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The Correlation between Game Theory and International Trade

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ABSTRACT

Game theory, in its most basic form, considers two or more players and analyses the different strategies that they can use and the effect that these strategies will have on each player. International trade allows countries to use better their resources (labor, technology or capital). Since countries have different capital or natural resources, some of them will produce a good more efficiently than others and therefore could sell it cheaper than other countries. By using game theory in international trade we could determine if the Heckscher-Ohlin-Samuelson model is correct and what would be the best specialization for each country. The aim of this paper is to test if game theory could be successfully used in a thorough analysis of international trade specialization.

1. Introduction

Nowadays, all countries, regardless of social order, size and economic strength, of their endowment with natural resources and labor, their geographical location, etc., must participate in one form or another in the world economic circuit, as a natural consequence of the general economic interdependence between all countries.

The level of economic development of the various countries and the degree of diversification and specialization of their production are the main factors determining the role that each country has in the world economy and reflect the place that each country has in the international division of labor.

As any country has its weaknesses and strengths in different industries and for each product category, which are reflected as deficits or surpluses of the trade balance, the specialization is based on the dynamic changes in the structure of production, on the structural transformation of consumption or on investment development processes. From this point of view, a country's specialization is the result of an ongoing effort to make better use of its specific strengths in an environment that goes through permanent transformation.

Basically, the law of comparative or relative advantages, which is based upon the idea of country or individual specialization, says that even if a country is less efficient in the production of all goods than the other, it can gain from trade if it specializes in producing the good for which it has the highest relative advantage.

Game theory was used mainly in the analysis of trade policy and less in the analysis of a country's decision about specialization. The games are characterized by a number of players or decision makers, who interact, possibly threaten each other and form coalitions, make decisions in uncertain situations, and eventually receive some benefit or reward or possibly suffer some monetary loss.

Although game theory has been used to analyze various issues of international relations, international negotiations, the formation and expansion of customs unions, the international law issues of ownership, the international implications of national macroeconomic policies, international income redistribution and the international environmental problems, this theory hasn't been used enough to analyze international trade. Game theory has been used to argue the need for trade liberalization, elimination or reduction of customs duties and tariffs and protectionism still practiced by some countries. But a more complete analysis of international trade should not be limited only to a trade policy analysis, but should also consider the more practical and more complex side of trade, i.e. trade flows in goods and services.

The aim of this paper is to prove that such an analysis is possible and that it can be used in order to show what would be the optimal strategy that a country should adopt in making the decision of specialization.

2. Theoretical Issues in International Trade

The international trade is formed by all commercial ties between the various countries of the world based on the international labor division. In other words, international trade is a form of link between national

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markets, between producers all around the world, link that is due to the international labor division and that expresses the economical interdependences between countries. [1]

As a result of international trade, the market contains greater competition and therefore more competitive prices, which bring a cheaper product home to the consumer.

Trading globally gives consumers and countries the opportunity to be exposed to goods and services not available in their own countries. Almost every kind of product can be found on the international market: food, clothes, spare parts, oil, jewelry, wine, stocks, currencies and water. Services are also traded: tourism, banking, consulting and transportation. A product that is sold to the global market is an export, and a product that is bought from the global market is an import. Imports and exports are accounted for in a country's current account in the balance of payments.

Global trade allows wealthy countries to use their resources - whether labor, technology or capital - more efficiently. Because countries are endowed with different assets and natural resources (land, labor, capital and technology), some countries may produce the same good more efficiently and therefore sell it more cheaply than other countries. If a country cannot efficiently produce an item, it can obtain the item by trading with another country that can. This is known as specialization in international trade. [2]

The analysis of international trade reveals some general characteristics that define its flows:

- **International trade is a dynamic flow**

The growth rate of world exports was higher than the world economic growth rate or than the growth rate of world production. This great dynamism of trade flows is determined by the increasing interdependencies between economies and by the fact that trade is the first and the easiest way for the less advanced countries to become a part of the world economy. The gains in computer science and communication, the decrease in transportation costs, the faster and cheaper access to information were the main reasons for the exceptional boost in international trade.

- **An ongoing change of international trade flows**

Given the technological progress and innovation, the traded goods' list has continuously grown and the complexity of the products has skyrocketed. The diversity of the international trade flows can also be explained by the fact that goods have become more and more "international", because their production is done by companies from different countries.

