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THE APPLICATION OF IMPERFECT COMPETITION MODELS

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Abstract: *After Augustin Cournot (1838) found the treatment of perfect competition models in economics along with modern conceptions of monopoly, the Cambridge tradition of economics is as a tool to the potential distortion in economics markets theoretically or realm including oligopoly, monopolistic competition, monopsony and oligopsony known as imperfect competition. Over the past few decades, many economists and researchers have developed and improved the imperfect competition models to fit into current economic situations. Hence, this paper aims to assess several popular models adopt in imperfect competition particularly in international trade which includes the discussion on the Cartel model, the Cournot competition model, the Krugman model, computable general equilibrium (CGE) model and the spatial equilibrium model. In addition, this paper analyses the application of these models.*

Keywords: Imperfect Competition, Cournot Competition Model, Krugman Model, Computable General Equilibrium (CGE) Model.

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Introduction

An imperfect market refers to the market where violates and does not meet the condition lies in the perfectly competitive market as established by Marshellian partial equilibrium model.

The treatment of perfect competition models in economics, along with modern conceptions of monopoly, was founded by the French mathematician Augustin Cournot in his 1838 "Researches Ito the Mathematical Principles of the Theory of Wealth". His ideas were adopted and popularized by the Swiss economist Leon Walras and were considered to be the founder of modern mathematical economics.

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William Stanley Jones was a person who argued that the concept of perfect competition was effective and useful to the small numbers of buyers and large number of sellers in the industry. This idea was then adopted by the Cambridge tradition of economics as a tool to the potential distortion in economics markets theoretically or realm, which were oligopoly, monopolistic competition, monopsony and oligopsony known as imperfect competition.

James Brander and Barbara Spencer in (1981) focused on oligopoly and created a new theoretical literature for imperfect competition which became the blazing topic in international trade theory during the 1980s. Moreover, whether trade barriers reduced welfare is uncertain, it is paramount to gain a sense of whether the imperfect competition are likely to hold in typical world situations.

Hence, this paper aims to assess several popular models adopt in imperfect competition particularly in international trade which includes the discussion on the Cartel model, Cournot competition model, the Krugman model, computable general equilibrium (CGE) model and the spatial equilibrium model. In addition, this paper analyses the application of these models.

Cartel Model

A cartel is a group of independent companies which collectively agree to coordinate their supply, pricing or other policies in order to obtain greater profits than they would in the perfectly competitive market. Firms typically collude only if the price increase to generate a net incremental return sufficiently to cover the cartel costs.

The theoretical cartel model in Patinkin (1947a) is central in the theory of cartels, and this model is formally similar to multiplant monopoly models (Patinkin, 1947b). In addition, according to de Mesnard (2015), the Patinkin model of cartel is not so self-evident, as constant marginal costs are impossible to handle with Patinkin cartels, and the de Mesnard's (2010) model of cartel with exogenous market shares solved this problem and guaranteed that there is no discrepancy between competition and cartel for what concerns the market shares. Furthermore, Escrihuela-Villar (2009) studied how the sequence of play between the cartel and the fringe affects cartel stability and cartel sustainability, and the result showed that a stable cartel in the static model only exist when cartel firms behave as a Stackelberg leader.

However, as the Cartels pursue their goals at the expense of interests and welfare of customers, and are harmful for society. Therefore, most advanced economies consider cartels as illegal (Allain et al., 2011).

The Cournot Model

The Cournot model was introduced and developed by Antoine Augustin Cournot in the year 1838. The traditional Cournot model involves duopoly and describes two

competing firms producing the same homogenous and undifferentiated products where each firm makes its own price and output decisions. However, in reality, firms of homogenous products would pay close attention to their competitors' strategy or to collude and corporate with each other to gain higher profits. Hence, many economists and researchers have developed and improved the Cournot's model to fit into current economic situations.

