Research Article

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Study on Economic Convergence Employing the 2.2.2 Model of Heckscher-Ohlin

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Abstract

This article presents a methodology to estimate disparities in factor endowments in a dynamic Heckscher-Ohlin model. The model integrates a static approach to intraindustry trade of two goods and two factors. By employing a Cobb-Douglas production function model (2 goods, 2 factors), we identify convergences and divergences in production, influenced by the elasticity of substitution between inputs. Our findings illustrate that, even if factor prices equalize, countries differing only in their initial capital-to-labor ratios may converge or diverge in income levels over time. Divergence can occur for parameter values that would imply convergence in a world of closed economies, and open ones.

Keywords: *Intra-industry trade, production function, economic convergence*

1. Introduction

Global economy and economic convergence are interconnected concepts describing significant trends and processes in worldwide economic development. The global economy refers to the interconnectedness and interdependence of economies across the world. This interconnectedness is facilitated by international trade, foreign investment, capital flows, technology, and communications. Economic convergence is a process whereby differences in per capita income levels, productivity, and development among countries tend to diminish over time. The interconnectedness of the global

economy can facilitate economic convergence through various mechanisms such as economic policies, education, infrastructure, and political stability. In the absence of these favorable conditions, some countries may lag behind and not fully benefit from the global economy.

Economic convergence is neither automatic nor guaranteed; it depends on factor endowments. The Heckscher-Ohlin theorem is essential in this analysis, as it provides a theoretical framework for understanding how differences in factor endowments influence nations' trade patterns and specialization. It addresses the most important question: Should countries trade or should they close themselves off and produce in autarky?

The classical models of international trade explain countries' comparative advantage based on differences in technology or resource endowments. Both the Ricardian model and the Heckscher-Ohlin (HO) model demonstrate that countries tend to specialize in the production of goods and services that intensively use the factors of production they possess abundantly and inexpensively, while importing products that require factors of production that are scarce and costly in their economy. The HO theorem suggests that countries tend to engage in intraindustry trade to obtain goods and services that require factors of production that are scarce in their economy. According to the HO model, a country that is relatively abundant in capital will export goods that intensively use this factor. In contrast, a country that is relatively scarce in capital will import these goods and export those that intensively use labor, in which it is relatively abundant. This explains how differences in factor endowments between countries determine patterns of international trade (Cuñat & Maffezzoli, 2004).

This article estimates disparities in factor endowments in an economy consisting of two countries, two goods, and two factors of production, based on a classical Heckscher-Ohlin model as a growth model in the sense that the two factors of production are identified as labor and physical capital. This methodology is supported by the econometric model (Beck, 2003) and a dynamic model where consumers have homothetic preferences (Bajona & Kehoe 2006, 2010). First, the validity of the theorem is evaluated with the classical factorial version of the model, considering two countries (domestic and foreign) and two factors (capital and labor). The standard form of the HO model is studied, which explains patterns of international trade based on differences in factor endowments between countries, postulating that countries specialize in the production and export of goods that intensively use the factors of production with which they are abundantly endowed. Second, we support this idea with empirical evidence, evaluating various hypotheses with the Cobb-Douglas production function on how these variables affect export diversification. Finally, we analyze both the analytical and numerical results of the model.

The rest of the document follows this structure. Section 2 details the methodology used to calculate the dynamic model of the Heckscher-Ohlin theorem, using equations to represent the relationship between the factors of production (capital and labor) along with a description of the different data sources. Section 3 presents and analyzes the results of the model simulations in various scenarios, including: Autarky, Sectoral equilibrium, and Free trade. Finally, Section 4 presents the study's conclusions.

2. Literature Review

2.1 Intra-industry Trade and the Heckscher-Ohlin Theorem

The Heckscher-Ohlin (HO) model has significantly contributed to understanding the interaction between market gains and factor mobility in intra-industry trade. This model explains patterns of international trade based on the relative factor endowments (labor, capital), assuming identical technology, internal factor mobility, and perfect competition. According to the model, countries specialize in the production and export of goods that intensively use the factors with which they are relatively abundant and inexpensive, while importing goods that require scarce and costly factors.