Processed products began to dominate the international trade not only in developed but also in developing countries. The international commodity trade structure reflects this diversity, by the very large share of manufactured (processed) goods in total trade.

Over 70% of world trade consists of processed goods, followed by fuels and mineral products, agricultural products and textiles. Also, the processed goods category is dominated by machines and transport equipment, chemicals and pharmaceuticals and electronic and office equipment.

- **Developed countries are still controlling the international trade**

The top 10 exporters and importers of the world belong to the group of developed countries, excluding China, and they accounted for nearly half of world exports and imports. Overall, developing countries carried out around 30% of world trade and most of that share is due to only a few developing countries (China, Brazil, Argentina, Mexico, Southeast Asian countries, Middle Eastern oil exporting countries).

- **The worsening of exchange rates on the expense of developing countries**

The developing countries' foreign trade is still dominated by products with a lower level of processing, even if, overall, the share of raw materials has been exceeded by the share of processed products. In addition, access to developed country markets is easier for products that need less technology and are generally cheaper than the technologically advanced products. The worsening terms of exchange are also enhanced by the global economy recession and the less advantaged countries are the first to feel the full effects of economic stagnation or decline.

- **A polarization of international trade**

This polarization is determined by the fact that international trade has been dominated for a long time by the three biggest countries in the world. But if a decade ago the most powerful countries in the world were the USA, Japan and EU, things have changed, and now international trade is dominated by the USA, EU and China. And if we want to be more precise, we should consider that in fact, the world trade is dominated by large trade unions, such as the EU, NAFTA, ASEAN (plus China), that account for more than three quarters of the world exports.

- **The regionalization of international trade**

An increasing number of regional agreements are negotiated in the WTO and the existing ones tend to increasingly strengthen. EU continues to expand, the Asia - Pacific is emerging ever more convincing as a future economic power and the African continent countries strive to achieve functional groups, all amid an effort by the WTO to ensure as free trade.

- **Increasing non-tariff protectionism by decreasing protectionist tariffs**

WTO efforts to reduce customs duties have had a positive effect not only on international trade but also on the developing of new tools to protect the economy, in order to circumvent the negotiated multilateral trade agreements.

- **An internalization of world trade**

Due to the increasing globalization and interdependence, the role of national borders tends to fade. In terms of transnational corporations, trade is a trade between subsidiaries, even if these flows involve crossing the national borders of the countries in which these subsidiaries operate. According to the estimations of experts, the value of trade between subsidiaries lays around 7000 billion dollars, which represent over three quarters of the value of world imports! [3]

The main advantages of international trade are:

- individual and national income growth due to the currency received from exports;
- increased internal competition due to competition from imported products, with beneficial effects on efficiency and quality;
- an increase in the consumer's freedom of choice;
- stimulation of other streams of world economic circuit.

The main disadvantages of international trade are:

- this kind of trade is not mutually beneficial, due to differences between countries, the developed ones exporting high value-added products and the developing countries exporting poorly processed products such as raw materials, semi-processed products, etc.;
- irrational exploitation of natural resources with adverse effects on the environment;
- the fight for markets can lead to the so-called "trade wars" which can generate military conflicts, making trade a cause of instability, etc. [4]

Through foreign trade, each country can increase its economic potential, has the opportunities to exploit its human and material resources towards the development of its productive forces, promoting technical progress and higher capitalization of natural resources, the creation of new products, the increase of labor productivity and higher labor qualification.[5]

Many economists have analyzed the international trade, trying to find answers to important questions such as:

- the reasons why trade may take place between countries;
- what criteria would be appropriate for different countries choosing to specialize in the production of certain goods and services and thus would be the foundation of the international division of labor;
- which is the mechanism used to conduct international trade and what leverage it uses;
- what are the immediate and long-term results of international trade for different categories of countries (developed, developing, in transition);
- what are the main advantages and disadvantages of participating in the world economy and how they are divided among the participants;
- what is the correlation between the different structures and the economic development of the various countries;
- what are the changes that occurred in the structure of international division of labor, the dynamic structure of commodity groups and geographical spread of international trade;
- what is the diversification of foreign trade operations and techniques that occurred during the last years;
- what influence does the international trade have on the growth and long-term development of the different categories of countries and on the structure and operating mechanisms of the world-wide economy. [6]

