

# Transformation of Industrial Policy towards Industry 4.0 and Its Impact on Firms' Competition

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**Abstract**—Although Europe is on the threshold of a new industrial revolution called Industry 4.0, many believe that this will increase the flexibility of production, the mass adaptation of products to consumers and the speed of their service; it will also improve product quality and dramatically increase productivity. However, as expected, all the benefits of Industry 4.0 face many of the inevitable changes and challenges they pose. One of them is the inevitable transformation of current competition and business models. This article examines the possible results of competitive conversion from the classic Bertrand and Cournot models to qualitatively new competition based on innovation. Ability to deliver a new product quickly and the possibility to produce the individual design (through flexible and quickly configurable factories) by reducing equipment failures and increasing process automation and control is highly important. This study shows that the ongoing transformation of the competition model is changing the game. This, together with the creation of complex value networks, means huge investments that make it particularly difficult for small and medium-sized enterprises. In addition, the ongoing digitalization of data raises new concerns regarding legal obligations, intellectual property, and security.

**Keywords**—Bertrand and Cournot Competition, competition model, Industry 4.0, industrial organization, monopolistic competition.

## I. INTRODUCTION

THE Industry 4.0 is the main topic of industrial policy that gets growing in importance to the European Union (EU). However, around 1 of 10 companies in the EU is classified as production. Overall, the production sector accounts for two mln. companies, generating 80% of EU exports and are accounted for 80% of overall research and development (R&D) funds [1].

As the Parliament of EU has summed up, many observers see Europe as the threshold for an industrial wave, which is called Industry 4.0. This industrial revolution is linked with information and communication technologies integrated into cyber-physical systems, helping to increase the speed of service, product quality and significant rise in productivity. However, all the benefits of Industry 4.0 mean a lot of inevitable changes and the challenges they pose at the same time. One such problem is the changes in the competition, revision of business models of standard companies that are currently in place. According to the Policy Department at European Parliament 2016 [2], Industry 4.0 changes the business model of the production sector, i.e., firms move from traditional competition to qualitatively new competition

following (a) innovation activity (to create new products); (b) introduction of user-friendly designs (new configuration of companies); (c) reduction of equipment stop-time by providing timely control and process automatization.

All these challenges ahead call into question the necessity for the new industrial policy, and its effective lunch to successfully address the challenges posed by the emerging business and competition model in the industrial manufacturing sector. Therefore, when planning industrial policy measures and their necessity, it is necessary to anticipate how the competitive behaviour caused by Industry 4.0 will change.

## II. INDUSTRY 4.0

The question of what is (or can be) considered an industrial policy cannot be answered unequivocally - so far. There is no consensus in the scientific literature on its definition, concept and meaning. There is disagreement on the scope of the objectives and measures to be attributed to it. The content can be caused by different results of industrial policy in other countries and at different times. In some countries, this has been successful: after World War II in Western European countries, later in Japan, South Korea, and elsewhere, interventionist policies created new industrial structures in countries with larger, stronger, and more advanced companies. At other times, some countries implemented an industrial intervention policy and have failed: distorted competition and problematic, technologically underdeveloped companies, which have benefited from the economic leases proposed by new policies.

In the early 1990s, industrial policy was first abandoned at the beginning of the XXI century in the European Union (EU) and later in other countries. It is suggested to maintain free competition in the markets. But such a policy has not yielded the desired results: the EU has relinquished its leading position in research and development in countries such as Japan, South Korea, and the United States. Therefore, industrial policy was introduced as a tool among industrial and competition policy, and that led to the creation of separate industrial policy.

The need for an industrial intervention policy is based on the theory of market failure, according to which markets are not perfect and corrective intervention is needed. The definitions of industrial intervention policy emphasize the evolution of the structure of the industry. Pack et al. threaten that the industrial policy among the policies is aimed at changing the structure of production in a way, which creates better conditions for growth [3]. Meanwhile, the characteristics of soft-intervention industrial policy can be

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seen in Warwick's definition directed to industrial policy [4]. According to it, industrial policy is a set of measures to improve the business environment or change the structure of economic activity to create industries, technologies or tasks that will increase economic growth. Welfare prospect distorts competition substantially (at least in the medium to long term) [4].

#### A. Competition Model

The first models of industrial organization describing product differentiation have shown that by differentiating their products, firms gain higher profits due to reduced direct competition. One of the most notable models of imperfect competition describing product differentiation was published by Shaked and others in 1982 [5]. In these models, companies try to differentiate products according to quality to avoid fierce competition from Bertrand. These and all later models of oligopolistic competition with differentiated goods are based on the idea of product space. Later some models were created following the empirical research of Mussa and Rosen [6], from which it follows that companies try to differentiate their products in such a way that they are as "remote" as possible from each other. Singh and Vives [7], by describing the model (the classic one) of horizontally differentiated goods, have shown that how to compete with prices (Bertrand competition) or quantities (Cournot competition) may be a choice depending on the endogenous factors of the firm. In the case of Bertrand competition, companies tend to try to differentiate their products. Economides [8] and Cremer et al. [9] modelled vertical and horizontal differentiation of goods in one model in which firms compete on quality, variety of goods, and prices.

