

## Articles

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### ENVIRONMENTAL REGULATIONS AND INNOVATIONS VERSUS COMPETITIVENESS

#### Abstract

*Environmental regulations influence the prosperity and sustainability of organisations and households. According to the traditional belief, they constitute an additional, undesired cost which lowers competitiveness of economic operators and the entire sectors, although they might be socially desirable. The issue can be, however, approached from a different perspective, namely from the viewpoint of the induced innovation theory – authored by J.R. Hicks in 1932, later developed and presented in 1991 by M. Porter, then on known as Porter hypothesis. It states that a company, affected by more stringent environmental regulations, is often forced to use simple reserves and to implement fundamental technological, organisational and product innovations, which can, all in all, offset the higher costs of adhering to the more severe environmental policy. Consequently, its competitiveness does not have to drop, sometimes it can even grow. Porter hypothesis already has strong theoretical grounds, but empirical verification of its accuracy is still an open issue. In general, today it is assumed that it is completely true (it checks out in the so-called strong version), only in some, rather restrictive conditions. This conclusion – as evidenced in the paper – is also applicable to the food sector, including agriculture.*

**Key words:** Porter hypothesis, Hicks induced innovation, competitiveness, environmental policy, environmental regulations.

## Environmental regulations

Environmental regulation means involvement of public authorities in convincing the pollution emitter to act in a socially desirable manner, which only seemingly does not correspond to the emitter's most vital interests (Kolstad, 2011). It is a part of the economic regulation theory, i.e. a concept explaining the reasons for and effects of governments' interference in running organisations and households. In general, this is made via the public interest theory and interest group theory (Principles of Environmental..., 2000). The former states that regulations are introduced to achieve important social goals. Their use is justified by imperfect competition, information and externalities. The interest group theory, on the other hand, explains that a regulation is a tool to achieve goals by larger groups which is based on the concept of rent-seeking and theory of agency.

There are two wide groups of environmental regulation instruments:

- prescriptive (administrative),
- having the character of economic incentives.

Each of them is composed of several specific tools, though. They are assessed, just like their composition, in the form of a defined environmental policy on the basis of several criteria. Most often these are: cost, environmental and dynamic efficiency; costs of monitoring, administration and compliance with regulations; long-term effects (net income, technological, structural, concerning labour market, generation of dividends); equity and redistributive impacts; elasticity, predictability, rigidity/sharpness and orientation at competitiveness (Albrizio, Koźluk and Zipperer, 2014a; Perman et al., 2011; Wagner, 2003). For the needs of the paper only the two last concepts will be discussed hereunder.

Rigidity/sharpness of regulations and environmental policy stand for a “price” assigned directly (rate of environmental tax or rate/price of pollution permit) or indirectly (standards and limits, orders and bans) to an externality. To put it differently, more rigid regulations, actually, mean higher cost equivalent of actions detrimental to the environment. Accordingly, implementation of a given instrument should be read by the regulated entities (companies and households) as a signal to change their actions in order to improve the environmental indicators (Albrizio et al., 2014b).

Orientation at competitiveness of the instrument and environmental policy means a drive to minimise deformations caused by them for the sake of fair competition, mainly by lifting barriers to entering or leaving a given sector, fostering eco-innovations and popularisation of low-carbon technologies (Albrizio et al., 2014b).

According to R. Perman et al. long-term impact of regulations and other environmental policy instruments depends, mainly, on the efficiency of:

- net income formation,
- implementing technological innovations (Perman et al., 2011).

The first factor covers mainly subsidies and environmental taxes. Extending the aggregated size of operations, which may negatively influence allocation. Theoretically, it is possible to attempt to counteract this by simultaneously imposing equivalent taxes on beneficiaries of the subsidies. In practice, however, such an attempt is politically unfeasible. Then, technological innovations are manifested through the mechanism termed as dynamic efficiency results. The very environmental regulations are treated as a rather poor incentive to innovate. This is to result from their discreet binary nature, i.e. achievement or not of a given state. The former is treated as satisfactory, not inducing or forcing further improvement of a technology, process, product or organisation. The impact of subsidies and environmental taxes, and environmental policy market instruments are said to have a different impact on the regulated entities. There is still another channel of impact of technological innovations. This, specifically refers to the case when a regulator has a very good knowledge on the status of environmental technologies and thus a standard may mean a recommendation for use of a given technological solution. This tactic is most often suggested to developing countries but the administrative instrument can also have a per balance advantage over market instruments under specific conditions in highly developed countries.

Ch. Kolstad reckons that environmental policy market instruments most often provide a stronger incentive to implement innovations than command ones, but much depends on whether or not there is a social pressure on constant improvement of the quality of the environment in a given country (Kolstad, 2011). It can, however, happen that under certain conditions market instruments completely lose their innovation oriented character. This is what has been going on for some time now in the EU, where the prices of emission permits dropped so low that it is simply not worth the trouble for the entrepreneurs to implement low-carbon technologies. In the wake of the above, it was decided to withdraw a part of the permits from the market, maybe temporarily, which is to increase their prices.