According to Paul A. Samuelson "The major advantage of international trade is that it expands the scope of trade. If people were forced to consume only what they produced at home, the world would be poorer on both the material and the spiritual planes. Canadians could drink no wine, Americans could eat no bananas, and most of the world would be without jazz and Hollywood movies". The author also argues that "Trade may take place because of the diversity in productive possibilities among countries. In part, these differences reflect endowments of natural resources. One country may be blessed with a supply of petroleum, while another may have a large amount of fertile land. Or a mountainous country may generate large amounts of hydroelectric power which it sells to its neighbors, while a country with deep-water harbors becomes a shipping center." [7]

On the other hand, the Romanian economist Mihail Manoilescu believes that the best way to exploit the national forces is that of breeding "high-value industries", which have the highest labor productivity. He contradicts the principle of free trade which states that "If a production line works in conditions that are less efficient than those of foreign countries, the country must produce something else" considering that this recommendation is the result of a superficial account of economic phenomena and economic structure of a country and is based on the assumption that production of this "something else" must be necessarily more advantageous than the production the country renounced at in its favor.

Manoilescu believes a country should give up producing a new commodity and choose production of another commodity of higher productivity, whether the latter is exported or consumed in the country, whereas export of those goods increases export figure (which it can use to import a greater quantity of goods than if it had first been produced in the country) and that consumption diminishes the import of goods (which would be made if the commodity was not produced in the country). [8]

As it opens up the opportunity for specialization and therefore more efficient use of resources, international trade has potential to maximize a country's capacity to produce and acquire goods. Opponents of global free trade have argued, however, that international trade still allows for inefficiencies that leave developing nations compromised. What is certain is that the global economy is in a state of continual change and, as it develops, so must do all of its participants. [2]

3. An Overview of the Main Theories of International Trade

The dominant doctrine of the 1600's and the 1700's, mercantilism, sought to demonstrate that the power of a country depends on the amount of precious metals owned. Mercantilist authors (such as Malyness and Josiah Child in England, Jean Bodin and Antoine de Montchrestien in France) argued that international trade should be used as a means of enrichment. Mercantilism had as a main objective maintaining a trade balance surplus, through higher export to import ratio. Thus, a country could accumulate large quantities of gold and silver, therefore, international trade could increase national wealth and prestige. The mercantilist doctrine justified state intervention in order to increase surplus in trade balance through policies meant to boost exports and reduce or limit imports.

British classical economists, Adam Smith, David Ricardo, John Stuart Mill, did not doubt the existence of a regulatory mechanism. Their analyses on international trade could have supported the hypothesis of the trade balance. Their merit was to have synthesized in their theories issues on international trade and on the balance of payments. [9]

Besides W. Petty, P. Boisguillebert, B. Franklin, David Ricardo and J.S. Mill, Adam Smith has impressed by the simplicity of exposure, originality and concise nature of ideas. He based its whole conception on the idea, opposed to mercantilism, that trade between nations allows all partners to specialize, thus raising the level of productivity within each country and at the same time, the general production level and consumption worldwide. Smith is committed to free trade, by which nations are able to direct resources to those goods that can produce more cheaply, benefiting from the advantages offered by the international division of labor. [4]

The genius of David Ricardo in the development of economic theory can be appreciated by the fact that he captured the issues of his era and has been identified as its exponent. At the same time he was above all a creative spirit in theory, whose work contributed to understanding the entire development of economic doctrines. [10] These three elements, namely: being the analyst of his time, the representative of its time and the important moment in the evolution of doctrines are valid for all theoretical issues addressed, especially for the international trade-field which is believed to have made him an immortal character in the "pantheon" of economics. [11]

Swedish economists Eli Heckscher (1919) and Bertil Ohlin (1933) go further in trying to explain the comparative advantage, arguing that its source is due the differences in the allocation of production factors.[9] The Heckscher-Ohlin-Samuelson model was developed as an improvement of the Ricardian model created by a better approximation of the real world Ricardian model. [11]

According to the three authors, the criterion for country specialization based on a mutually beneficial trade between partners is relative advantage, defined as a country's ability to produce and export an economic good for which it uses the most abundant factor of production (and therefore cheaper) in a relatively higher proportion and to a lesser extent the less abundant and therefore more expensive factor. [1]

