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The Market Structure Simulation of Heterogenous Firms

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Abstract: The paper aims at the need for economic policy evaluators to assess how and whether specific measures can influence the development of markets in a way that achieves greater wealth. Therefore, this study concentrates on well-documented firms' heterogeneity that significantly impact their ability to compete, influence the market structure, and decide to participate in trade. For the initial attributes and features of the simulated model, we chose Ottaviano demand function. However, we took a different approach regarding demand and its elasticities in the market by employing distributional functions to model the market demand and the demand for each firm's product. Allowing for the evolution of the market structure, the model reveals the importance of endowment factors and suggests the crucial role of firms' abilities to compete. What is more important—it affects the time needed for the market structure formation. Although the model does not track all the aspects of a firm's heterogeneity, it might guide economic policy makers to not only support the business in increasing its capabilities but keep it struggling over the competition to impede the collecting of Ricardian rents.

Keywords: dynamic efficiency; market structure; model simulation; heterogeneous firms

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1. Introduction

Authorities responsible for competition and economic policies are increasingly concerned with achieving dynamic efficiency (Kathuria 2015). It is widely believed that while static (distribution and productive) efficiency can promote well-being in the short term, dynamic efficiency promotes relatively higher wealth but in the long run (Geerolf 2013). However, economists still disagree on the exact definition of dynamic efficiency. Still, it is noted, for example, that relatively higher prices can stimulate innovation in the long run, leading to better and new products. In general, dynamic efficiency is understood as creating greater wealth in the long run by stimulating investment and innovation.

As a result, there is a growing need to assess whether specific policy choices (particularly in competition and innovation policy making) can lead to a long-run dynamic efficiency. Therefore, the community of economic policy evaluators has to assess how and whether specific measures can influence the development of markets in a way that achieves greater wealth. This means that the evolution of the market structure and the resulting competition processes between undertakings are inevitably encountered. In addition, the ongoing Industrial 4.0 revolution (https://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf (accessed on 19 December 2021)) is making these processes even more intense.

This paper contributes to this discussion with their simulation model of asymmetric oligopolistic market structure evolution. To this end, we thoroughly analyse industrial organisation literature and new trade theories that offer many incentives for how competition and market structure evolve, including investment and innovation activities.

Theoretical and empirical studies reveal the heterogeneity of the enterprise level in terms of productivity, size, and other characteristics, even in narrowly defined industries.

These differences between companies significantly impact their ability to compete, influence the market structure, and participate in trade (if they can finance expensive export activities by achieving higher productivity before exporting begins).

These are some of the essential postulates of the new trade theory, which emphasises technological progress (Uddin 2021). Undoubtedly, these empirical discoveries represent the possibility of a new approach to competition between firms and the market structure. However, how it could be related to the evolution of the market structure remains to be explored. The discussion is still ongoing: although Arkolakis et al. (2012) presented their initial findings in this respect on the Armington, Krugman, and Melitz models, subsequent studies carried out by Costinot and Rodriguez-Clare (2014); Melitz and Redding (2015); Balistreri and Tarr (2018); and Marjit and Mandal (2021) showed different results in market structure formation. It is important because differences in factor endowments and used technology across countries determine the pattern of trade (Wyrwa 2020; Marjit and Mandal 2021; Prakash 2021; Elhassnaoui et al. 2021; Laužikas et al. 2021; Grenčíková et al. 2021).

Our paper employs industrial organisation and new trade theories to simulate the market structure and its evolution. For the initial attributes and features of the simulated model, we chose Melitz and Ottaviano (2008) with the Ottaviano demand function. However, we chose a different approach regarding demand and its elasticities in the market by employing distributional functions to model the market demand and the demand for each firm's product.

Allowing for the evolution of the market structure, the model reveals the importance of endowment factors and suggests the crucial role of firms' abilities to compete. In this sense, our study results are in line with Meramveliotakis and Manioudis (2021) findings of small firms not being the backbone of the economy.

What is more important—it affects the time needed for the market structure formation. For innovation policy, that could mean not only the need for business support in increasing its capabilities but keeping it on struggling over competition instead of collecting Ricardian rents.

At the beginning of this article, the scientific literature examining the market structure and the behaviour of enterprises is analysed, ranging from the industrial organisation to the theories of the new trade. After that, the model of simulation of market supply and demand proposed by the authors is presented in detail, which allows looking at the dynamics of the evolution of the market structure and the decisive consequences of the heterogeneity of enterprises. Finally, this article offers some conclusions of the simulation modelling.

2. Literature Review

The early industrial organisation relied on the SCP (interaction between industrial structure, business behaviour (conduct), and performance indicators) paradigm. Another parallel developed in the direction of the early industrial organisation—company and transaction cost theories. In the industrial organisation, great attention has always been paid to monopoly and analysis of decisions taken by the monopolist. Many new interesting problems dealt with by the industrial organisation were raised (Norman and Chisholm 2014).

A new (or also called modern) industrial organisation has focused on strategic interaction between companies: it has been observed that companies not only accept the environment as an exogenous given but also try to influence it, especially each other, which engages companies in a kind of game. The theory of games proposed for examining this game allows analysing the relationship between market power and pricing, using, for example, the competition models of Cournot and Bertrand, together with ms Hotelling's positioning (or simply horizontal differentiation) or vertically differentiated product models. Moreover, this theory distinguishes between static balance and endlessly repetitive games crucial due to different modelling results.

The models developed by the representatives of the industrial organisation are widely used in the formulation of competition policy and ensuring compliance with competition law provisions in specific cases or investigations conducted by the responsible competition authorities.

2.1. The Models of the Industrial Organisation Theory

Church and Ware (2000) states that an industrial organisation distinguishes between two types of product differentiation: horizontal and vertical. Monopoly competition models usually describe horizontal product differentiation. This is because the consumer prefers the diversity of goods, sometimes referred to as consumers' "love of the diversity of goods" or "love for variety". Meanwhile, in position models, horizontal differentiation is defined by the different attractiveness of imperfect substitutions to individual groups of customers according to the other characteristics of the goods.

The modified linear Hotelling model can also describe vertical product differentiation, i.e., according to the quality of the goods. The customers in the middle of this linear model are indifferent to goods at the same distance: there is higher quality on one side than the other item. Other buyers prefer a product that is closer to them. Therefore, as Shy points out (Shy 1995), in the case of vertical differentiation, customers purchasing one product abandon the other. Unfortunately, for linear Hoteling models, customisation is not yet found in models that describe, in addition to product differentiation, other characteristics of company behaviour, such as productivity levels.

Di Comite (2014) proposed a model combining vertical and horizontal product differentiation in a dissertation examining the compliance of monopoly competition models with conditions in markets of imperfect competition between undertakings. Under this model of product differentiation, consumers pay (WTP) in vertical differentiation depends only on value-added and, in the case of horizontal differentiation, on the elasticity of demand.

The first models of the industrial organisation describing product differentiation showed that companies make higher profits by differentiating their products due to reduced direct competition. Some of the models of imperfect competition portraying the differentiation of the more prominent products were published in Shaked and Sutton (1982, 1983); Gabszewicz and Thisse (1979); and Motta (1993). In these models, companies try to differentiate goods according to quality to avoid fierce Bertrand competition. These and all subsequent oligopolistic competition models with differentiated goods are based on the notion of product space proposed by Lancaster (1979, 1990). The later models were developed based on empirical research by Mussa and Rosen (1978). It follows that companies try to differentiate their goods so that they are as far away as possible from each other. Singh and Vives (1984) showed how firms compete with prices (Bertrand competition) or quantities (competition from Cournot). In the case of competition from Bertrand, companies usually try to differentiate their products. Economides (1989); Neven and Thisse (1990); and Cremer and Thisse (1991) observed that undertakings then tend to differentiate goods horizontally but not vertically. The model proposed by Vandenbosch and Weinberg (1995) shows that differentiation according to one attribute will be the maximum, but differentiation of goods according to several characteristics weakens the intensity of differentiation. Vives (1985) and Singh and Vives (1984) showed that, if demand and cost conditions are the same, the industry in which competition of the Bertrand type operates is characterised by lower profits, lower prices, and higher consumer surpluses. The model developed by Benassi et al. (2006) showed that the increasing unevenness of the distribution of consumer income leads to an increase in the intensity of differentiation of goods, which is more beneficial for companies selling higher quality goods. However, the Boccard and Wauthy (2010) model showed that increasing capacity could transform the company's product differentiation strategy into a more effective means of avoiding competition. Wildenbeest (2011) observes that even where the products sold by competitors appear to be homogeneous, their prices still differ for a number of reasons, which give different preferences to purchasers of the same goods. Boccard and Wauthy (2010) model showed that increasing capacity could transform the company's product differentiation strategy into a more effective means of avoiding competition. Wildenbeest (2011) observes that even where the products sold by competitors appear to be homogeneous, their prices still differ for a number of reasons, which give different preferences to purchasers of the same goods. Tremblay and Tremblay (2011) concluded that if it happens on the market that some companies choose Cournot's strategy and others choose Bertrand, then all companies remain on the market. A well-established balance remains sustainable if the product differentiation is sufficient. However, in the absence of product differentiation, only companies that have chosen Cournot's quantity leader strategy remain. However, Makadok and Ross (2013) conclude that little is considered on how product differentiation contributes to the evolution of the industry's structure.