Regarding the dynamic models of Heckscher-Ohlin, two countries are considered, both with

identical constant returns to scale (CRS) production functions, differing relative factor endowments between the two countries, and demand in each country is generated by a single consumer whose income is determined by their ownership of capital and labor. Under this assumption, consumers have homothetic preferences and no goods are inferior in the countries. In this context, each country partially specializes in the production of the good that intensively uses the factor it possesses in greater abundance. Conversely, each country exports part of its specialized production and imports the good that intensively uses the scarce factor in its economy. This process is repeated in the other country, but with goods and factors reversed.

There is an extensive literature that is at least partially related to the topic (Grubel & Lloyd, 1971; Oniki & Uzawa, 1965; Stiglitz, 1970; Helpman & Krugman, 1989, Atkeson & Kehoe, 2000b; Melitz, 2003; Ottaviano, 2008; Hinloopen & Van Marrewijk, 2008; Opp et al., 2009; Agosín, 2009; Agosín, 2009b; Bajona & Kehoe, 2010; Haddad et al., 2013; Matulevich, 2013, Malki & Thompson, 2014; Bekkers & Stehrer, 2015; Sen, 2015; Balavac & Pugh, 2016; Hesse & Poghosyan, 2016; Gozgor & Can, 2016; Balavac & Pugh, 2016; Lectard & Rougier, 2018; Kaitila, 2019; Aistleitner et al., 2021; Young, 2022) as well as in the theoretical studies of, Atkeson and Kehoe (2000), Cuñat and Maffezzoli (2004), Kaneko (2006), Caliendo (2009), Kehoe and Ruhl (2010), Chatterjee and Shukayev (2012), Sen and Shimomura (2013). The Heckscher-Ohlin (HO) model mainly focuses on open economies, explaining how factor endowments influence patterns of international trade. This trade exchange often equalizes factor prices between countries, generating significant implications for income distribution by benefiting countries with abundant factors and harming those with scarce ones. Conversely, in closed economies where there is no international trade, the principles of the model do not directly apply, and decisions on production and factor prices are internally determined.

This article examines patterns of intra-industry trade and explores how disparities in factor endowments between countries can result in mutually beneficial trade patterns. This type of trade is intrinsically linked to the Heckscher-Ohlin model, which posits that differences in factor endowments between countries are determinants of international trade (Agosín et al., 2011). Within the realm of intra-industry trade, variations in the quality, design, or specific characteristics of traded goods may reflect differences in the intensity of particular factors, such as capital or specialized labor (Gupta & Dutta, 2011). Therefore, intra-industry trade can be understood as an extension of the HO model, which not only considers differences in factor abundance but also disparities in production capacity and specialization of countries in differentiated goods within the same industry (Malki & Thompson, 2014).

Long-term international trade leads to the equalization of factor prices among countries with intra-industry trade. This notion suggests that observations from the Heckscher-Ohlin model in its classical form, where technological differences and economies of scale are not considered, raise expectations about how this model may be limited in its ability to fully explain international trade processes. In other words, by omitting these aspects, the HO model may offer a simplified understanding of economic reality, suggesting the need to revise or expand the model to better capture the complexity of global trade patterns. The Leontief paradox challenges the assumptions of the HO model by demonstrating that some countries, despite having an abundance of capital, exported labor-intensive goods and imported capital-intensive goods. In contrast, Ricardian theory maintains that a country should specialize in the production and export of goods in which it has a comparative advantage in terms of production costs, even if it is less efficient in producing all goods compared to other countries.

3. Methodology

The article develops a methodology based on the Heckscher-Ohlin model (2x2x2), describing an economy composed of two countries, two goods, and two factors of production. This methodology combines a static analysis of trade in two goods and two factors with a two-sector growth model. It is assumed that differences in endowments are not pronounced, leading to factor price equalization.

This allows for an examination of exchange and production dynamics between countries, considering how the availability and relative productivity of factors of production influence patterns of international trade and resource allocation within each economy. It enables analysis of how variations in the endowment and relative productivity of capital and labor in different countries affect productive specialization and trade flows between them.

The specific model employed in this article incorporates elements from various research sources (Beck, 2003; Bajona & Kehoe, 2006, 2010). To determine if production factors differ significantly between industries, a graphical approach is used to represent factor usage in the integrative equilibrium in vector form. This method allows for verification of whether a country's factor endowment lies within the set defined by the vectors plotted in a parallelogram. Figure 1 illustrates this representation, facilitating visualization and comparison of factor endowments between different industries.