This is the Heckscher-Ohlin theorem*:* a country exports goods that are produced relatively intensively by the country's relatively abundant factor of production, and imports goods that are produced relatively intensively by the country's relatively scarce factor of production. Under these conditions, international trade corresponds to the exchange of abundant factors against scarce ones (countries will export goods whose production required a significant amount of abundant factors and will import goods produced with factors which they are lacking). As a result, there is a tendency to equalization of costs of factors. [9]

The HOS model has two basic implications:

- Under free trade, countries tend to export the good that uses their relatively-abundant factor relatively intensively.
- Under free trade, relative factor prices will be the same in all countries.

There are two further implications about how prices and trading patterns change. One is that if a country's factor endowments change, its trade will change as well. The other is that this change would also affect the international price, especially if our world consists of only two countries.

If the relative price of the two traded goods changes for any reason, then the factor that is used relatively more intensively in the good that is now more expensive will benefit. The factor that is used relatively more intensively in the good that is now cheaper will lose. [12]

For a country where labor is the abundant factor of production, foreign trade can provide a more complete way of using it and/or increase its price (wages), obtaining the currency they need to pay for the necessary imports of capital goods. [13]

The H-O-S model can be extended, provided that the number of countries is equal to the goods and factors, which each country has a full occupancy point that produces a unique collection of goods determined by its

endowment with production factors, that factor prices differ between countries and their mutual trade is expected to have effects on these prices. [14]

The neo-factorial approach remains in the HOS model logic, but takes into account several factors of production, mainly linked to the existence of human capital, that of skilled labor, which is, in every country, in different proportions. This new approach allows considering education as a major factor in industrialization and development of a country's comparative advantages.

H. Kierzowski and R.L. Findlay developed an econometric model, which showed that skilled labor is the combination of two primary factors, labor and capital. In the model proposed by the two, education, which makes unskilled workers become skilled workers, corresponds to a factor called the educational capital, which can generally be treated as capital. [15]

The model proposed by P. Krugman analyses two regions: North and South. Unlike the South, the North innovates, innovation taking rapidly the shape of new products manufactured in the North and only after a while in the South. The author shows that new industries must permanently provide something new in the North to allow this area to maintain revenues. New industries tend to decline and disappear, sooner or later due to the competition created by low wages in the South. High wages in the North reflect monopoly on new technologies. [16]

Raymond Vernon is the one who explained international trade in manufactured goods in terms of product life cycle. Thus, in its evolution, any product has four phases: emergence, growth, maturity and decline. In the first stage, the product is intensive in technology, then in the growth, the mass production stage, it will require a high intensity in capital (investment), in the mature and decline stage it will become a trivialized product, intensive in unskilled labor and will expire slowly. [17]

In 1990, Michael Porter published the results of extensive research (he analyzed 100 industries in 10 nations) in "The Competitive Advantage of Nations". One of the issues M. Porter tried to resolve was that of the definition of a nation's competitiveness. M. Porter believes that the term national competitiveness requires a certain economic prosperity and in order to reach this the key word is productivity. Labor productivity determines wages and capital productivity determine gains that belong to the owner. [18]

According to opinions expressed by many authors [19], [20], [21], [22], [23], the main limitations of classical and neo-classical theories are:

- They are based on overly simplistic assumptions. Thus the assumption that the nation is the existence of an area in which factors of production are immobile is invalidated by contemporary reality, in which capital is even more mobile than goods, while the pure and perfect competition assumption is also unsuitable to contemporary world.
- The conclusions derived from these theories are not consistent with actual economic developments: specialization of countries was explained based on differences between countries, differences related to: cost, productivity, factor endowment, demand structure, level of industrialization or economic and social organization. The logic of differences should determine, at least theoretically, different exchange rates, a completely different range of a country's exports.

Currently, trade between countries is even more intense as the countries are closer in economic terms (the development and application structure are similar).