Companies differ not only in the differentiation of goods but also in terms of productivity. Both static and dynamic empirical studies confirmed it: Bartelsman and Doms (2000); Syverson (2011); Das et al. (2007); Eslava Marcela et al. (2008); Foster et al. (2008); De Loecker (2011); Roberts et al. (2012); De Loecker and Goldberg (2014).

A significant group of empirical dynamic models consists of research into companies' investments in product or process innovation. Firstly, the theoretical models of Shaked and Sutton (1982, 1983) and Gabszewicz and Thisse (1979) follow the fact that companies have to invest additional resources to improve the quality of goods, whereas the number of companies remaining on the equilibrium market is finite; companies entering the market above tend to occupy niches of high-quality goods. Subsequent models of the industrial organisation (Dutta et al. (1995); van Dijk (1996); and Lambertini and Tedeschi (2007)) showed that, in the absence of financing opportunities for product quality innovations, companies tend to supply low-quality goods initially. Bacchiega et al. (2011) observe that companies offering high and low-quality goods engaged in oligopolistic competition for vertically differentiated goods were looking at what investments in R&D and innovation activities: process or product innovation; low-quality goods companies in Bertrand's competition are opting for process innovations, while companies selling high-quality goods continue to invest in improving the quality of goods. In general, as Bacchiega et al. (2011) observes, the literature of an industrial organisation is dominated by the opinion, based on the life cycle of technology, that companies prefer innovations in goods rather than processes since it is believed that the return on the innovation of goods is higher and faster. However, according to Adner and Levinthal (2001), the example of Skoda shows that the opposite can be the case.

Meanwhile, Bacchiega et al. (2011), using the Schmitt's vertical differentiation duopoly model, has shown that if companies are heterogeneous in terms of their abilities, their propensity for process innovation will also differ: more efficient companies will always be inclined to continue process innovation regardless of how much they invest in improving the quality of goods. Spielkamp and Rammer (2009) also found that R&D and innovation activities investments are associated with high uncertainty and risks. As many as 87% of European companies studied finance innovation projects from their own funds, but not from credit institutions.

The simulations obtained using game theory have shown that incentives (in the form of expected profits) to invest in R&D and innovative activities are higher when competition is lower. Still, companies are more likely to invest in R&D and innovative activities to reduce their variable costs in cases of fierce competition. The model developed by Qiu (1997) concluded that, in the interests of improved profitability, Cournot's competition should further encourage undertakings to engage in R&D and innovative activities. Similar results were obtained by Symeonidis (2003). Meanwhile, empirical research by Aghion (2006) has shown that companies and industries with the most advanced knowledge and technology are more likely to innovate and increase their efficiency, but only if there is competitive pressure. Therefore, it can be assumed that it is the most productive oligopolistic company that has accumulated the financial resources and the knowledge necessary for R&D and innovative activities.

Meanwhile, Filippini and Vergari (2012) showed that in the competition of Bertrand differentiated goods oligopolistic companies, innovation owners are not interested in disseminating knowledge but prefer granting exclusive innovation rights based on licences, which promotes product differentiation. Brander and Spencer (2015) showed that Bertrand companies are always more likely to differentiate their products than Cournot companies, while Bertrand companies are less efficient. Aghion et al. (2002) examined an inverted U-link between the intensity of competition and investment in R&D and innovative activities: as competition increases, incentives for innovation decrease. However, with a high intensity of competition, incentives for investment in productivity gains or product differentiation are again increasing due to the increasing expected return on investment. Moreover, the productivity of enterprises and the differentiation of goods are determined by the uneven distribution of the ability of enterprises to carry out R&D and innovative activities and investment in it (Redding 2010).

In their empirical dynamic model, Doraszelski and Jaumandreu (2013) showed that enterprises with the same R&D and innovation costs level do not necessarily have the same productivity as is the case with regular structural empirical models. Thus, it has been observed that R&D and innovation investments are subject to considerable uncertainty. On the other hand, Kancs and Siliverstovs (2012) argued that companies have different productivity and depend on R&D investment and innovation activities. However, productivity growth only becomes significant from a certain intensity threshold of the above investments (Amoroso 2014). Therefore, it is not by coincidence that Santos' (2015) empirical dynamic model shows that the company has a higher market share and a positive impact on R&D investment and innovation activities. Furthermore, Foster et al. (2016) revealed that differences in companies' market shares do not reflect their heterogeneity in terms of productivity.

Many of these and other empirical studies indicate that they were inspired by Melitz's (2003) theoretical model of the new theory of enterprise heterogeneity (in terms of productivity). Consequently, empirical studies of industrial organisations often look for evidence to support the conclusions of this and the subsequent parallel models.

2.2. The Models of the New Trade Theory

It has already been mentioned that particular attention is paid to product differentiation and heterogeneity of enterprises according to productivity levels in the basic theoretical models in the new trade theory (which sometimes distinguishes a new trade theory) and adapted to international trade modelling. Empirical studies based on the new trade theory allow us to justify assumptions of theoretical models, parameterise models, and determine the values of the selected parameters so that the models more accurately describe the reality in question. Therefore, since an industrial organisation and a new trade theory have a great deal in common in modelling the behaviour of enterprises, new insights or methodological solutions made in one of these fields of economic science can be applied in another.

In a new trade theory, the first economist to come up with a way to describe the heterogeneity of companies in terms of their productivity was Melitz (2003) (which is considered a pioneer of a separate new direction of trade theory—a new theory of new trade). In this way, the new trade theory changed the previously, not very realistic, assumption of the homogeneity of enterprises in terms of their productivity. The Melitz (2003) model included models of enterprise and industry dynamics from the literature of an industrial organisation (Hopenhayn 1992). Hopenhayn, H. brought the distribution of corporate productivity in balance from profit maximisation solutions companies, which are initially the same but are not sure about their current and future productivity. Melitz's (2003) innovative improvement lies in the realised idea that differences between companies in terms of productivity can be described in the distribution of productivity levels that must be realistic.

The Melitz (2003) model à la Dixit–Stiglitz–Krugman (Krugman 1979, 1980, 1981; Dixit and Norman 1980; Helpman and Krugman 1985) uses a concave utility feature describing consumer preferences, which is increasing as the variety of goods increases. Homogeneous business models have taken over the assumption that markets in international trade are oligopolistic. Thus, in principle, Melitz (2003) merely improved the basic model of the new trade theory developed by Krugman (1979, 1980, 1991, 1995) in such a way as to assess the impact of the heterogeneity of undertakings on simulated international trade in terms of productivity (an industry characterised by monopoly competition). However, the improvements made by Melitz (2003) made it possible to abandon the fictitious assumption of uniformity between companies and to model the market economy in light of the differences between companies in terms of their productivity. These improvements have generally made monopoly competition models more realistic and opened up new opportunities for economic analysis that the industrial organisation lacks.

