of less than one from all its years, demonstrating that the country is scarce in capital.

Table 3
Capital abundance

Capital Abundance		
Year	**US**	**Philippines**
2005	1.39	0.31
2010	1.06	0.46
2015	1.16	0.52

Table 4
Total labor force composition

Total Labor Force Composition (in Billions)				Share of World GDP	
Year	**World**	**US**	**Philippines**	**US**	**Philippines**
2005	2.953	0.152	0.034	19.03%	0.55%
2010	3.151	0.157	0.038	16.68%	0.59%
2015	3.305	0.160	0.043	16.25%	0.66%

The total labor of both countries in three separate years is shown in Table 4. Nominally speaking, the United States has more workers available than the Philippines. According to the H-O theorem, the United States benefits from a comparative edge in pricing because of its abundance because it can hire labor at a lower cost than the Philippines. Moreover, the data indicate that the United States has a comparatively higher proportion of qualified workers. Nevertheless, this benefit only applies to the nominal value; it is not the primary cause of the labor abundance of a country.

Table 5
Labor abundance

Labor Abundance		
Year	**US**	**Philippines**
2005	0.27	2.09
2010	0.30	2.04
2015	0.30	2.37

The United States' labor supply advantage, as shown previously in Table 4, was in the nominal value. Thus, the researchers considered the proportion between the Total Labor Force Composition and the Share of World GDP to determine the Labor Abundance. When the ratio is more than 1, assuming that that aspect is abundant makes sense. According to the table, the Philippines exhibits a ratio higher than one from 2005, 2010, and 2015. This suggests that the Philippines has been abundant in labor throughout the last ten years.

On the contrary, the United States' ratio is less than 1, indicating a lack of abundance in the labor component. According to the results, the Philippines has an abundant skilled workforce, while the United States lacks in that area. According to the results, the Philippines is abundant in labor, whereas the United States is scarce in that factor.

The group unit root test was executed on a set of time series variables, encompassing EXPORTS, PHGFCF, PHLABOR, USGFCF, and USLABOR, spanning from 2000 to 2021. The analysis integrated exogenous variables such as individual effects and individual linear trends. Automatic selections were made for maximum lags and lag length based on the Schwarz Information Criterion (SIC). The Newey-West method, employing a Bartlett kernel, was utilized for automatic bandwidth selection to address concerns related to heteroskedasticity and autocorrelation. Two-unit root tests, namely the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), were carried out, assuming the null hypothesis of an individual unit root process. The obtained test statistics for ADF (26.5131) and PP (61.5216) yielded low probabilities (0.0031 and 0.0000, respectively), indicating rejection of the null hypothesis and suggesting that the time series variables are likely stationary. The analysis involved five cross-sections, possibly representing different entities, with varying numbers of observations ranging from 94 to 100 across different tests. Overall, the results suggest the absence of unit roots and support the stationarity of the examined time series variables.

Table 6
Group unit root test

Group unit root test: Summary
Series: EXPORTS, PHGFCF, PHLABOR, USGFCF, USLABOR
Sample: 2000 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross sections	Obs
Null: Unit root (assumes individual unit root process)				
ADF - Fisher Chi-square	26.5131	0.0031	5	94
PP - Fisher Chi-square	61.5216	0.0000	5	100

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 7
Unrestricted cointegration rank test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.941779	122.4795	69.81889	0.0000
At most 1 *	0.742768	65.60936	47.85613	0.0005
At most 2 *	0.585697	38.45380	29.79707	0.0040
At most 3 *	0.472116	20.83065	15.49471	0.0071
At most 4 *	0.331457	8.053089	3.841466	0.0045

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The table 7 shows the results of an Unrestricted Cointegration Rank Test using the Trace statistic, aimed at assessing the long-run relationships among time series variables. The analysis assumes a linear deterministic trend in the data and focuses on five variables: EXPORTS, PHGFCF, PHLABOR, USGFCF, and USLABOR. The test, conducted on first differences of the series with a lag interval from 1 to 1, involves hypothesizing different numbers of cointegrating equations. The rejection of the null hypothesis for each case, from "None" to "At most 4," indicates the presence of cointegrating equations. Specifically, the test suggests the existence of 5 cointegrating equations at the 0.05 significance level. The asterisks denote rejection of the null hypothesis at the 0.05 level, and the MacKinnon-Haug-Michelis (1999) p-values provide additional significance measures. In conclusion, the findings imply a statistically significant long-term relationship among the specified variables, with evidence supporting the presence of at least 5 cointegrating equations in the system.