Assuming that horizontal differentiation of goods occurs earlier than vertical and marginal costs increase as the quality of goods increases, it has been observed that firms then tend to differentiate goods horizontally rather than vertically. Vandenbosch et al. [10] proposed the model, which shows that differentiation of goods according to one characteristic will result in maximum differentiation. Still, the differentiation of goods, according to several elements, will weaken the intensity of differentiation. Singh et al. [7] in imperfect competition models have shown that, if demand and cost conditions are equal, an industry in which Bertrand-type competition operates has lower profits, lower prices, and greater consumer surplus. Benassi et al. [11] in their model showed that the growth of consumer income observed in Western economies in the second 20th century. It influenced changes in demand for goods and differentiation of goods. Increasing inequality in consumer income distribution, i.e., the higher concentration of higher-income consumers leads to an increase in the intensity of product differentiation, which is more beneficial for companies selling higher quality goods. However, Bocard et al. [12] have shown in their model that increasing production capacity can transform a firm's product differentiation strategy into a more effective means of avoiding competition. Wildenbeest [13], by reviewing empirical studies, noted that products sold by competitors

appear as homogeneous, their prices differ for several reasons and different preferences by buyers. Tremblay et al. [14] modelled market equilibrium with the mixed competition when both Cournot and Bertrand strategies are used in the market. They concluded that if there is a market for some companies opting for Cournot's strategy and others for Bertrand, all companies remain in the market and the established balance remains sustainable if the differentiation of the goods is sufficiently high. However, in the absence of product differentiation, only companies that have opted for Cournot's volume-leading strategy remain. Makadok et al. [15], reviewing the scientific literature on commodity differentiation, notes that relatively much attention is paid to the influence of industry structure on firm behaviour and performance. Still, little is examined about how commodity differentiation contributes to the formation of industry structure.

By summarizing the literature on the industrial organization and commodity differentiation, it can be observed that in the theoretical models of the industrial organization, commodity differentiation is usually described by assuming the symmetric differentiation of commodities. This feature of industrial organization models significantly limits the ability to model realistic competition cases.

Companies differ not only in the differentiation of goods but also in productivity. In an empirical study that had a wide resonance among researchers, representatives of the practical industrial organization identified and confirmed the high heterogeneity of firms in terms of productivity, excluding particularly productive exporting firms. The crucial importance of productivity for the survival of companies in the competitive struggle has been confirmed. These facts are approved by both static and dynamic empirical studies: [16]-[23].

### III. INDUSTRIAL INTERVENTION POLICY

Bianchi et al. researched industrial intervention policy and suggested such main characteristics: (1) the nationalization of enterprises; (2) the protection of new growing industries by providing import quotas, subsidies, etc.; (3) support of large companies by taking initiation for promoting mergers and acquisitions (M&A), an artificial increase of the market share of the company; (4) export support (awards for exporting companies); (5) attracting foreign direct investment (FDI) (such as subsidies, tax rebates, etc.); (6) focus on the management of supported enterprises [24].

There are theoretical bases. The intervention follows the 'soft' industrial policy (SCP) paradigm (industry structure; firm behaviour and activities). It was initially interpreted as meaning that if market concentration determines the firm size, profitability, and efficiency, interventions can help create large firms (or simply national leaders), and such modification of the industrial structure should have positive consequences. Therefore, this model provides two main assumptions:

- There is a stable interaction and causal relationship that starts with the structure and manifests itself through the company's behaviour concerning the company's

performance.

- Enterprise market power parameters can be calculated using available data. Accounting data can be used to estimate the Lerner index (LI) or economic benefits.

The basic idea of the SCP paradigm is clear: it seeks to establish links between industry structure and enterprise performance indicators that are specific to the industry.

Over time, the paradigm has also been criticized. Church et al. [25] argue that revised positive correlation between market concentration and firm profitability does not represent enterprises having exceptional market power. According to the authors, enterprises become more profitable when their marginal cost is lower, allows to trade more and make more profit when the amount of competing firms decreases. Therefore, higher profitability in higher concentration industries does not necessarily depend on the gained by companies' market power. Higher efficiency industries receive Ricardo economic leases as a financial benefit because the costs of alternative sources to reach advantages are not presented at firms' costs. Following the statement, the concentration increase in the industry should only be linked with the increase in profitability of SMEs.