The model proposed by Melitz (2003) attracted a lot of interest from economists: as mentioned above, a wide range of theoretical and empirical works followed, in which the idea of describing and interpreting the heterogeneity of enterprises by productivity was developed and applied to deepen into various aspects of international trade. For example, Helpman et al. (2003) has shown that companies with higher productivity can carry out more expensive projects. In their modification of the Melitz (2003) model, companies' decisions to sell goods on national or foreign markets by export or through foreign direct investment (FDI) depend on their level of productivity: only companies with higher productivity can invest in expensive export or even more costly foreign direct investment activities.

In addition to this model, the authors also published an empirical study showing that exporters have higher productivity than companies operating exclusively in national markets. In comparison, multinationals have significantly higher productivity (on average more than 15%) than ordinary exporters.

It has also been empirically established that the distribution of enterprises by productivity can be described under the Pareto distribution function.

The model developed by Helpman et al. (2003) logically concludes that ceteris's marginal productivity determines the market share of companies.

In other words, there are less productive companies on the market, which, unable to cover the fixed costs of exports and direct investments abroad, focus only on domestic demand. Moreover, only a small percentage of enterprises whose productivity is sufficient to cover the fixed costs of exports or foreign direct investment, depending on the level of productivity achieved, export, or invest in production in foreign countries.

Melitz (2008) observes that, as a general rule, only a tiny part of all undertakings active on the market or in the industry as a whole is engaged in export activities, the revenue from which the company's gross income would represent a significant proportion. In most cases, such enterprises are larger and more productive than companies that do not export or are more random in their activities. This is illustrated by empirical studies carried out by Bernard et al. (2006) and Helpman et al. (2003). Here, Bernard et al. (2006) point out that out of the companies operating in the USA in 2000, only 4 per cent were engaged in export activities.

The strong correlation found in these works between the status of companies as exporters and their high productivity naturally raises the question of causation. Looking for an answer to this question, empirical studies have found that companies have already achieved higher productivity before entering export markets (Bernard and Jensen 1999; Clerides et al. 1998). It was also found that companies can innovate in the hope of starting to export to foreign markets (Melitz 2008).

Intuitively, it could be assumed that if the most significant companies are the most productive, then the prices of their goods should also be the lowest. However, empirical studies show that the largest and most productive enterprises do not offer a negative correlation between productivity and the prices of their goods. On the contrary, their prices are significantly higher than those of competitors. A series of empirical studies show that the largest and most productive companies invest in R&D and innovative activities to increase the differentiation of their goods, especially in terms of the value of goods expected by buyers.

As Gervais (2013) observed, the formal model of Melitz (2003) heterogeneous enterprises (which inspired a significant part of the empirical studies mentioned above), in addition to the fact that exporters are larger and more productive than non-exporting companies, also shows a negative correlation between the company's productivity and its price. However, the results of empirical research cannot confirm the latter's theoretical insights. Here is an analysis of imports from the United States of America (USA) carried out by Schott (2004), which revealed that in narrowly defined markets, companies operating in countries with high income, capital, and knowledge export to the USA at relatively higher prices. Thanks to this data, Gervais (2013) makes some insights. Firstly, assuming that companies in wealthier countries are more productive on average, the case described for cotton shirts may mean that more productive companies produce more attractive products to consumers. Secondly, if consumers are rational about differentiated goods, the value of each of them reflects not only the efficiency of the production process but also the quality of the product. In other words, the product's value is influenced by the vertical differentiation of products (in terms of quality).

Duvaleix-Tréguer et al. (2015), reviewing empirical studies conducted by other economists, noted that exporting companies are also trying to differentiate their products according to quality vertically. Often, productive larger companies produce and sell higher quality products. In addition, even small companies with high product quality can also successfully export. The quality of companies' products correlates with the company's investment intensity, R&D operating costs, product and process innovations, and the cost of acquiring quality standard certificates. The evidence shows that more efficient companies sell more high-quality products, covering more markets. It is also possible to note here the margin surveys carried out by De Loecker et al. (2016), which follow the fact that the margins of the exporting companies are significantly higher than those of producers with markets limited to India.

The importance of the quality of goods for exports is revealed by Baldwin and Harrigan (2009) article, which describes the model together with the results of the empirical study shows that high-quality and high-priced goods are the most competitive. This is because their exports can cover the highest trade costs associated with long transport distances. Therefore, as evidenced by the empirical investigation above, exports to more remote markets are made of medium–higher-quality (and higher-priced) products. In other words, if consumers are concerned about the quality of the product, then the product for which the highest price is requested is the most competitive, and the lowest observed prices are the least competitive (Baldwin and Ito 2011).

Mayer et al. (2011), who described in its heterogeneous enterprise model competition between companies selling more than one product, found that higher productivity of companies also allows them to produce and sell more types of products, but that as competition between companies intensifies, they abandon the production of the least profitable products (as competition intensifies, companies produce only the most efficient products, abandoning other products).

As a result, higher productivity allows companies to invest more in developing a range of goods, which means that as productivity increases, companies can also invest more in the quality of goods. In other words, more productive companies can invest more in product differentiation. Ultimately, the more productive companies spillover technology to less productive ones (Burinskas et al. 2021; Mura and Hajduová 2021).

All of the above literature has demonstrated the need to develop models in which product differentiation and heterogeneity of enterprises in terms of productivity are described together. Therefore, such theoretical models also started to be developed. For example, the model developed by Hallak and Sivadasan (2008), in which companies differ in productivity and product quality, reveals positive dependence on higher productivity, higher product quality, and higher prices. Meanwhile, Kugler and Verhoogen (2008) show in their model that the increase in the company's productivity provokes both an increase in the quality of the intermediate products purchased and the effects produced. The results of the simulations were based on an empirical study that revealed a positive correlation between the prices of the Colombian producers' products and the size of the factories, as well as the prices of the intermediate products purchased and the size of the plant.

Particular attention should be paid to the Johnson (2012) heterogeneous enterprise model. The model shows that productivity can have a compensatory effect on prices. On the one hand, higher productivity reduces prices by reducing marginal production costs. However, on the other hand, higher productivity allows the company to improve the quality, which increases marginal costs and prices. Whether high-productivity companies will set higher or lower prices than lower-productivity companies depends on the company's incentives to improve product quality. Companies decide whether to improve the quality of products while deciding on export opportunities.

Melitz and Ottaviano (2008) proposed a heterogeneous model that deals with trade between two countries of different sizes. The model shows that larger countries have a wider variety of products and more and more productive companies with lower margins due to increased competition, although companies still make higher profits (due to higher sales). Due to increased competition in the market, there are only a tiny number of unproductive companies. It is also clear that the lower the marginal costs for undertakings, the lower their price on the market. However, the margin increases (in other words, companies do not pass all the benefits of cost reductions) to consumers. In this model, only companies with the lowest marginal costs can generate the highest profits in the industry. Profits also depend on the overall level of product differentiation between enterprises. However, the more companies on the market, the smaller the broad differentiation of enterprises, the lower the companies' profits due to the reduced market power.

Melitz and Ottaviano (2008) have shown by their model that competitive pressure forces companies to increase productivity. This conclusion is also supported by the model proposed by Baldwin and Okubo (2014), which shows that companies do not have to be significant. Instead, they need to be efficient to remain competitive.

There are many studies that associate the performance of companies not with size but with digitalisation and overall innovativeness (Slogar 2021; Marino and Pariso 2021; Kurniawati et al. 2021; Kasperovica and Lace 2021).

In the new trade theory models, reviewed companies are heterogeneous in terms of productivity and compete in conditions of monopoly competition (this is a particular variant of oligopoly—models that emphasise the importance of product differentiation and diseases of free entry). The models mentioned (together with the results of empirical research published by the representatives of this theory) show that the heterogeneity of enterprises in terms of productivity and their differentiation of goods are among the most critical factors determining trade and competition between enterprises. However, in the models of the new trade theory, the heterogeneity of enterprises in terms of productivity and differentiation of goods is modelled as exogenous variables. In addition, the simulated product differentiation is symmetrical: all goods are differentiated in the same way (Motta 1993). Therefore, although those shortcomings do not preclude the modelling of international trade between countries, they do not allow a more in-depth analysis of the interaction between competing undertakings and their behaviour in the context of oligopolistic competition.