4. Basic Concepts in Game Theory

Game theory studies in a simplified and stylized way the choices we make in various situations in which individuals must take into account each other. Game theory is a mathematical theory and therefore it can depict real situations that individuals are put in only in a sketched, but systematic manner. The purpose of this economic theory is to find different combinations of individual decisions, the balanced combination. [24]

Game theory is the study of multiperson decision problems. At the micro level, models of trading processes (e.g. bargaining and auction models) involve game theory. At an intermediate level of aggregation, labor and financial economics include game-theoretic models of the behavior of a firm in its input markets. There also are multiperson problems within a firm: many workers may compete for one promotion; several divisions may compete for the corporation's investment capital. Finally, at a high level of aggregation, international economics includes models in which countries compete (or collude) in choosing tariffs and other trade policies, and macroeconomics includes models in which the monetary authority and wage or price setters interact strategically to determine the effects of monetary policy. [25]

Game theory was developed in 1944 by John von Neumann and Oskar Morgenstern in "The Theory of Games and Economic Behavior". They have defined the game as „any interaction between various agents, governed by a set of specific rules that determine the possible moves of each participant and earnings for each combination of moves". [26]

A *game* is a description of strategic interaction that includes the constraints on the actions that the players can take and the players' interests, but does not specify the actions that the players *do* take. A *solution* is a systematic description of the outcomes that may emerge in a family of games. Game theory suggests reasonable solutions for classes of games and examines their properties. There are four groups of game

theoretic models: strategic games, extensive games with and without perfect information and coalitional games.

A *strategic game* is a model of a situation in which each player chooses his plan of action once and for all, and all players' decisions are made simultaneously (that is, when choosing a plan of action each player is not informed of the plan of action chosen by any other player). By contrast, the model of an extensive game specifies the possible orders of events; each player can consider his plan of action not only at the beginning of the game but also whenever he has to make a decision.

An *extensive game* is a detailed description of the sequential structure of the decision problems encountered by the players in a strategic situation. There is *perfect information* in such a game if each player, when making any decision, is perfectly informed of all the events that have previously occurred. The model of an extensive game with *imperfect information* allows a player, when taking an action, to have only partial information about the actions taken previously. The model encompasses not only situations in which a player is imperfectly informed about the other players' previous actions, but also, for example, situations in which during the course of the game a player forgets an action that he previously took and situations in which a player is uncertain about whether another player has acted.

A *coalitional game* has two primitives: (1) the collection of sets of joint actions that each group of players (coalition) can take independently of the remaining players and (2) the profile of the players' preferences over the set of all possible outcomes. An outcome of a coalitional game is a specification of the coalition that forms and the joint action it takes. Thus although actions are taken by coalitions, the theory is based on the individuals' preferences. [27]

According to John McMillan „The distinctive feature of a game is the presence of interdependencies among the agents: one agent's utility depends not only on his own actions, but also on the actions of each of the other agents. It is the agents' awareness of interactions among their decisions which give rise to the subtle problems of game theory. "The author also gives a definition of *strategy*: „a complete description of the agent's planned actions". [28]

Although it didn't meet all expectations, game theory has found numerous applications in social sciences and especially economics, from the study of oligopolies, cartels and the externalities, to the analysis of the military strategy and international trade negotiations. [29]

5. The Role of Game Theory in an International Trade Analysis

The main rationale for free trade has been the notion that free trade is always and everywhere a win-win proposition for the countries involved. Indeed, the argument has been that even if one trade partner is protectionist or mercantilist, the other is still better off sticking with free trade.

The conventional argument has always been based on restrictive assumptions including that all markets are perfectly competitive (no producer has market power), that there are no economies of scale and no cross border flows of investment or technology or people, that all resources (labor, equipment, land, etc.) are fully utilized, that there are no costs of adjustment in closing and opening factories or switching jobs and types of production, and that exchange rates are fixed. The conventional argument does not say there will be any losers from trade. Rather it is careful to explain that some industries and workers might suffer temporary losses and emphasizes that the gains of the winners will outweigh the losses of the losers and that the winners will therefore compensate for those less successful.

Of course, a main difficulty over the years has been the fact that the winners have never compensated the losers adequately. But the new studies suggest that there may not be enough winners to do any compensating. The main problem is that the conventional assumptions obviously do not hold any longer if they ever did. Most markets are not perfectly competitive, investment and technology do cross borders, economies of scale exist and are enormously important, and adjustment costs not only exist but can be very significant. Indeed, the new work indicates that the adjustment costs are huge. [30]

Game theory has a role in explaining the actions of states both in their trade strategies and the strategies employed during negotiations pertaining to the institutional rules under which trade can be conducted. Game theory and other aspects of modern industrial organization theory including transaction costs and New Institutional Economics have been adapted for, and harnessed to, the analysis of trade policy. [31]

Although this analysis is very important, given the growing complexity of international relations, and aims to integrate the system and game theory in empirical-analytic theory, but due to the pragmatically oriented nature of international conflict, we believe that game theory can be applied in the analysis of international trade.