The Bertrand model developed by Bertrand in year 1883 based on the weaknesses of the Cournot model. He proposed that product price is more strategic than product quantity. Hence, Bertrand's model focused on price competition whereby he proposed the equilibrium (Nash) solution concept in prices. However, the result of this model created a paradox, known as Bertrand's paradox. Edgeworth's model was developed by Edgeworth in 1925, and it presented a slight modification to the Bertrand model as it included constraints in the production capacity of the firms. Hence, the Edgeworth's model solved the Bertrand's paradox. However, it does not give a definitive solution towards collusion. Edward H. Chamberlin suggested that a stable equilibrium can be reached when firms of homogenous products recognized their interdependence with each other and colluded to enjoy higher profits together.

Recently, there are some studies which focus on improved Cournot models. For example, Abada et al. (2011) formulated the Generalized Nash-Cournot competition model in the study of price behaviour of European natural gas markets. Sharma et al. (2014) built a Stochastic Cournot model to analyze wind power producers' strategic behavior in which wind uncertainty and imbalance costs are considered for evaluating the expected profit. Gautier (2014) studied multilateral and unilateral policy reforms of environmental R&D subsidies and emission taxes by using a two-country Cournot model with oligopolistic interdependence. Kebriaei et al. (2015) used two decision making methods: model-based and learning-based bidding strategies in Cournot competition to find the best way of exploiting available information for optimal decision making of the agents.

In addition, Alves and Forte (2015) developed a Cournot model to compare the initial situation (without agreement) and the situation after the implementation of the open skies agreement to understand if the airlines and the consumers will benefit after the market deregulation. Cournot duopoly model is examined with a random quadratic cost function to handle the multi-objective optimization problem with maximizing expected profit and minimizing uncertainty (Sameh et al., 2016).

There are some articles which focus on the stability of Cournot model. The Bischi et al. (2007) considered two different discrete-time Cournot models in an oligopoly: the classical Best Reply (BR) dynamics and Local Monopolistic Approximation (LMA) and proved that the Nash equilibrium was stable under LMA adjustments, but it was unstable under BR adjustments. While the results of Bischi et al. (2015) show that for sufficiently high levels of the speed of adjustment, the Nash equilibrium is stable both

under pure BR oligopoly and under pure LMA oligopoly. Vallée and Murat (2009) analyzed convergence to the Nash equilibrium in a Cournot oligopoly through two types of potential equilibrium: the Cournot equilibrium (CE) and the Walrasian equilibrium (WE), and the result showed that the WE is quite stable under general conditions. Carvajal et al. (2013) developed revealed preference tests for Cournot equilibrium, and the tests were similar to the widely used revealed preference tests for consumption.

Hence, even though the Cournot model has been in existence for more than 150 years. It has proven to be significant to be applied in contemporary studies especially in studying the behaviour of rival firms of homogenous good in variety of fields.

The Krugman Model

According to the traditional trade theory, trade could only arise when there is comparative advantage in technology and resources. Krugman (1979) developed a simple formal model of non-comparative advantage trade, which is a simplified version of the model developed by Dixit and Stiglitz. In Krugman's (1979) model, trade is caused by economies of scale instead of differences in factor endowments or technology. In addition, this model explained that gains from trade would occur even between countries with identical tastes, technology, and factor endowments. Furthermore, Krugman (1980) explained that welfare gain arises from strategic response of oligopolistic firms when the economy is opened. Despite Krugman's contribution to the trade theory that demonstrated that trade can arise and lead to mutual gain even when countries are similar, it is unclear about the process through which trade lowers the price the price and increases the varieties available to consumer. Emanuel and Pedro (2009) solved this problem by explaining the process through which trade lowers the price to increase welfare gain.

There are some studies which developed the Krugman model to apply in the current economic condition. For example, Gros (1987) had studied optimal tariffs and the two-country Nash equilibrium for the Krugman (1980) model of monopolistic competition and trade in differentiated goods. Felbermayr et al. (2011) extends Gros (1987) to the case of firms differing with respect to productivity. In addition, Paolo and Federico (2013) examined the role of per capita income in closed and open economy of monopolistic competition based on non-homothetic goods as described in Krugman (1979).