3. The Experimental Modelling

3.1. The Structure of the Experimental Model

The experimental simulation aims to define the potential impact of industrial policy measures on competition and economic efficiency. To achieve it, the main objective of this experiment is to identify and compare possible scenarios of competition between undertakings and what implications for economic policy measures might be. Furthermore, we use market simulations based on the features and attributes of an asymmetrical oligopolistic competition model to allow further market evolution.

The methodology for experimental simulations is summarised in Figure 1. For a start, a theoretical deterministic model is discussed, based on which the data used in the experiment is simulated. Next, the experiment compares the evolution of competition between enterprises with cases where industrial policy measures are applied.

The methodology of experimental simulations is based on already identified methodological estimates. Initially, demand is simulated, defined by three main variables: the maximum value of the item given by buyers, the expected (most likely) value of the item, and the variance of customer preferences (determining the slope of the demand curve). All values of these variables are individually simulated as random values using the Tuber distribution function.

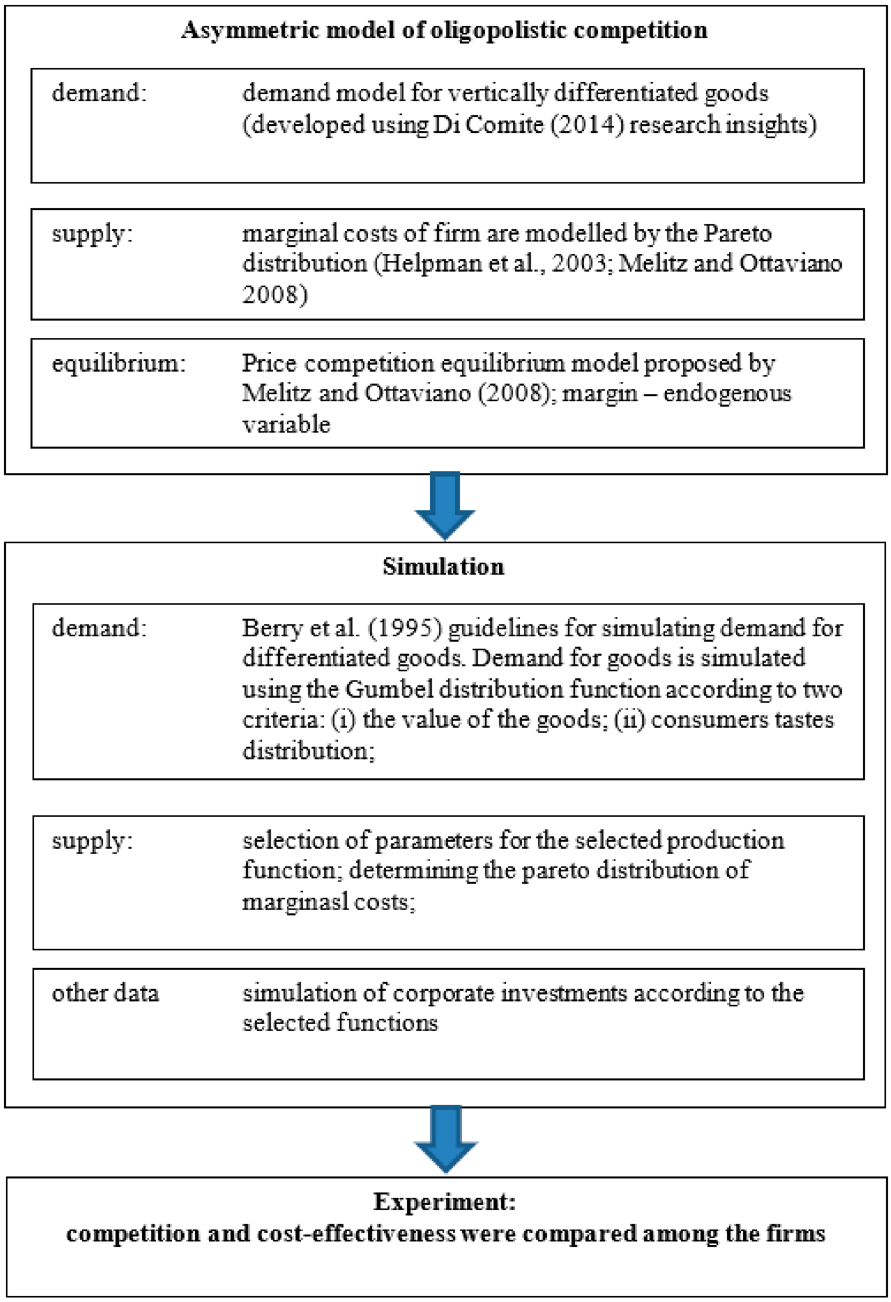

Figure 1. The process of experimental simulation.

The resulting random values of these variables are used to calculate consumer preferences according to the CLP model. Next, in the model, the data in the matrix form is processed by automated calculations. Consumer preferences are automatically distributed according to the maximum values given to competing products. In a model, customers can choose neither item if the value they give to the items is negative. Users will also not select those items that they cannot buy in the model because of their under-income restriction, defined by a simple monotonous function. The remaining customers form groups loyal to individual items, which are rated in a way that forms a curve with a negative slope. Simple linear regression is applied to the expressed customer preferences for each item, and the demand model parameters for each item describe each demand function.

The marginal costs of enterprises are simulated according to the theoretical supply model of De Loecker et al. (2016) according to the selected production function, the parameters of which are simulated for enterprises to match the Pareto distribution function according to the Melitz (2003) and Helpman et al. (2003) guidelines.

The calculation of the marginal cost functions of each undertaking determines the balance sheet and the price following the methodology proposed by Melitz and Ottaviano (2008), which is included in the theoretical model of imperfect competition discussed below but replaces the assumptions of a monopoly competition with an oligopolistic market assumption (by the way, the combinations of marginal costs and the demand above parameters are entirely random, but the results obtained are assessed based on the productivity of the undertakings). It should also be noted here that at the beginning (simulating demand), the prices of the goods are determined by the expected values of the goods. In contrast, the final (independently fluctuating) price settles only after several cycles of the whole model have been calculated. All variables shall be calibrated so that the price levels correspond to the following proportions: 100–95%, 90-80% and 75–65%. Goods belong to the same market if the difference between the most expensive and the cheapest goods is not more than 40% of the price of the most expensive item.

Income, average variable costs, and corporate profits are further calculated. Depending on demand and supply parameters, investments are determined on equal terms for companies as sunk fixed costs as in the Melitz and Ottaviano (2008) model. Fixed cost payback time (exogenous variable) is 4.5 years. Companies with a longer fixed cost payback time withdraw after the first year. Only companies that fully cover fixed costs in the first and second years invest in the following year. Companies continue to reinvest their profits in such a way as to obtain the highest return. For the most productive companies, investing in the most profitable model is in the accumulation of demand and added value, as set out in empirical research by Santos (2015) and Foster et al. (2016).

The entire calculation cycle is repeated in the following year, but at the beginning of the year, the calculations use the prices of items at the end of last year. All calculations can be repeated with random results. For all parameters, the most likely estimates (and their standard errors) shall be determined assuming that the data are distributed according to the Gauss distribution function. The Lerner and HHI indices are also counted. The analysis of the practical examples under consideration follows the guidelines on the methodology discussed, but additionally, De Loecker et al.'s (2016) methodology for determining the productivity of enterprises is applied. Competition between companies in the market is modelled as an evolutionary process.