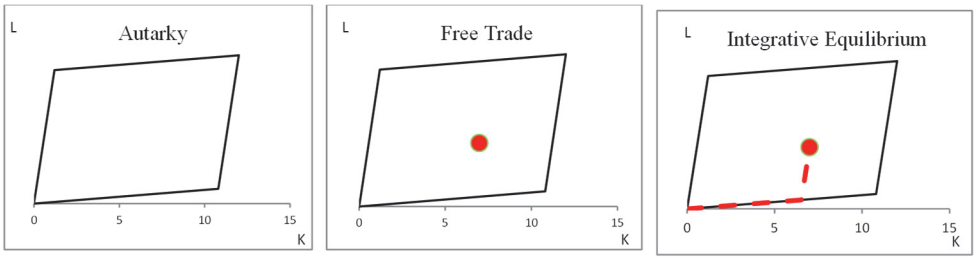

Figure 1. Vector Diagram in Parallelogram

The presentation of the model begins by describing an economy with two factors of production, capital (K) and labor (L), and two consumer goods, (X) and (Y), produced under constant returns to scale (CRS) and perfect competition. It is proposed that the quantities of goods produced by each country in autarky, free trade, and integrative equilibrium, as well as the prices of goods and factors, are determined. Additionally, the quantities of goods produced by each country in trade integration, along with the prices of goods and factors, are investigated. It is analytically demonstrated that the transition from autarky to positive levels of trade costs amplifies productivity differences between the comparative advantage sector and the comparative disadvantage sector. The goods are produced with Cobb-Douglas technologies.

Using Cobb-Douglas production functions for the production of goods (y1, y2), the equations are employed[1] (1).

$$y_1 = 4K_1^{0.2}3L_1^{08} \text{ y } y_2 = 2K_2^{0.8}5L^{0.2}. \text{ (1)}$$

Using equations (2) and (3), it is described how the total production of each good depends on the inputs of capital (K) and labor (L). The general Cobb-Douglas production function is defined as:

$$Y\_1=Ak\_1\text{^}\alpha L\_1\text{^}(1-\alpha) \text{ (2)}$$

$$Y\_2=Bk\_2\text{^}\beta\ L\_2\text{^}(1-\beta) \text{ (3)}$$

It will be assumed that $\alpha > \beta$, where production of good 1 is relatively capital-intensive and that of good 2 is relatively labor-intensive (Equation 4).

$$\forall r, w, \quad \frac{k_1}{L_1} > \frac{k_2}{L_2} \text{ (4)}$$

This means that, for any level of income (r) and wages (w), the capital-to-labor ratio (k/L) is

[1]. *In the case of Y1, production relies more on labor than on capital, given that α=0.2 and 1–α=0.8. In the case of Y2, production depends more on capital than on labor, with β=0.8 and 1–β=0.2. These functions demonstrate how changes in the factors of production (capital and labor) affect the quantity produced of each good.*

higher in the production of good 1 than in that of good 2. The factor endowments of each country (represented with an asterisk notation for the foreign country) are: $\overline{K}$ *y* $\overline{L}$ for the domestic country and $\overline{K}^*$ *y* $\overline{L}^*$ for the foreign country. The factor endowments are generally not equal and define the relative abundance of each country as follows (Equation 5): Assuming: the domestic country is relatively abundant in capital2.

$$\frac{\overline{K}}{\overline{L}} > \frac{\overline{K}^*}{\overline{L}^*} \quad (5)$$

The domestic country, being relatively abundant in capital, will be an exporter of good 1, which uses that factor relatively intensively. The foreign country, being relatively abundant in labor, will be an exporter of good 2, which uses that factor relatively intensively. The optimal factor combination for production given their prices is (Equation 6):

$$\max = P_1 A K_1^{\alpha} L_1^{1-\alpha} - wL_1 - rK_1 \quad (6)$$

This gives us the first-order conditions:

$$r = P_1 \alpha A \left(\frac{L_1}{K_1}\right)^{1-\alpha} \quad (7)$$

$$w = P_1(1-\alpha)\left(\frac{K_1}{L_1}\right)^{\alpha}$$

The condition of factor market clearing:

$K_1 + K_2 = \overline{K}$ y $L_1 + L_2 = \overline{L}$ (8)

In constant returns to scale, total income equals total factor cost:

$P_1 Y_1 = wL_1 + rK_1$ (9)

$P_2 Y_2 = wL_2 + rK_2$

A Cobb-Douglas utility function with a parameter of 0.5 is assumed. Expenditure on both products will be equal. For the case of autarky, it is represented as:

$P_1 Y_1 = P_2 Y_2$ (10)

Competitive markets with constant returns to scale technologies do not generate profit and are represented as:

$P_1 Y_1 = wL_1 + rK_1 P_2 Y_2 = wL_2 + rK_2$(11)

To estimate the levels of the relationship between the capital endowment of countries, an economy with two countries, two goods (or services), and two factors of production (capital and labor) is assumed. The two goods are produced with Cobb-Douglas technologies:

$y_1 = K_1^{0.4} L_1^{0.6}$ y $y_2 = K_2^{0.5} L^{0.5}$.