Modern theoretical explanation of the empirical regularities is based on some variations of Krugman's monopolistic competition model (Krugman, 1979) and its variant with heterogeneous firms, suggested by (Melitz, 2003). For example, Hsieh and Ossa (2011) develop a many- country, many-industry model of trade which combines Ricardian comparative advantage, Krugman (1980) imperfect competition, and Melitz (2003) firm heterogeneity to analyze the effects on world incomes of productivity growth in China. Etro (2014) focused on a micro founded demand based on the constant elasticity

of substitution (CES) preferences, introduced by Dixit and Stiglitz (1977) and applied to trade in the models of Krugman (1980) and Melitz (2003) under monopolistic competition with homogeneous and heterogeneous firms, respectively.

Computable General Equilibrium (CGE) Model

Computable General Equilibrium (CGE) model is a standard tool of empirical analysis which is used to estimate the reaction of an economy where there is changes in policy, technology or other external factors by using actual economic data. This model is a combination between abstract general equilibrium model formulated by Arrow and Debreu in the 1950's and applied general equilibrium model pioneered by Herbert Scarf in 1967. The CGE model is actually being constructed to provide an answer with regard to the public finance and international trade under the assumption of perfect competition as well as constant return to scale in the 1970's (Shoven and Whalley, 1974). In addition, a number of researcher introduced a new trade theory which explains the imperfect competition and the increasing return to scale (IRS) to explain gain from trade at the end of 1970's (De Santis, 2002). This theory argues that the conventional comparative advantage causes it to gain from trade because the exploitation of economies of scale is allowed to expand and compete in the international market.

Basically, the circular flow of the commodities in a closed economy is a starting point for a CGE model where the households as the main actors on it. Besides, many CGE model obviously represent the government to collect taxes and distribute the revenue to firm and households in the form of subsidies (Wing, 2004).

The choice between the Armington, Krugman and Melitz specifications of international trade is potentially important in policy-focused computable general equilibrium (CGE) modelling of trade issues. Oyamada (2013) has developed a prototype global CGE model that includes the Armington-Krugman-Melitz (AKME) module. Recently, Dixon et al. (2015) conducted a thorough analysis of their AKME module. One of their most important findings is that once the elasticity of substitution satisfies certain conditions, it is possible to have equivalent economic effects of liberalization on trade and welfare both in the Armington-type and in the Melitz-type specifications. Oyamada (2014a) investigated properties in a global CGE model with the AKME module by running a set of simulations, targeting at preference parameter on product variety, and the result identifies that the preference parameter has significant effect on the welfare of trade liberalization. Welfare gains from trade liberalization can be larger in the Melitz-type specification than in the Krugman-type, or vice versa. Dixon *et al*. (2015) and Oyamada (2014a) are among a few studies comparing Armington, Krugman, and Melitz trade specifications in CGE model (Itakura & Oyamada 2016).

There are some weaknesses of this model. First is the model can only be applied in the small open economy format as the economic distortions on prices and quantities in all markets affect the demand of the products to reduce. Secondly, this CGE model treats the capital as homogeneous which is difficult for the producers when there is policy changes in terms of price. Another shortcoming of this model is labour where it is assumed as full employment (Krugman, 1979). However, in reality, they will be less mobile because the adjustment of prices and quantities occur more slowly and it will result in inducing the number of unemployment to increase (Wing, 2004).