3.2. The Theoretical Model of the Simulation

The model starts with the square utility functionality offered by Melitz and Ottaviano (2008) and outputs demand features:

$$U_i = q_0 \int_{j\in\Omega} \alpha_j\, q_j\, di - \frac{1}{2} \int_{j\in\Omega} \gamma_j\, {q_j}^2\, di - \frac{1}{2}\, \eta \left(\int_{i\in\Omega} q(i) di \right)^2 \tag{1}$$

where q_0 and q_j shows customers' demand for a particular product: for the homogeneous product and differentiated goods i respectively. Coefficients α_j, γ_j are positive values. The coefficient α denotes the substitutability of each differentiated item with homogeneous goods: as the coefficient α increases, the demand for the differentiated product increases compared to the homogeneous product. The α factor shows how many units users tend to exchange for a homogeneous item to receive one unit of a differentiated item. The coefficient of vertically differentiated goods is not the same α. As will be shown in Figure 2, reflecting demand simulation, as the slope of the demand curve increases γ_j, the maximum possible price of demand increases (when demand is approaching zero). Factor α_j for each differentiated item described as follows:

$$\alpha_j = -d\left(-c\,\alpha_0 - \gamma_j\right) \tag{2}$$

where c is a module on the theoretical negative slope factor of demand, d is a parameter that reveals the slope of the demand curve influence (in the simulation model of demand mentioned above, and d is a constant, i.e., ≈ 5.4 and $c \approx 0.1852$, $\forall\,\gamma_j$). When the slope of the demand curve $\gamma_j \to 0$, $\alpha_j = \alpha_0$.

Factor γ_j not only indicates the slope of the demand curve but at the same time reveals the dispersion of the preferences of buyers: the higher the slope factor of the demand curve, the higher the variance around the average: $\left(\alpha_j - \gamma_j\right) - \gamma_j\,\gamma^E$ (where: γ^E—Eulerio-Macheroni constant).

Coefficient η in the performance function (Formula (1)) shows the extent to which market demand lies with homogeneous goods (which generally corresponds to all other alternatives to differentiated goods): the marginal benefit for all differentiated goods is limited, i.e., not all buyers can choose differentiated goods. Since the model proposed in this thesis focuses only on differentiated goods, it is assumed that $\eta \to 0$.

The following utility function is differentiated using the Lagrange method with a budgetary constraint:

$$q_0 + \int_{j\in\Omega} q_j\, p_j dj = E \tag{3}$$

$$L = q_0 + \alpha_j \int_{j\in\Omega} q_j dj - \frac{1}{2}\int_{j\in\Omega} \gamma_j {q_j}^2 dj - \frac{1}{2}\,\eta\left(\int_{j\in\Omega} q_j dj\right)^2 - \lambda\left(q_0 + \int_{j\in\Omega} q_j q_j dj - E\right) \tag{4}$$

$$\frac{dL}{dq_j} = \alpha_j - \gamma_j q_j - \eta\int_{j\in\Omega} q_j\,dj - \lambda\,p_j \tag{5}$$

where E is consumer income. When $\frac{dL}{dq_j} = 0$ (optimising consumer choice), $\lambda = 1$ and $Q^c = \int_{j\in\Omega} q_j dj$ (where Q^c *is* the total consumption of alternative homogeneous goods), then the reverse differentiated goods p_j demand functions:

$$p_j = \alpha_j - \gamma_j\, q_j \tag{6}$$

$$p_{max} = \alpha_j \tag{7}$$

$$p_j = \frac{1}{2}\left(\alpha_j - c_j\right) \tag{8}$$

Demand for differentiated goods (ε_j) and crossover ($\varepsilon_{kr,j}$) elasticity is defined as follows:

$$\varepsilon_j = \left(\frac{p_{max}}{p_j} - 1\right)^{-1} \tag{9}$$

$$\varepsilon_j = \frac{p_j\,\gamma_j}{\alpha_j - p_j}\frac{1}{\gamma_j} \tag{10}$$

$$\varepsilon_{kr,j} = \frac{p_j\,\gamma_j}{\alpha_j - p_j}\frac{1}{\gamma_k} \tag{11}$$

Buyers (S_{cu}) are calculated using the formula:

$$S_{cu} = \int_{j=1}^{J}\int_0^{q_j} L\left(\left(\alpha_j - \gamma_j\, q_j\right)dq - p_j q_j\right) = \int_{j=1}^{J}\int_0^{q_j} L\left(\left(\alpha_j - \gamma_j\, q_j\right)dq - \frac{\alpha_j - c_j}{2} q_j\right) \tag{12}$$

In the model, the only factor of production is the work supplied in the net competition market on-demand without any restrictions. Under these market conditions, the output of a single homogeneous product requires one unit of labour when the acquisition value of the latter is equal to the value of one homogeneous product. The production of homogeneous and differentiated goods has a constant return on the scale, so the marginal costs are also ongoing. Marginal costs of differentiated goods c_j are equal to the number of labour units consumed (as mentioned above, the value of one division of labour is equal to one unit, which is also equal to the value of one homogeneous item).

In the Melitz and Ottaviano (2008) model, companies initially invest in technology and production organisation at fixed costs f_E to enter the market. Companies do not know what level of marginal costs c_j of investments will be to start production. This is a random size. The distribution of enterprises by marginal cost (distribution $G\,(c_j)$) is the function of the Pareto distribution to be described, $c_j \in [0, c_M]$. The marginal costs of only a part of the undertakings make it possible to cover fixed costs of entry f_E. Only undertakings with marginal costs up to the cut-off point threshold, as in the Melitz (2003) model, remain on the market. Existing undertakings are presumed to be sufficiently productive, i.e., their marginal costs do not exceed *the threshold of* c_D.

As in the Melitz (2003) model, the use of labour in production is a linear function:

$$l = f + \frac{q}{\varphi} \tag{13}$$

where l is total labour consumption, f is fixed *costs*, and φ is productivity, defined as marginal costs incurred for the production of one differentiated product $\frac{1}{c_j}$.

In the model, the price maximising the company's profits $p_j(c_j)$ and the number of goods produced $q_j(c_j)$ must meet the following condition:

$$q_j(c_j) = \frac{\mathrm{L}}{2\gamma_j}(p_j(c_j) - c_j) \tag{14}$$

The profit maximising price $p_j(c_j)$ may exceed P_{max}, which, as mentioned in the model, is equal to α_j. In the Melitz and Ottaviano (2008) model, this price also corresponds to c_D. These are marginal costs for a company that is indifferent to whether it will remain in the industry. Such an undertaking makes a zero profit because its price equals marginal costs due to competition on the market, i.e., the profit is approaching zero.

Therefore, all indicators describing the activity of an enterprise are defined in the model as α_j and c_j. Features:

$$p_j(c_j) = \frac{1}{2}(\alpha_j + c_j) \tag{15}$$

$$\mu(c_j) = \frac{1}{2}(\alpha_j - c_j) \tag{16}$$

$$q(c_j) = \frac{\mathrm{L}}{2\gamma_j}(\alpha_j - c_j) \tag{17}$$

$$r(c_j) = \frac{\mathrm{L}}{4\gamma_j}\left(\alpha_j{}^2 - c_j{}^2\right) \tag{18}$$

$$\pi(c_j) = \frac{\mathrm{L}}{4\,\gamma_j}(\alpha_j - c_j)^2 \tag{19}$$

where $\mu(c_j)$ is the company's margin, $r(c_j)$ is the company's income, and $\pi(c_j)$ is the company's profits.

The excess of enterprises consists of the total income of enterprises:

$$S_{pro} = \int_{j=1}^{J} \frac{L\left(\alpha_j{}^2 - c_j{}^2\right)^2}{4\,\gamma_j} \tag{20}$$

As can be seen, companies with lower marginal costs charge lower prices but receive higher incomes and profits than companies with higher marginal costs. However, more productive companies also charge higher margins, so the benefits of reduced marginal costs go to the buyers. However, the extent to which these regularities will largely depend on the slope of the function of the demand for the product γ_j. It should be noted that the higher the slope of the demand curve, the smaller the market share held by the companies and the profits generated.

Before entering the market, the company expects to obtain a profit equal to the difference between the average gross margin of the market and the fixed costs of entering the market. If the expected profit is negative, no company will hesitate to enter the market and, upon entering, will withdraw from it. Therefore, the following entry equilibrium condition can be derived from the enterprise's profit formula:

$$\int_0^{c_D} \pi(c_j)dG(c_j) = \int_0^{c_D} \frac{1}{4\,\gamma_j}(\alpha_j - c_j)^2 dG(c_j) = f_E \tag{21}$$

In the model, the market is in the balance of the Bertrand–Nash market for differentiated goods: commodity prices will not differ at the exact marginal costs, but depending on the slope of the demand curve, each product will have a different market share.