4. Results

In autarky, the quantities of good 1 and good 2 that each country would produce are defined based on their factor endowments and production technology. The prices of goods and factors are determined by the internal supply and demand of each country. The model evaluates the quantities of good 1 and good 2 that each country would produce and checks whether these are influenced by the terms of trade and comparative advantages. The capital and labor endowments in each country are obtained from export and import data extracted from the Comtrade Database, enabling the simulation of multiple scenarios.

4.1 Simulations of the model regarding: Autarky

The endowments of capital and labor in each country are:

$\overline{K} = 4,\ \overline{L} = 3,\ \overline{K}^* = 5,\ \overline{L}^* = 5.$

[2] It implies that the local country will export good 1, which is capital-intensive, while the foreign country will export good 2, which is labor-intensive.

The equilibrium in autarky is derived:

$K_1 = \frac{\alpha}{\alpha+\beta}\overline{K}, \quad K_2 = \frac{\beta}{\alpha+\beta}\overline{K}$

$L_1 = \frac{1-\alpha}{2-\alpha-\beta}\overline{L}, \; L_2 = \frac{1-\beta}{2-\alpha-\beta}\overline{L}$

$C_1 = Y_1 = AK_1^{\alpha}L_1^{1-\alpha}, \; C_2 = Y_2 = BK_2^{\beta}L_2^{1-\beta}$ (12)

$P_1 = \frac{C_2}{C_1}, \; P_2 = 1$

$w = (1-\beta)B\left(\frac{K_2}{L_2}\right)^{\beta}, \; r = \beta B\left(\frac{L_2}{K_2}\right)^{1-\beta}$

Factoring, the equations will be modified to the following: Equilibrium in relative prices:

$P_1Y_1 = P_2Y_2P_1^*Y_1^* = P_2^*Y_2^*P_2 = P_2^* = 1$ (13)

$P_1Y_1 + P_1^*Y_1^* = P_2Y_2 + P_2^*Y_2^*P_1 = P_1^*$ (14)

$P_2 = P_2^* = 1$

In autarky, a country is self-sufficient without depending on foreign trade. The economy seeks internal equilibrium to meet demand without imports or exports. These equations indicate that expenditure on good 1, including both domestic expenditure and external expenditure (exports), equals expenditure on good 2. Additionally, they establish that the price of good 1 is the same for both the domestic country and the foreign country (Table 1).

Table 1. Parameters of the Countries

Parameters			
A	1		
alfa	0,4		
B	1		
beta	0,5		
FACTORS			
K bar	4	K barra*	5
L bar	3	L barra*	5

The table presents the essential parameters that define the production structure of the economic model, with coefficients "A" and "B" indicative of the relative influence of production factors in the production of goods A and B, respectively. Specifically, the parameters alpha and beta, with values of 0,4 and 0,5 respectively, reflect the weighting of capital and labor factors in the production of each good. Regarding production factors, values are provided for both the entire economy and a specific country. For example, the values of "K bar" and "L bar" represent the average endowments of capital and labor for the entire economy, while "K bar*" and "L bar*" denote the endowments of the asterisk (*) foreign country.

Table 2. Countries in Autarky

Local Country		Foreign Country	
K1	1,777777778	K1*	2,222222222
K2	2,222222222	K2*	2,777777778
L1	1,636363636	L1*	2,727272727
L2	1,363636364	L2*	2,272727273
C1	1,691526793	C1*	2,512766516
C2	1,74077656	C2*	2,512594538
Y1	1,691526793	Y1*	2,512766516
Y2	1,74077656	Y2*	2,512594538
r	0,391674726	r*	0,452267017
w	0,638284739	w*	0,552770798
P1	1,02911557	P1*	0,999931558
P2	1	P2*	1