International relations, as defined by different authors such as Evans and Nenham [32], Lake and Powell [33], Reynolds [34] and Wolfers [35], deal with interactions between various actors and nation-states, international organizations and multinational corporations.

Game theory, whose objective is the formalized analysis of relationships among two or more actors, can assist international relations theoreticians in explaining the interactions among the actors it considers, and practitioners in the field to influence those interactions to benefit the actors they represent or, hopefully, all humankind. [36]

In fact, as Poundstone [37] argues, game theory and international relations have influenced each other almost since the publication of The Theory of Games and Economic Behavior by von Neumann and Morgenstern (1944) and according to Bennett and Nicholson [38] this interaction has been both friendly and conflictive, and considered by some to be constructive and by others destructive.

The competition between firms, the conflict between management and labor, the fight to get bills through congress, the power of the judiciary, and war and peace negotiations between countries, and so on, all provide examples of games in action. [39]

McMillan [28] argues that game theory has had a rather feeble influence on the international economy theory, and it is almost nowhere to be found in international trade books. Despite the low impact that game theory has had on international trade theory, the most important international economic policies can be analyzed using game theory.

Most of the works and articles published in this area show that the main application of game theory in international trade is somewhat limited to trade policy and is less concerned with an actual analysis of international trade. In addition, in the literature we have found that game theory is considered an instrument for the analysis of international relations in the form agreements and treaties between countries.

Game theory has been used to argue the need for trade liberalization, elimination or reduction of customs duties and tariffs and protectionism still practiced by some countries. But a full analysis of international trade is not limited to trade policy analysis, but should consider the more and more complex and practical side of trade, i.e. trade flows in goods and services.

We argue that game theory can be used in the analysis of international trade without limiting the analysis to the trade policy or the international relations between countries.

International trade and, more specifically, the decision of country specialization can also be considered as a strategic game and we argue that it should.

6. Conclusion

In nowadays market economy, the importance of trade is always expanding, because the very notion of product covered by exchange enriches its content, expanding from tangible goods, the economic services of all kinds and other income-creating activities.

Exchange relations which value these products are included in the research area of trade, the economic theory defining them as commercial acts. It thus requires an enrichment of specific trade theory by offering a better explanation of all acts of exchange and conditions of their exercise (material basis, logistics, marketing, management, economic resources) and a reconsideration of the very role and importance of trade in the national economy.

As a mathematical tool for policy makers, the importance of game theory is given by the methodology it provides for the design and analysis of strategic decision problems. The modeling of a situation as a game requires the decision maker to establish clearly who the players are and what their strategic options are and to consider their preferences and reactions. The discipline and rigor necessary in the construction of such a model are able to provide the decision-maker with a clearer and more comprehensive view of the situation. This is a "prescriptive" application of game theory, which leads to better strategic decision making.

Developed over the course of three decades (1919-1948), the Heckscher-Ohlin-Samuelson theory offers a subjective rebuilding of the Ricardian theory. The three authors, Eli Heckscher, Bertil Ohlin and Paul Samuelson, have reshaped the content of the classical theory according to each country's natural endowment of factors of production and to the marginal utility theory.

The H-O-S model requires that the country that has a relatively abundant endowment in capital will export relatively capital-intensive goods. Similarly, the country that has a relatively abundant endowment in labor will export the relatively labor intensive goods. Logically, the imports of each country will focus on relatively intensive goods in the weak factor of each country.

From production decision to conduct in traffic and from the price war to gambling, everything can be scientifically analyzed using game theory. This mathematical theory has found numerous applications in social sciences and especially economics and we believe that it can be successfully applied in an international trade analysis and more specifically in the analysis of country specialization.

Thus, game theory will have a leading role in interpreting the results obtained by applying the H-O-S model and would provide a substantiated criticism or praise of the Heckscher-Ohlin-Samuelson model.

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