3.3. The Simulation Process

Initially, data on demand, supply, and market balance are simulated, which are then used in the test.

The demand simulation model, with the changes described below, focuses on the Berry et al. (1995) demand simulation instructions and the demand function:

$$u_{ijt} = x_j + \xi_j + v_{ix_{jk}} + \varepsilon_{ij},\ \text{kai}:\ x_j + v_{ix_{jk}} \geq \alpha_{ij}\ p_j \tag{22}$$

$$\delta_j = x_j + \xi_j \tag{23}$$

$$x_{ij} = x_{j,max} - \beta_j \tag{24}$$

$$\mu_{ij} = v_{ix_{jk}} + \varepsilon_{ijt} \tag{25}$$

where *j* is the number of differentiated goods in their entire population Ω, q, and p are the vectors of demanded quantity and price of the amount *j*, respectively, α_j is the maximum possible price in the demand function, γ_j is the slope ratio of the demand function of the differentiated item (when $\gamma_j \approx \beta_j$ the vector (or moda (or expected value) of the value of the most *common* buyer preference (due to the specific characteristics of the product) in the buyer preference $x_j - K = 1$ Gumbel distribution function, $x_{j,max}$ is the vector of the maximum possible moda when $\beta_j = 0$, β_j, variable of the standard deviation in the Gumbel distribution function, where the standard deviation is $\beta_j\pi/\sqrt{6}$, ξ_j is the characteristics of the product not monitored by the researcher, ε_{ij} is the error, α_I is the marginal benefit of the consumer's income (assimilated to a unit in this model), $v_{ix_{jk}}$ is the *marginal* utility of the buyer x_{ij} vector (when $v_{ix_{jk}} \sim Gum(0, \beta_j)$), δ_j is the expected value of the utility when using *its* product *j*, and μ_{ij} is the deviation from the expected value of the utility. The deviation from the expected usefulness of *their* item, i.e., μ_{ij}, depends on the interaction between consumer preferences and the characteristics of the item $v_{ix_{jk}}$.

Such model specification allows modelling the demand functions for differentiated goods depending only on the distribution of the item's value for each of their customers' preferences. The model assumes that both the company and the researcher are aware of the most common assessment of the product among buyers, i.e., its expected value. However, how unanimously buyers assess the quality of the product for the company and/or the researcher may not be known. The more diverse the opinion on the value of the product among buyers, the greater both the marginal utility of the buyer $v_{ix_{jk}}$ variance and slope of the demand curve (Figure 2).

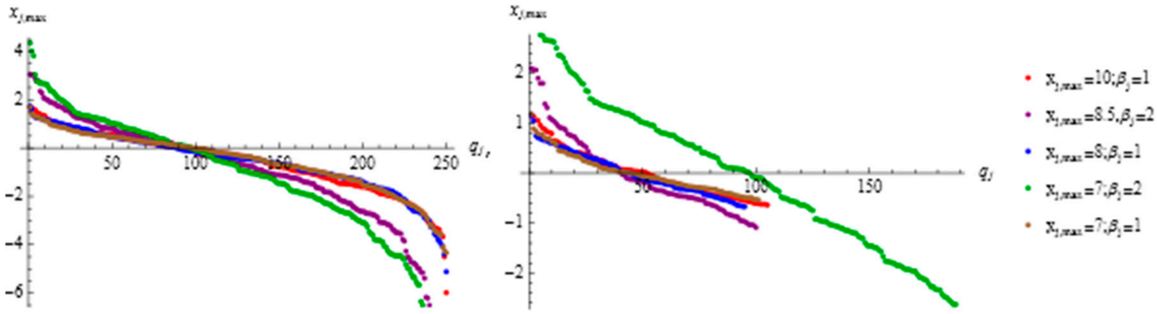

Figure 2. Marginal utility for buyers $v_{ix_{jk}}$: on the left is for all buyers, on the right is for who are not lower than the product's price.

The marginal utility of the customers of each item $v_{1x_{jk}}, v_{2x_{jk}}, v_{3x_{jk}}, v_{ix_{jk}}$, random sizes must be $x_j - \gamma^E \beta_j$ average (γ^E is the Eulerio-Mačeroni constant) and constant dispersion $\beta_j^2 \pi^2/6$. In the vertically differentiated item model, introducing an item price determines the reallocation of demand: customers select the item to which the difference between the value assigned by the customer and the price is most incredible. If there is no single product left in the buyer's sight for which such a difference would be positive, the buyer shall not buy any competing products. The buyer also does not choose the outcome if they cannot purchase it due to budget constraints (see Figure 3).

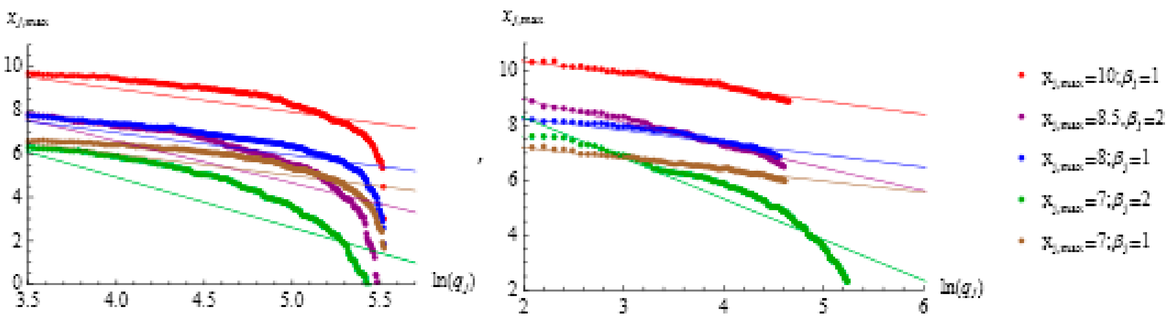

Figure 3. Demand curves: on the left for all customers, on the right for which the price is not lower than the item's price.

In the simulation model, applying a simple linear regression analysis to the demand curve data, it is noted that it allows some estimates of the parameters of the demand distribution function to be determined: standard deviation and possible maximum buyer choice $x_{j,max}$ (Figure 4).

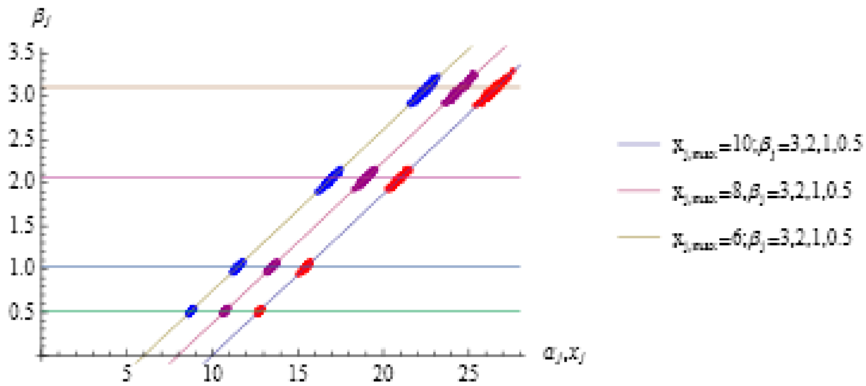

Figure 4. Expected item values α_0, maximum prices available α_j and the relationship between user demand differentiation (simulating demand with the help of the Tubel distribution function).

By establishing demand function and marginal revenues for each product based on the simulated data, supply and market balance continue to be affected. Supply data shall be simulated using:

$$Q_{jt} = F(DJ, K, M)\exp(\omega_{jt}) \tag{26}$$

$$q = \frac{2^{1-\frac{v}{2}}\, e^{-\frac{dj}{af}}\, dj^{\frac{v}{2}-1}}{as\ v} + \frac{2^{1-\frac{v}{2}}\, e^{-\frac{k}{af}}\, k^{\frac{v}{2}-1}}{as\ v} + \frac{2^{1-\frac{v}{2}}\, e^{-\frac{m}{af}}\, m^{\frac{v}{2}-1}}{as\ v} \tag{27}$$

where dj, k, m are the factors of production—labour force, h, capital, i.e., euro, and "materials"—all purchase costs of intermediate products (no stock in the model); af, as, v, are the parameters of the production function.