A comparison is presented between the local country and the foreign country in a context of autarky, addressing aspects such as factor endowments, production, relative prices, wages, and goods prices. For the local country: Capital (K1 and K2): 1.7 and 2,22 units respectively. Labor (L1 and L2): 1.62 and 2.72 units respectively. For the foreign country: Capital (K1* and K2*): 2.22 and 2.77 units respectively. Labor (L1* and L2*): 2.72 and 2.72 units respectively. Production: Production of goods (C1 and C2) and income production (Y1 and Y2) for both countries. Relative prices: Relative prices (P1 and P2) for both goods in both countries. Wages: Wages (w and w*) for the local country and the foreign country respectively. In a state of autarky, the local country leverages its relative scarcity by producing and consuming everything it can. There's a slight disparity in production between goods B1 and B2 in the local country, as B2 requires higher labor intensity (r-w). In the local country, this ratio is 1.62962963, whereas in the foreign country, it's 1.22. Consequently, workers in the local country earn 1.62 units, benefiting from their relative scarcity, while in the foreign country, a worker earns 1.22 units.

In autarky, a country aims to meet all its needs internally, without relying on foreign trade. This means it produces all the goods and services it requires and does not import or export products. In this context, the equations mentioned indicate that spending on a specific good within the country (including both domestic expenditure and exports) equals spending on another good. Additionally, they establish that the price of a good within the country is equal to the price of that same good abroad. This equality of expenditure and relative prices is an important feature of equilibrium in autarky, where the country is not influenced by international trade flows.

Simulations of the model regarding: Sectoral Equilibrium

Sectoral equilibrium is characterized by a relationship between the profit condition and an expression for the number of firms where prices are equalized. When the conditions for factor price equalization are met, several important results are obtained. The following equations are established:

$$P_1Y_1 = P_2Y_2P_1^*Y_1^* = P_2^*Y_2^*P_2 = P_2^* = 1 \qquad (15)$$

$$P_1Y_1 + P_1^*Y_1^* = P_2Y_2 + P_2^*Y_2^*P_1 = P_1^*$$

$$P_2 = P_2^* = 1$$

Factoring, the equations will be modified to the following:

$$P_1Y_1 + P_1^*Y_1^* = P_2Y_2 + P_2^*Y_2^*P_1 = P_1^* \qquad (16)$$

$$P_2 = P_2^* = 1$$

These equations illustrate the equality of expenditures and relative prices, establishing that the price of good 2 is equal to 1 in both countries, with the following parameters (Table 3).

Table 3. Parameters of the Countries

Parameters			
A	1		
alfa	0,4		
B	1		
beta	0,5		
FACTORS			
K bar	12	K bar*	2
L bar	12	L bar*	5

The parameters A and B represent different aspects of the countries' productivity. The values of alpha and beta indicate the shares of production factors (labor and capital) in the production of goods. An alpha of 0.4 suggests that labor has a relatively low share compared to capital (lower alpha indicates more capital intensity). A beta of 1.0 indicates that capital has a high share in the production of goods compared to labor (higher beta indicates more capital intensity). Factors: The local country has more capital (K bar = 4) than the foreign country (K bar∗ = 2), but less labor (L bar = 3) compared to the foreign country (L bar∗ = 5). The local country might be relatively more capital-intensive compared to the foreign country, while the foreign country might be more labor-intensive.

Table 4. Sectoral Equilibrium Countries

Local Country		Foreign Country		Sectoral Equilibrium	
K1	1,777777778	K1*	2,222222222	K1	5,33333333
K2	2,222222222	K2*	2,777777778	K2	6,66666667
L1	1,636363636	L1*	2,727272727	L1	6,54545455
L2	1,363636364	L2*	2,272727273	L2	5,45454545
C1	1,691526793	C1*	2,512766516	C1	6,03063964
C2	1,74077656	C2*	2,512594538	C2	6,03022689
Y1	1,691526793	Y1*	2,512766516	Y1	6,03063964
Y2	1,74077656	Y2*	2,512594538	Y2	6,03022689
r	0,391674726	r*	0,452267017	r	0,45226702
w	0,638284739	w*	0,552770798	w	0,5527708
P1	1,02911557	P1*	0,999931558	P1	0,99993156
P2	1	P2*	1	P2	1

The analysis of Table 4 reveals that, in sectoral equilibrium, there is an unequal distribution of production factors and production of goods between the local country and the foreign country. Although relative prices (P1 and P2), wages (w), and labor earnings (r) are identical in both countries, it is observed that the local country has a smaller amount of capital (K1 and K2) and labor (L1 and L2) compared to the foreign country. This results in unequal production of goods (C1 and C2), with higher production of good 2 in the foreign country and higher production of good 1 in the local country. These data suggest differences in resource endowments and production specialization between the two countries in sectoral equilibrium, which could influence their strategies for international trade and economic development, the following, in Figure 2, provides a graphical representation of the context of Autarky and Integrative Equilibrium.