Table 8
Pairwise granger causality tests

Sample: 2000 2021
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
PHGFCF does not Granger Cause EXPORTS	20	6.16870	0.0111
EXPORTS does not Granger Cause PHGFCF		2.72069	0.0981
PHLABOR does not Granger Cause EXPORTS	20	6.70790	0.0083
EXPORTS does not Granger Cause PHLABOR		3.39342	0.0608
USGFCF does not Granger Cause EXPORTS	20	9.10897	0.0026
EXPORTS does not Granger Cause USGFCF		1.53594	0.2473
USLABOR does not Granger Cause EXPORTS	20	2.79816	0.0927
EXPORTS does not Granger Cause USLABOR		0.17701	0.8395

Table 9
Regression analysis of exports (Philippines)

Dependent Variable: EXPORTS
Method: Least Squares
Sample (adjusted): 2001 2021
Included observations: 21 after adjustments
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	22778660	6135555.	3.712567	0.0017
PHGFCF	0.000128	3.04E-05	4.202178	0.0006
PHLABOR	-0.533313	0.194659	-2.739734	0.0140
AR(1)	0.419910	0.237020	1.771621	0.0944
R-squared	0.794336	Mean dependent var		8677731.
Adjusted R-squared	0.758042	S.D. dependent var		1410112.
S.E. of regression	693622.9	Akaike info criterion		29.90689
Sum squared resid	8.18E+12	Schwarz criterion		30.10584
Log likelihood	-310.0223	Hannan-Quinn criter.		29.95007
F-statistic	21.88636	Durbin-Watson stat		1.204098
Prob(F-statistic)	0.000005			
Inverted AR Roots	.42			
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.041042	Prob. F(2,15)		0.3772

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.595711	Prob. F(2,18)	0.5617

Chow Breakpoint Test: 2010
Null Hypothesis: No breaks at specified breakpoints
Equation Sample: 2001 2021

F-statistic	1.565725	Prob. F(4,13)	0.2416

Ramsey RESET Test
Equation: UNTITLED
Specification: (EXPORTS) C (PHGFCF) (PHLABOR) AR(1)
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.577081	16	0.5719

Variance Inflation Factors
Sample: 2000 2021
Included observations: 21

The Pairwise Granger Causality test results showed no short-run causal relationship between the Philippines' labor supply and exports, indicating that the labor supply has no short-term impact on the country's ability to export. This complies with the criteria of supply since it requires time for businesses to use factors of production and turn them into finished goods, particularly when engaging in international trade. Likewise, additional factors like the Capital Supply of the Philippines and the Capital and Labor Supply of the United States have no bearing on the Philippines' short-term exports to the United States. Furthermore, Pairwise Granger Causality lack of short-run causation suggests that estimating the model's short-run OLS is insignificant. On the other hand, the model's analysis as determinants for the H-O theorem greatly benefits from the long-term OLS.

In Table 9, the regression analysis unveils a significant explanatory power, as indicated by the R-squared value of 0.794336. This implies that around 79.43% of the variability in EXPORTS is explained by the incorporated independent variables. Notably, the coefficients indicate that PHGFCF has a positive impact, reflecting the influence of gross fixed capital formation, while PHLABOR has a negative impact on exports, implying a potential adverse effect of labor supply on export levels. However, the Durbin-Watson statistic of 1.204098 raises concerns about potential autocorrelation in the model, indicating the need for further investigation into the temporal dynamics of the data.

Moving to Table 10, a similar pattern emerges. The model effectively explains the variation in exports, with an R-squared value of 0.843286. The coefficients reveal that USGFCF has a positive impact, while USLABOR has a negative impact on exports. The Durbin-Watson statistic of 2.287487 suggests a

Table 10
Regression analysis of exports (United States)
Dependent Variable: EXPORTS
Method: Least Squares
Sample (adjusted): 2001 2021
Included observations: 21 after adjustments
Convergence achieved after 7 iterations

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	25512335	11720191	2.176785	0.0439
USGFCF	3.06E-06	6.24E-07	4.907394	0.0001
USLABOR	-0.172678	0.085490	-2.019867	0.0594
AR(1)	0.374035	0.144571	2.587212	0.0192
R-squared	0.843286	Mean dependent var		8677731.
Adjusted R-squared	0.815631	S.D. dependent var		1410112.
S.E. of regression	605477.9	Akaike info criterion		29.63507
Sum squared resid	6.23E+12	Schwarz criterion		29.83402
Log likelihood	-307.1682	Hannan-Quinn criter.		29.67825
F-statistic	30.49261	Durbin-Watson stat		2.287487
Prob(F-statistic)	0.000000			
Inverted AR Roots	.37			
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	2.425292	Prob. F(2,15)		0.1223
Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	0.192924	Prob. F(2,18)		0.8262
Chow Breakpoint Test: 2010 Null Hypothesis: No breaks at specified breakpoints Equation Sample: 2001 2021				
F-statistic	1.560119		Prob. F(4,13)	0.2431
Ramsey RESET Test Equation: UNTITLED Specification: EXPORTS C USGFCF USLABOR AR(1) Omitted Variables: Squares of fitted values				
	Value		df	Probability
t-statistic	0.776908		16	0.4485
Variance Inflation Factors Sample: 2000 2021 Included observations: 21				

potential lack of autocorrelation, indicating a different dynamic compared to the first model. Diagnostic tests, including the Breusch-Godfrey Test and the Chow Breakpoint Test, do not conclusively indicate serial correlation or structural breaks.