Next, the assumptions for optimising production and marginal costs are calculated according to the methodology proposed by (De Loecker 2011; De Loecker et al. 2016). The production function is assumed to be homogeneous and can be differentiated twice. Since the model minimises their costs, the application of the Lagrange function produces a mathematical expression from which it follows that the minimisation of costs, this means that the optimal demand for factors of production is met when the elasticity of any factor of production and the total production costs of the enterprise is $\frac{1}{\lambda_{jt}} \frac{P_{jt}^{X^V} X_{jt}^V}{Q_{jt}}$

$$\frac{\partial Q_{jt}(.)}{\partial X_{jt}^V} \frac{X_{jt}^V}{Q_{jt}} = \frac{1}{\lambda_{jt}} \frac{P_{jt}^{X^V} X_{jt}^V}{Q_{jt}} \tag{28}$$

where $P_{jt}^{X^V}$ refers to the prices of the factors of production of enterprises, and the marginal production costs for the given level of production are $\lambda_{jt} = \frac{\partial L_{jt}}{\partial Q_{jt}}$.

The balance for each product is determined by the principles laid down in the Melitz and Ottaviano (2008) basic model of monopoly competition: marginal income must be equal to marginal costs, and margin remains an endogenous variable.

As estimates of the expected value of goods and the differentiation of demand, the distribution of marginal costs is modelled on the Pareto distribution function. However, all these estimates are distributed entirely randomly among enterprises.

At the end of the data simulation, competition between companies is compared through the application and non-application of industrial policy measures. This uses the Bajari et al. (2007) investment gaming model. At the beginning of each period, companies select the level of investment to improve their status variables in the following period. Investment performance is sporadic, and companies' investments only affect their status variables (competitors have no influence). Therefore, the status change for each company can be defined as a certain probability of the expected result: Pr $(s_{i,t+1}|s_{i,t}, I_{i,t})$. Since the model assumes that prices and quantities do not affect the status variables of enterprises, they are determined by the static balance of the state of a particular market. Companies operating in any period t then generate profits; we divide fixed costs by five years. If the company's profits in the first year do not allow it to be expected to be set within a specified period, the enterprise decides to withdraw.

The model developed examines industrial policy measures during the test: horizontal, i.e., where support is distributed on "equal" terms to all enterprises; financial aid only for large enterprises and only for small enterprises. Financial support to enterprises shall be provided in coordination with public procurement.

The insights made during the test shall be applied to selected practical examples. Demand is determined based on actual company data, and supply is assessed by the methodology proposed by (De Loecker 2011; De Loecker et al. 2016).

Competing undertakings are presumed to have productivity that is Hicks' scalar neutral size (a change in productivity is considered neutral if the change in productivity does not alter the labour-to-equity ratio in the production function). The technology used by competing undertakings is also considered to be the same. The following discusses the estimate of the production function parameters, the estimates of which are needed to calculate the elasticity of income. The investigator shall be considered to have a logarithm of the observed level of production if the y_j consists of two compositions: lnQ_j and errors ϵ_j. However, companies are not surprised by the latter component. Thus, the production function, the parameters of which are to be evaluated, is defined as follows:

$$y_{jt} = f(x_j, k_j; \beta) + \omega_j + \epsilon_j \tag{29}$$

where x_j is the factor of production, and β is the vectors for all coefficients. The specification of the production function is based on the logarithmic function of the output, i.e., $f(.)$ approximation of the second series of polynomials, which includes (logarithm) factors of production, (logarithm) squares of factors of production, and their interaction. The removal of both the squares of the factors of production and their interactions from this polyonomy produces the usual production function of Cobb-Douglas. De Loecker (2011) is a proposed value-added function that includes "late" (fictitious) variables; it is assumed that a fixed quantity of materials is used to produce one unit of the product. To avoid a possible correlation between productivity and factors of production, productivity is an approximation based on the material (including energy) procurement data.

Productivity is thus derived from material demand:

$$m_{jt} = m_j(k_j, \omega_j, z_j) \tag{30}$$

$$\omega_j = h_t(m_{jt}, k_j, z_j) \tag{31}$$

where z_j is other variables that potentially influence the optimal demand for the production factor by companies. The list of such variables may vary from case to case, but almost always, it will be the purchase price of the factor of production.

The use of materials as a factor of production in the approximation of productivity, taking into account the production function, is vital due to the monotonous relationship between intermediate products and productivity recorded in practically all models of imperfect competition. This is an essential condition.

The evaluation of the production function takes place in two stages, and its parameters are obtained only in the second stage. Initially, it describes the logarithmic production function and evaluates the expected production volume $\hat{\varphi}_{jt}$ and error ϵ_j:

$$y_{jt} = \beta_l l_{jt} + \beta_k k_{jt} + \beta_{ll} l_{jt}^2 + \beta_{ll} k_{jt}^2 + \beta_{lk} l_{jt} k_{jt} + \omega_j + \epsilon_j \tag{32}$$

$$y_{jt} = \varphi_t(l_{jt}, k_{jt}, m_{jt}, z_{jt}) + \epsilon_j \tag{33}$$

$$\hat{\varphi}_{jt} = \beta_l l_{jt} + \beta_k k_{jt} + \beta_{ll} l_{jt}^2 + \beta_{ll} k_{jt}^2 + \beta_{lk} l_{jt} k_{jt} + h_t(m_{jt}, k_j, z_j) \tag{34}$$

The second step shall provide estimates of all parameters of the production function, including productivity, for which additional (time-lagging and researcher-monitored) enterprise decision-making variables are to be used (together with the productivity estimate of the previous period) that affect the expected productivity estimate:

$$\omega_{jt} = g_t(\omega_{jt-1}) + \xi_j \tag{35}$$

After the first stage, it is possible to calculate productivity for any parameter vector value β, where $\beta = (\beta_l, \beta_k, \beta_{ll}, \beta_{kk}, \beta_{lk})$. Using the following productivity formula: $\omega_{jt}(\beta) = \hat{\varphi}_{jt} - \beta_l l_{jt} + \beta_k k_{jt} + \beta_{ll} l_{jt}^2 + \beta_{ll} k_{jt}^2 + \beta_{lk} l_{jt} k_{jt}$.

4. The Results of the Experimental Modelling

The theoretical model by which the experimental simulation was carried out in the practical part of this work showed that, under conditions of imperfect competition from Bertrand, the undertakings are not only exposed to other undertakings and market structures (or industries) but that the undertakings themselves (at least the largest) are able to influence the market for their benefit.

First of all, it is possible to achieve this by changing buyers' preferences regarding the value of goods, for example, by creating brands. Another way is to accumulate demand, which in the theoretical model equates to a decreasing dispersion of consumer preferences due to the spread of the expected value of the item or a decreasing slope of the demand curve. Examples of such demand accumulation can be found in Santos's (2015) and Foster et al. (2016) empirical studies. Furthermore, as mentioned above, Di Comite (2014) proposed the idea of simulated demand in such a way.

By successfully affecting the named demand parameters, an enterprise can expect the cross-elasticity of demand to change in its favour (see Figure 4). The theory states that it is more beneficial for a monopolist to determine the price of a product when the value of the elasticity of the demand for the product is equal to or less than one, i.e., when the demand is inelastic. However, as the value of the item changes and/or demand is accumulated, at the same time, the demand curve moves left or right, and the slope increases or decreases. As a result, cross-elasticity also changes: the higher the demand curve slope, the lower the price the monopolist must offer so that the cross-elasticity is equal to the unit.

In the model of experimental simulation, this corresponds to changes in the variances of the preferences given to each product by buyers: the more buyers that evaluate the product as more advantageous than the price paid or the value of the competing product, the more preferences are given to the product by all buyers and (at the same time) the slope of the demand curve will be lower; therefore, the higher the price at the cross elasticity equal to the unit. Conversely, the greater the spread of preferences given to the buyer's product, i.e., the more insufficient and negative preferences, the lower the price it is profitable for the company to offer.