A direct correlation between market share and profitability is linked with the increase of market power in an oligopoly. Therefore, the SCP paradigm probably incorrectly assumes a causal relationship [25]. The main hypothesis points to concentration variables and barriers to market entry because an exogenous hat has nothing to do with earnings. Also, it is doubtful whether this is the case. First, in an oligopoly market, expected market share and acquired market power are judged by the range of activities, costs, and competing firms. The concentration is endogenous, as is the barrier to entry (up to a certain limit). Also, the parameters of entry barriers that reflect firm behaviour are endogenous (a clear example of this is advertising intensity).

In general, a reciprocal relationship can be expected to exist: the behaviour of a firm today affects the concentration of tomorrow's firms, their size, and profitability, which later affect their behaviour. Assessing the relationship between positive concentration, the correlation between barriers to entry and market power, although profitability, concentration and barriers to entry can be addressed earlier, means that a positive correlation will be biased. Therefore, the SCP paradigm can be interpreted as a cycle.

Barthwal argues that in addition to the conditions mentioned, the market structure depends not only on the needs of concentration and market entry of firms but also on the degree of differentiation of goods [26].

The interpretation proposed by critics of the SCP paradigm, states that the structure of the market depends on many conditions, namely not only the efficient use of resources and the strategic behaviour of the firm but also investment in Research, Development and Innovation (R&D&I) activity and its results into efficiency. During this time companies need to revise their strategies, improve R&D&I activities to the new market or industry structure that presents how resources are assigned by competitors [27].

Over the years, researchers of economic policy such as Stiglitz and co-authors started to prioritize the intervention of SCP for several reasons [15].

First, the economy of scale is treated as a significant factor in corporate competition. Product differentiation, including branding; the introduction of new technologies and innovations, which usually lead to lower marginal costs and higher product quality, can determine the results of companies' competitive struggle. This contrast, according to Perrot, was evident in France between the 1970s and 1980s, when the demand for products from the country's national champions was steadily declining due to competition from more technologically advanced countries like Germany. The continuous update of current products and the development of new products presented by international competitors often seemed more attractive to French consumers [29].

Second, the higher market concentration could be a major barrier to the increase of dynamic efficiency. The largest and once efficient former companies with significant market power may lose initiatives to invest in R&D&I activity. Other companies could not have enough knowledge, competencies, capacity, and technologies to compete successfully with the market leaders.

Practical examples from Japan, South Korea and the US, clearly show that it is the protection of local SMEs from competition maintaining fierce competition between them, i.e., by leaving long-term and sustainable growth.

For all these stated reasons, as Cimoli et al. note, the emphasis over the past decade has been on industrial policies that use only mild interventions [28]. They are not aimed at artificially transforming the industry, but at stimulating economic growth by increasing its dynamic efficiency. Attitudes towards the competing market structure have changed radically. It is now treated not only as an indicator determining company size, efficiency, or profitability but as a tool that motivates larger enterprises to start R&D&I (seeking to get the power in the competing market) and leave barriers to SME investment to such activities. High concentrations of leading companies and markets with market power distort market signals so that there is no reason for dynamic efficiency growth. Therefore, successful examples of gentle interventions in industrial policy reveal how the management of competition in the industry, by intervention, changes these signals so that they again promote dynamic efficiency. According to [28]), soft industry policy is characterized by success with these traits:

- Public sector institutions, such as universities, are emphasized for the implementation of new technological paradigms.
- Good intentions alone are often not enough. It is the company's capacity and its expansion that play an important role in industrial and innovation policy.
- Market discipline (maintaining competition) is beneficial till it helps to wake up lagging companies.
- Mechanisms are in place to protect companies and the pursuit of financial leasing.
- Industrial policies that successfully achieve per capita

income and the growth of wages are combined with technologically advanced paradigms and focus on market provided signals [28].

The policy of soft intervention is characterized by (i) research programs (promotion of R&D&I cooperation); (ii) promotion of the development of competencies (learning and education); (iii) supporting industries by promoting contemporary R&D&I programs [28]. For all these reasons, a mild industrial intervention policy is sometimes referred to as a 'catch-up' policy: it aims to strengthen the position of protected companies in the markets by investing in research and development to reduce commodity prices due to increased productivity. Also, it seeks to improve and exploit existing production capacity [30], leading to the expectation of successful exports [31]. Herein governments promote R&D&I, competencies, and foreign trade through a variety of fiscal incentives, as well as strictly protecting the domestic market from not prohibited international obligations [32], [33]. Meanwhile, soft-intervention industrial policy partially focuses on the support of SMEs helping to start R&D&I, staff training, money and physical infrastructure [34].