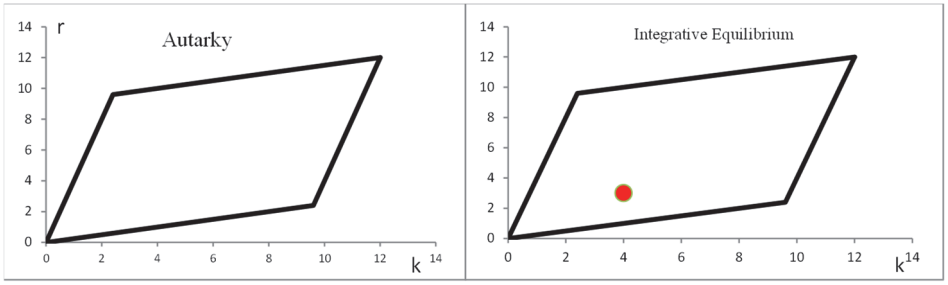

Figure 2: Context of Autarky and Integrative Equilibrium

In an autarky context, the country produces and consumes all goods and services within its own borders, without engaging in trade with other countries. The local country "autarky" (C2 Y2) takes advantage of its relative scarcity. The foreign country* greater production in b1 than b2 in the local country, because good 2 is labor-intensive. When the red point lies within the parallelogram, foreign trade becomes a substitute for free factor mobility. Free trade in goods will drive convergence in the prices of production factors used in both countries. Thus, free goods mobility acts as a replacement for free factor mobility.In the given context, it is assumed that differences in factor endowments between countries are not significant, leading to a convergence in factor prices. As a result, each country will specialize in producing the good that uses the factor it has in greater abundance more intensively, while not specializing in consumption. Instead, it will export part of its specialized

production and import the good that uses the relatively scarce factor more intensively. This process is reversed for the other country, implying opposite specialization in production and an exchange of goods to maximize economic efficiency between nations.

Simulations of the model relationship: Free Trade

In the model, Free Trade equilibrium is derived from the equations presented below, which describe the quantities of capital and labor used in the production of goods, as well as the production and prices of goods in a context of sectoral equilibrium between two countries (equation 17):

$$K_1^M = \frac{\alpha}{\alpha+\beta}(\bar{K}+\bar{K}^*),\quad K_2^M = \frac{\beta}{\alpha+\beta}(\bar{K}+\bar{K}^*)$$
$$L_1^M = \frac{1-\alpha}{2-\alpha-\beta}(\bar{L}+\bar{L}^*),\quad L_2^M = \frac{1-\beta}{2-\alpha-\beta}(\bar{L}+\bar{L}^*)$$
$$C_1^M = Y_1^* = A\left(K_1^M\right)^{\alpha}(L_1^M)^{1-\alpha},\quad C_2^M = Y_2^M = B(K_2^M)^{\beta}(L_2^M)^{1-\beta} \qquad (17)$$
$$P_1^M = \frac{C_2^M}{C_1^M},\quad P_2^M = 1$$
$$w^M = (1-\beta)B\left(\frac{K_2^M}{L_2^M}\right)^{\beta},\quad r^M = \beta B\left(\frac{L_2^M}{K_2^M}\right)^{1-\beta}$$

Factoring, the equations will be modified to the following:

$$P_1Y_1 + P_1^*Y_1^* = P_2Y_2 + P_2^*Y_2^*P_1 = P_1^* \qquad (18)$$
$$P_2 = P_2^* = 1$$

These equations are illustrated in both countries, with the following parameters (Table 5).