This demand model shows how the demand side creates downward pressure on companies to lower prices and thus marginal costs. As mentioned above, the decision proposed by Melitz (2003) and Melitz and Ottaviano (2008) to describe the heterogeneity of undertakings in terms of productivity simulated secondary data on the markets: customer preferences, their distribution by-product, their prices, and budgetary constraints. The market for 17 products (and the same number of enterprises) is examined, where estimates of the parameters of demand and supply of goods are selected at random.

The simulation results show that firms with higher productivity (lower marginal costs) do not pass on all the benefits of such economies to the buyer by applying higher margins and higher profits (see Figure 5). This allows them to make a profit despite the higher slope of the demand curve for some of them. However, even with higher marginal costs, companies can compensate for them and generate profits thanks to higher value-added to the goods and a lower demand curve slope.

Further experimentation simulates competition in the following period (in this case, the next year). Only the most productive (first listed) companies can reinvest part of the profits generated in the model, while others have to allocate all profits to cover fixed costs. The profits of the most productive companies are allocated to creating added value of goods and the accumulation of demand. This leads to the emergence of several oligopolists who together occupy about 60% of the market at the end of the second period.

It should be noted that the sixth company, although characterised by one of the lower marginal costs, is limited by a higher slope of the demand curve, with only a tiny percentage of customers willing to purchase the product. Therefore, this company cannot generate higher profits, even if it can offer lower prices. When the first companies were able to take the lead, other companies had not invested in their productivity or accumulation of demand on time and later faced an increase in investment barriers—a significant increase in their payback period. Meanwhile, incentives for market leaders to invest are also diminishing, as downward pressure on prices is no longer left due to the increasing slope of the demand curve. However, such an outcome is possible only on the assumption that undertakings do not take each other's actions into account in their competition. For example, it does not start a price war.

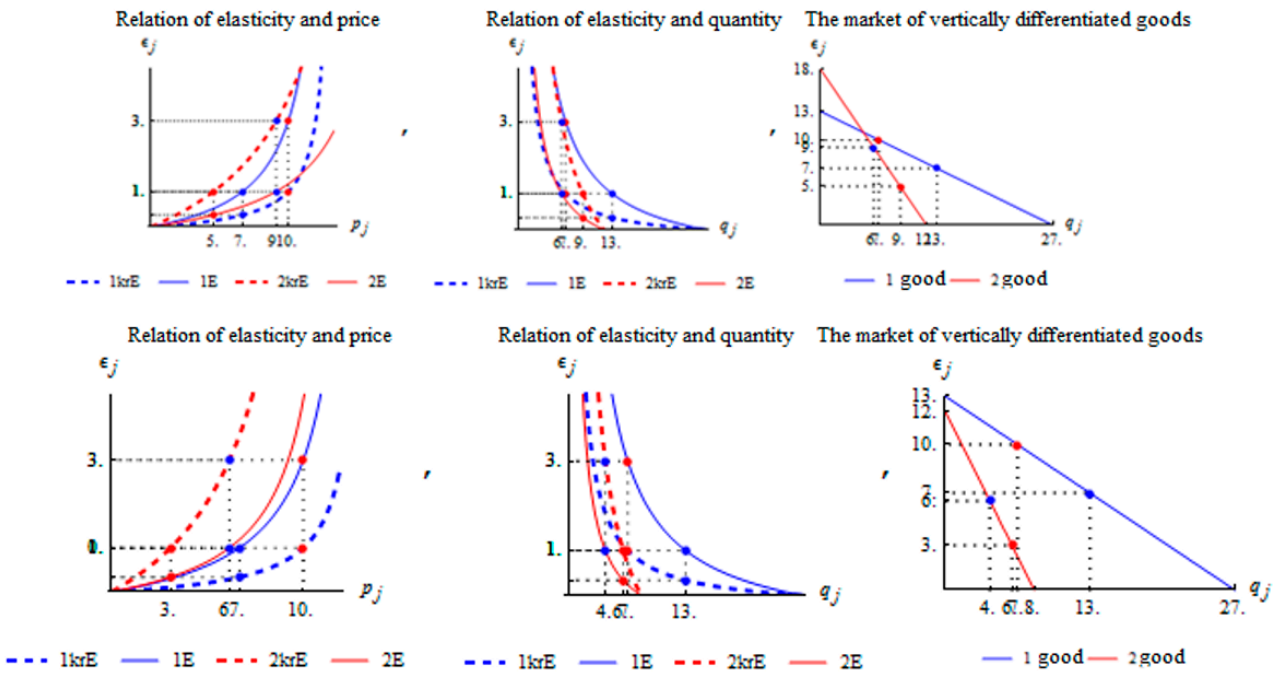

Figure 5. The theoretical model of competition for vertically differentiated goods via Bertrand: demand and elasticity.

The market concentration increases significantly in the second year: the HHI index rises from 0.085 to 0.223. It should be noted here that, although the market becomes only moderately concentrated (up to 0.25), it is quite evident in terms of market shares that the market power of the largest oligopolists is equivalent to that of all other competitors. The Lerner index, commonly used to determine companies' market power, clearly does not sufficiently reflect differences in the market power of significantly higher companies.

Thus, in experimental simulations, companies operating in the market lose incentives to invest over time, particularly in marginal cost-reducing innovations. In addition, two extremums can be distinguished in experimental simulations: in one case, firms with high value for goods and low slip of demand, competition prices, i.e., the importance of productivity, decrease. Conversely, in the case of rough parameters of demand for goods, the importance of heterogeneity of enterprises in terms of productivity for the market share and power of enterprises increases significantly. All other market structure combinations can be considered intermediate market states between the two extremums.

5. Conclusions

Being increasingly concerned with dynamic efficiency, the authorities responsible for economic policy experience the urge to assess whether specific policy choices can lead to greater wealth in the long run. They need to evaluate how and whether specific measures can influence the development of markets to achieve greater wealth. This means that the evolution of the market structure and the resulting competition processes between undertakings are inevitably encountered.

The industrial organisation and the new trade theories offer many incentives as to how competition and market structure evolves, including investment and innovation activities. While discussion proceeds, there is still a lack of theoretical and methodological insights in an integrated approach. Without complete theoretical models, it is difficult for researchers to properly specify econometric structural market balance models describing the imperfect competition between companies. Therefore, data simulation techniques are often used.

The simulation methodology allows for easily verifiable results. This may be particularly important when testing the proposed theoretical model. On the other hand, it is also important that the study results on the impact of industrial policy measures on competition and cost-effectiveness do not depend on the specificities of specific cases. Therefore, it can be argued that the optimal methodological choice to solve the scientific problem in question may be a simulation model developed not on a case-by-case basis but in a simulation experiment.

In our model, allowing the market structure to evolve over time, on the one hand, we enable competing for several firms with different endowment factors and abilities to affect demand. However, on the other hand, changes in demand preferences affect competing firms' capabilities to profit and further invest in demand accumulation. Under such Bertrand competition conditions, undertakings are not only exposed to other undertakings and market structures (or industries), but undertakings themselves (at least the largest) can influence the market for their own benefit.

Firms might either try to change buyers' preferences or further invest in demand accumulation. They can change the cross-elasticities of demand by affecting the variances of buyers' preferences. Moreover, having stable demand of loyal buyers' firms with higher productivity levels are better off by increasing margins, i.e., firms with higher productivity (lower marginal costs) do not pass on all of the benefits of such economies to the buyer by applying higher margins and higher profits.

Moreover, time is key for rivals: when the preferences balance is changed, the market leader is quick to change. As a result, other firms operating in the market might lose incentives to invest over time, particularly in marginal cost-reducing innovations. Although the model does not track all the aspects of firms' heterogeneity, it is able to evidently show that the market structure may constitute an obstacle to greater dynamic efficiency in the longer term.

Therefore, it can be recommended that a policy intervention into the market might be needed. Supporting SME capacity building, as well as encouraging incentives for enterprises to innovate, can be appropriate policy measures that can at least partially remove potential obstacles created by the market structure. However, according to the analysis of the scientific literature, policy measures must be combined with pressure to make good use of the support received.

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