The Spatial Equilibrium Model

Traditional spatial equilibrium model is a very famous model in applying for markets which are either perfectly competitive or monopolistic (Kawaguchi et al., 1997). For example, Labys (1989) stated that the quadratic programming spatial equilibrium model was widely used in agricultural, mineral and energy markets in the 1970's and 1980's. For example, Betty et al. (2009) proposes a spatial multimodal and temporal equilibrium model expressed by a nonlinear programming model, which was tested the exports of the soybeans for evaluating the competitiveness of soybean production. Phan et al. (2011) stated that a spatial equilibrium model with linear supply and demand functions for the forestry and wood-processing industries. Hall and Heady (2016) used the spatial competitive equilibrium model to provide a mechanism for examining the effects of a variety of policy measures with respect to U.S. agriculture to maximize aggregate producer profits. In addition, Monras (2016) discussed the effects of minimum wages in a spatial equilibrium model.

Based on the types of competition, the spatial equilibrium model was applied in perfect, oligopoly, monopoly and imperfect competition. For example, Xefteris and Ziros (2014) introduced a spatial equilibrium model in a perfect competitive market, and each participant decided strategically where and what quantities to trade, and the result showed that not all market structures can support a Nash Equilibrium. Pompermayer, et al. (2007) presented a new oligopoly spatial price equilibrium model applied in the oil derivatives market, and this model considered the possibility of newcomers into the market, operating as trading companies, and simulated short-term and long-term strategies of firms in oligopoly markets. Cheng and Yang (2012) replicated two spatial monopoly models: the first one was a simple spatial monopoly model, and the second model allows for arbitrage between any consumption regions if the price differential exceeds transportation cost the corresponding unit.

Kawaguchi et al. (1997) stated that a "dual structure" spatial imperfect competition equilibrium model was developed which incorporates any degree of market structure from perfect competition to monopoly, and this model was applied to the Japanese milk market.

Inra (2005) analyzed imperfect competition in a spatial model that is applied to the European dairy industry. Kolsiad and Burris (n.d.) proposed a model of spatial imperfectly competitive equilibrium, and this approach increased the applicability of spatial equilibrium models to markets of oligopolies/oligopolies, and even offers promise for formulating conventional competitive spatial equilibrium models.

With the generalized spatial equilibrium model developed to accommodate any degree of imperfect competition for importers and exporters, imperfect competition will depend on the conjectural variation approach (Chen, McCarl, & Chang, 2004). As the empirical works deal with the imperfectly competitive market either entirely in the exporting or importing market, this SE model was developed to determine the behavior of traders which incorporates any degree of market structure for both importers and exporters. In addition, this model is a general form of imperfect competition is permitted on both the demand and supply sides without any pre-assumption of market structure. (Chen, McCarl, & Chang, 2004). However, Yang and Chen (1987) explained that the spatial equilibrium model is highly degenerate, and it predicts little interregional activities.

Conclusion

Imperfect competition consists of numerous models from different fields of study. Hence, our study focuses on modern models that has great significance in their particular industry, as well as classical models that are consistently evolving in contemporary economics such as the Cournot model. This model has been constantly applied in large variety of fields in economics to study the behavior of firms in duopoly or oligopoly. This shows that even though the model is aged over 150 years, the model is still relevant and a big part of economics in international trade.

In the quest to find the exact determinant of the exchange rate movement several model have been developed such as dynamic trade model, quantitative dynamic general equilibrium model, elementary model with sticky currency and partial equilibrium model. Nonetheless, conflict occur as these model presented some drawbacks in explaining the real shock in the exchange rate movement. Therefore, more research is needed in the future to acquire better explanting with regards the determinant of exchange rate fluctuations when the law of one prices is violated in imperfect competition.

Another model that can be applied in imperfect competition is Computable General Equilibrium (CGE) model. A CGE model is a main tool for analyzing the impact of changes in one or more policy variables across international markets. This model has two parameters which are price based such as taxes and subsidies as well as quantity based such as constraints on demand or supply. The CGE model provide an answer regarding the public finance and international trade under the assumption of

perfect competition as well as constant return to scale in the 1970's.

Even though this model can help the policy makers to see the impact of changes in some policy on the economy of the country in order to make the producers competitive in the international market, but some limitations are still there. Therefore, some adjustment is needed in order to establish a model which is applicable in today's economic situations.

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