Table 5. Parameters of the Countries

Parameters			
A	1		
alfa	0,4		
B	1		
beta	0,5		
K bar	4	K bar*	5
L bar	3	L bar*	5

The endowments of capital and labor in each country are:

Table 6. Free Trade

Local Country		Foreign Country	
K1	0,533333333	K1*	1,2
K2	3,466666667	K2*	0,8
L1	2,133333333	L1*	4,8
L2	0,866666667	L2*	0,2
C1	2,122003193	C1*	2,122003193
C2	2,122003193	C2*	2,122003193
Y1	1,616764338	Y1*	3,63771976
Y2	2,627242049	Y2*	0,606286627
r	0,606286627	r*	0,606286627
w	0,606286627	w*	0,606286627
P1	1	P1*	1
P2	1	P2*	1

The following graph presents the Free Trade scenario (Fig. 2).

Figure 3. Context of Free Trade

Note: Trade patterns can be interpreted by the red line, which represents the production of good 1 by the local country compared to the rest of the world, indicating what portion is produced locally. Additionally, the vertical section of the red line indicates the local production of good 1. On the other hand, the upward part of the red line shows the proportion of production of good 2 carried out by the local country compared to the rest of the world. In the model, the local country experiences a loss of its relative scarcity, while the foreign country gains a worker. The vertical red line shows the proportion of production of good 1 carried out by the local country compared to the rest of the world, while the upward part of the red line indicates the proportion of production of good 2 carried out by the local country. If the red point lies within the parallelogram, it represents a substitute for free factor mobility.

Model simulations on the relationship: Welfare

With the same parameters, the model is simulated under a welfare situation. Table 7 presents the consumption levels of goods 1 and 2 (represented by C1 and C2 respectively) in different scenarios: autarky, trade, and a variant of each of these scenarios marked with an asterisk (*).

Table 7. Countries in sectoral equilibrium

	C1	C2
Autarky	1,691526793	1,74077656
		4,221158824
Trade	1,733808896	1,733690231
Autarky *	2,512766516	2,512594538
	2,512766516	2,512594538
Trade *	2,512766516	2,512594538

In the case of autarky, the country produces and consumes its own goods without trading with other countries. It is observed that, in this scenario, the country consumes less of good 1 but more of good 2 compared to the trade scenario. This may indicate a specialization in the production of one good in autarky and a diversification in trade. As for the scenarios marked with an asterisk (*), a reversal in consumption patterns between goods 1 and 2 can be noticed compared to normal scenarios, which could suggest a different response to changes in economic or political conditions. Below, the data presented in Table 8 show values of different variables (K1/K-b, K1, K2, L1, L2, Y1, Y2) for different levels of the relationship between the endowment of capital of the local country and the sum of the endowments of capital of the local country and the foreign country.

Table 8. Endowment of capital for the local country and the foreign country

K1/K-b	K1	K2	L1	L2	Y1	Y2	K1/K-b	K1	K2	L1	L2	Y1	Y2
0,50	2,00	2,00	2,82	0,18	2,64	1,23	0,50	1,00	1,00	4,71	0,29	3,45	0,78
0,60	2,40	1,60	2,88	0,12	2,78	0,95	0,60	1,20	0,80	4,80	0,20	3,64	0,61
0,70	2,80	1,20	2,92	0,08	2,90	0,70	0,70	1,40	0,60	4,87	0,13	3,80	0,44
0,80	3,20	0,80	2,95	0,05	3,00	0,45	0,80	1,60	0,40	4,92	0,08	3,93	0,29
0,81	3,24	0,76	2,96	0,04	3,01	0,43	0,81	1,62	0,38	4,93	0,07	3,94	0,27
0,82	3,28	0,72	2,96	0,04	3,02	0,41	0,82	1,64	0,36	4,93	0,07	3,96	0,26
0,83	3,32	0,68	2,96	0,04	3,03	0,38	0,83	1,66	0,34	4,94	0,06	3,97	0,24
0,84	3,36	0,64	2,96	0,04	3,04	0,36	0,84	1,68	0,32	4,94	0,06	3,98	0,23
0,85	3,40	0,60	2,97	0,03	3,05	0,34	0,85	1,70	0,30	4,95	0,05	3,99	0,21
0,86	3,44	0,56	2,97	0,03	3,06	0,31	0,86	1,72	0,28	4,95	0,05	4,01	0,20
0,87	3,48	0,52	2,97	0,03	3,07	0,29	0,87	1,74	0,26	4,95	0,05	4,02	0,18
0,88	3,52	0,48	2,97	0,03	3,08	0,27	0,88	1,76	0,24	4,96	0,04	4,03	0,17
0,89	3,56	0,44	2,98	0,02	3,09	0,24	0,89	1,78	0,22	4,96	0,04	4,04	0,16
0,90	3,60	0,40	2,98	0,02	3,09	0,22	0,90	1,80	0,20	4,97	0,03	4,05	0,14
0,91	3,64	0,36	2,98	0,02	3,10	0,20	0,91	1,82	0,18	4,97	0,03	4,06	0,13
0,92	3,68	0,32	2,98	0,02	3,11	0,18	0,92	1,84	0,16	4,97	0,03	4,08	0,11
0,93	3,72	0,28	2,99	0,01	3,12	0,15	0,93	1,86	0,14	4,98	0,02	4,09	0,10
0,94	3,76	0,24	2,99	0,01	3,13	0,13	0,94	1,88	0,12	4,98	0,02	4,10	0,08
0,95	3,80	0,20	2,99	0,01	3,14	0,11	0,95	1,90	0,10	4,98	0,02	4,11	0,07
0,96	3,84	0,16	2,99	0,01	3,15	0,09	0,96	1,92	0,08	4,99	0,01	4,12	0,06
0,97	3,88	0,12	2,99	0,01	3,15	0,07	0,97	1,94	0,06	4,99	0,01	4,13	0,04
0,98	3,92	0,08	3,00	0,00	3,16	0,04	0,98	1,96	0,04	4,99	0,01	4,14	0,03
0,99	3,96	0,04	3,00	0,00	3,17	0,02	0,99	1,98	0,02	5,00	0,00	4,15	0,01
1,00	4,00	0,00	3,00	0,00	3,18	0,00	1,00	2,00	0,00	5,00	0,00	4,16	0,00