In both models, the consistent finding of a positive impact of investment (PHGFCF and USGFCF) and a negative impact of labor (PHLABOR and USLABOR) on exports reveals valuable insights into the factors influencing export behavior. However, the potential presence of autocorrelation in the first model, as indicated by the Durbin-Watson statistic of 1.204098, raises concerns and necessitates further investigation into the temporal dynamics of the data. One plausible explanation for the observed autocorrelation may be dynamic adjustment processes within the Philippine economy. Economic variables often exhibit dynamic responses to changes, and if there are lagged effects or time-dependent adjustments in labor and capital markets influencing export levels, this could lead to the observed autocorrelation. Additionally, external shocks during the specified period, such as global economic downturns or geopolitical uncertainties, could be another contributor to autocorrelation. While diagnostic tests like the Breusch-Godfrey Test and the Chow Breakpoint Test did not provide clear evidence of serial correlation or structural breaks, the indication of potential autocorrelation in the Durbin-Watson statistic necessitates a closer examination of time-dependent patterns and a nuanced understanding of the economic context for a comprehensive interpretation of the observed autocorrelation in the first model.

Despite the uniform negative impact of labor (PHLABOR and USLABOR) on exports in both models, a departure from traditional economic theories, including Leontief's Paradox, is evident. The paradoxical observation by Leontief, where a capital-abundant country exports labor-intensive goods, aligns with the negative impact of labor on exports found in these models. This discrepancy suggests that, despite being labeled as labor-abundant (PHLABOR) or capital-abundant (USLABOR), the countries may be exporting goods that are less intensive in their abundant factor. This paradoxical scenario challenges theoretical expectations based on factor endowments and highlights the nuanced nature of real-world trade patterns. The findings underscore the importance of considering additional factors beyond traditional economic theories and potentially reassessing classical economic models to explain observed trade patterns.

5. Conclusion

This study investigated the Heckscher-Ohlin Trade Theorem concerning international trade between the United States and the Philippines. The researchers deduce that despite the Philippines being relatively abundant in labor and the United States being relatively abundant in capital, both countries may be exporting less intensive goods in their abundant factor, which satisfies the Leontief Paradox. The Leontief Paradox states that a capital-abundant country is importing goods that

required capital-intensive production and exporting commodities that required a lot of labor-intensive output (Ito et al., 2016).

The persistent negative influence of labor on exports observed in both the Philippines and the United States, as depicted in Figures 4 and 5, resonates with the enigma encapsulated in Leontief's Paradox. This paradox, which defies traditional expectations based on the Heckscher-Ohlin (H-O) theorem, posits that a country exporting goods intensive in its abundant factor contradicts the anticipated trade patterns. In the context of this study, the consistent negative impact of labor on exports challenges the conventional notion that a labor-abundant country like the Philippines would predominantly export labor-intensive goods.

Leontief's Paradox manifests in the empirical findings, suggesting that despite being labeled as labor-abundant (PHLABOR) or capital-abundant (USLABOR), both countries may be exporting goods that deviate from their expected factor endowments. This departure from classical economic theories underscores the nuanced and multifaceted nature of real-world trade patterns. It prompts a reevaluation of traditional expectations, acknowledging that factors beyond raw abundance may shape a country's export portfolio.

In essence, the paradoxical scenario unveiled in this study aligns with Leontief's observations and challenges the straightforward application of the H-O theorem. The consistent negative impact of labor on exports serves as a tangible manifestation of the complexities inherent in international trade, urging a deeper exploration of the intricate factors influencing trade dynamics and a reconsideration of established economic models.

Future researchers are encouraged to adopt a more nuanced approach in their investigations by disaggregating both labor and capital supply dynamics. Dissecting labor into skill-levels allows for a deeper exploration of the intricacies within a country's workforce, providing insights into how different skill levels contribute to its comparative advantage in international trade. Similarly, disaggregating capital supply into various investment types, such as technology, infrastructure, or research and development, offers a granular understanding of how distinct forms of capital influence a country's trade patterns. This detailed examination may uncover subtle correlations that remain obscured when treating capital as a uniform and undifferentiated factor. By delving into the diverse components of both labor and capital supply, researchers can gain comprehensive insights into the specific factors driving a country's export patterns and economic competitiveness.

Furthermore, in light of the unprecedented disruptions caused by the COVID-19 pandemic, researchers are advised to exercise caution in their data inclusion. Temporarily excluding data from the post-2019 period acknowledges the significant shifts in the global economic landscape during this time. This cautious approach ensures that the analysis remains focused on pre-pandemic data, providing a clearer and more accurate assessment of trade dynamics unaffected by the exceptional circumstances induced by the pandemic.

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