#### IV. THE INDUSTRIAL 4.0 POLICY AND THE IMPACT ON COMPETITION

As already stated, outcomes reached under the Industrial 4.0 policy are the reduction of marginal costs and increase of added value. The impact on firm competition is described in the literature, i.e., theory of new trade focusing on empirical industrial organization.

Firms are heterogeneous in terms of productivity. Their market share depends on productivity: only higher productivity enterprises could invest in export activity or make FDI [35], [36].

Melitz [36] notes that the small number of enterprises focus on export activity which guarantees a large share of gross income. In many cases, such firms are larger and more productive than non-exporting enterprises.

The most productive and the largest companies have the lowest prices for products. But research shows the opposite. Schott found that enterprises operating in higher-income countries, which are rich in financial resources and knowledge, sell products outside with higher margins and prices [37].

Productive companies manufacture products that are more attractive. The value of products is also dependent on vertical product differentiation [38]. Larger and productive firms make and sell products having higher quality. Moreover, even small but higher quality enterprises can successfully sell outside the national market. The quality of products strongly correlates with the firm investment' intensity, R&D&I costs, innovations into products, processes, and technology, and the costs dedicated to obtaining quality standards certificates. More productive enterprises sell higher quality products and export them to other markets [39]. Higher quality and more expensive items are the most competitive - their exports may cover the maximum trade costs associated with long-distance transport [40]. Also, the increase in productivity of companies

allows them to produce and sell a wider range. However, as competition between firms intensifies, they are abandoning the production of the least profitable products [41]. Therefore, the increase in productivity lets enterprise improve the quality of existing products and develop new ones. This means that enterprises with higher productivity invest in goods differentiation.

Productivity has a compensatory effect on prices. Productivity impacts the prices of the products by lowering marginal production costs. But the higher productivity helps a firm to improve product quality by increasing marginal costs and selling prices. Whether these enterprises could change prices to higher or lower, such depends on the firm's initiatives to enhance the quality of the product and export opportunities [42].

While it may seem that only large firms can be more productive and create added value, firms' productivity is not increased by their size but by competitive pressures. The size of the liabilities is only a consequence of this. For companies to remain competitive and engage in export or FDI activities, they do not have to be large - they need to be efficient [43], [44].

In summary, all the above evidence of corporate competition reveals the potential impact of the current process of digitalization and the implementation of Industry 4.0.

It can be predicted that with enormous financial investments, larger companies could have opportunities and are more likely to achieve dynamic efficiencies. Without such support and initiatives to promote digitalization, small and medium-sized enterprises lose the market competition. Let's suppose SMEs were to fall out of the competition. In that case, the remaining large companies could increase their margins and prices by collecting Ricardian economic leases, thus losing the incentive to innovate, i.e., to increase dynamic efficiency further. Therefore, support for small and medium-sized enterprises under the Industrial 4.0 policy, although in principle can be considered as a soft intervention by the State, has a strong economic basis for exempting it from State aid rules. Horizontal aid to SMEs for business digitization and R&D&I will help competition, despite gentle intervention with direct state aid. Therefore, it allows us to anticipate sustainable competition and greater dynamic efficiency in the long run.

#### V. CONCLUSIONS

Although many see Europe as the threshold of a new industrial revolution called Industry 4.0, this paper addresses the issue of the place of industrial policy of the same name in the entire industrial policy hierarchy, including relations with competition policy.

In the context of all industrial policy to date, the EU's 'soft' industrial policy, Industry 4.0, cautiously incorporates the best measures that have taken place in different countries and at other times. Despite the abandonment of industrial policy in the European Union during the 1990s, 'soft' industrial policy was introduced at the beginning of the XXI century. Due to that, the EU now pursues a de facto broad intervention policy,

providing state aid to SMEs without applying state aid rules, but developing its policy of competition. The competition is ensured by harmonization of support, which is in line with basic principles not to have discrimination in the European Union among small and medium-sized enterprises.

The European Union choice follows the theoretical level of the competition paradigm. It is not discussable that the size and market power of an enterprise can compete by using main characteristics like the improvement of products' quality, productivity, etc. that eventually lead to growth and competitiveness.

Competitiveness is mentioned in theoretical and empirical studies delivered by [9] and [41] investigating the industrial organization and the theory of new trade. These works also revise potential risks associated with the industry 4.0 revolution under which larger firms have the higher advantage against SMEs by having abundant resources, so they can more quickly reap the benefits of business digitization and drive out the existing competing companies from the industry. Also, it is reasonable to believe that soft industrial policy in the European Union is well placed to address this issue by promoting small and medium-size enterprises towards innovation and research and development to ensure long-term competition.

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