It is observed that as the proportion of the endowment of capital for the local country relative to the sum of the endowments of capital increases, so do the values of K1, L1, Y1, while the values of K2, L2, and Y2 decrease. This suggests an inverse relationship between the relative endowment of capital and the production, employment, and consumption of goods in the local country.

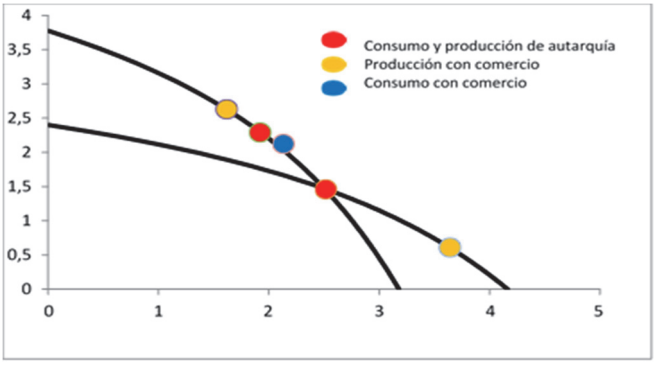

Figure 4. Integrative Equilibrium

In the provided dataset, the relationship between the capital-to-labor ratio (K1/K-b) and the quantities of capital (K1, K2), labor (L1, L2), and goods production (Y1, Y2) for different values of the capital-to-labor ratio is observed. It can be noted that as the capital-to-labor ratio increases, the production of goods that intensively use capital (K1 and K2) also increases, while the production of

goods that intensively use labor (L1 and L2) decreases. This suggests a relative specialization in the production of goods according to the relative endowments of capital and labor in each country, which is consistent with the predictions of the Heckscher-Ohlin theorem.

5. Conclusions

The study aims to investigate the assumptions necessary for the validity of the Heckscher-Ohlin (H-O) theorem in a two-country, two-good, two-input trade model using data simulation. The results reveal that, although allowing for different utility functions between countries, there is a tendency to fulfill the H-O theorem. However, when allowing for different production functions, no clear trend towards compliance is observed, suggesting that similarity in production technologies between countries is more relevant than similarity in utility functions. Since in the real world it is unlikely that two countries have the same production structure or identical production functions, the importance of examining to what extent similarity in production structure is necessary for trade equilibrium is emphasized. Additionally, caution is advised regarding the assumption that factor price equalization in a given period implies equalization in the future, as this is not always a guarantee of future equalization, especially in dynamic H-O models.

The research also reveals that opening up to free trade for an economy poorer than the world average can hinder its growth and lead to convergence to a steady state with a lower capital-production ratio. Although free trade can increase utility, it does not necessarily lead to higher growth rates. These findings underscore the complexity of the effects of international trade and the importance of considering multiple variables when formulating trade policies.

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