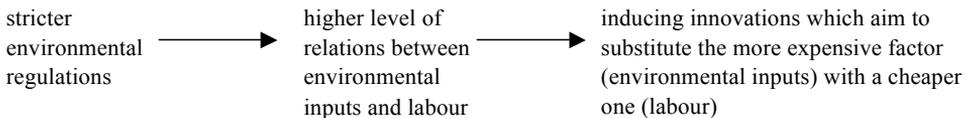
### **Hicks induced innovation hypothesis**

The British economist – J.R. Hicks, formulated his hypothesis in 1932 in a paper devoted to the theory of wages. In line with the hypothesis, a wage growth should encourage entrepreneurs to implement labour-saving innovations. Soon this reasoning was translated into energy, climate and environmental issues. The impact of Hicks induced innovation theory on the development of agriculture is quite interesting. It does, however, highlight quite obvious issues, namely the fact that, given the limited land resources in agriculture and constant growth in demand for agri-food products, it is necessary to make investments in the sector and continually rise the productivity of all resources at the disposal. Following the changing elasticities of supply of individual inputs used in agriculture and

relative prices, the involvement of less elastic resources should be substituted or limited. What is necessary at this point are innovations, which should cause a drop in production costs by substituting rarer resources with those which are more abundant and cheaper. At this point, public intervention may come into play but it will be targeted, above all, at providing support to innovations.

The Hicks hypothesis sparks off various controversies. It is emphasised that it is not known whether or not it rightly explains the development paths of highly varied countries. In case of agriculture, it is argued that land productivity growth primarily results from demographic pressure and scarcity of its resources and not a change in relative prices. Even if because of the latter induced innovations will appear, there is no guarantee that the process will be continued, i.e. that the economic entity or the whole sector will move to the new, higher curves of production possibilities. Assuming that all economic entities are guided by a drive to reduce costs in the conditions of fair competition, all factors of production will be remunerated at the level of their marginal productivity. As in such case there is no stimuli to undertake innovations targeted at saving any of them.

It is also very interesting how Kolstad (2011) perceives the induced innovation hypothesis of J. Hicks. By fleshing it out at the background of the environmental issues, it is to trigger the following sequence of interdependencies:



As it is clear, this refers to the mechanism of relative prices. Its logic is quite complex, though. The changes in relative prices influence the operations in the area of research and development, which is to provide environmental innovations. But, in order to do that, the innovators should have the right to fully appropriate thus obtained benefits. In practice, there is no place where it is possible. As a result, the so-called smart network externality emerges. Its internalisation is, in general, performed via public investments in the R&D area. But it can cause a side effect manifested in lower innovation activity in the private sector. The literature review carried out by Kolstad shows that the induced innovation hypothesis most often holds good in the power economy sector. The impact of innovations is, in general, moderate as it comes to reduction of pollution emission costs and achievement of other environmental policy goals.

The induced innovation hypothesis is indirectly linked to the hypothesis of environmental Kuznets curve. This concept was presented by S. Kuznets in 1955, as a sort of sideline, because the economist was initially focused on changes in the income differences along with their per capita growth. By ana-

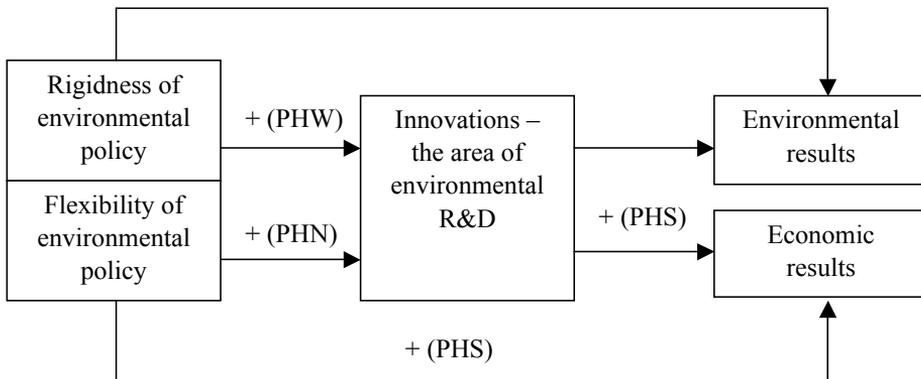
logy, in the simplest terms it is assumed that the curve, termed by an acronym EKC (an environmental Kuznets curve), initially goes up – meaning a growth in the pressure on the environment caused by harmful emissions (per capita) – then, at some moment, it reaches the maximum and, finally, it drops (the emissions relatively decrease). At closer analysis, it turns out that the course of the EKC is highly differed depending on the type of emissions. But a growth in global emissions is a serious problem. Other conclusions are obtained for short- and long-term analyses. It comes as no surprise, as in fact these are very complex interdependencies. Hence, empirical research also reveals very divergent findings, which is well illustrated, e.g. by the paper of S. Coderoni and R. Esposti (Coderoni and Esposti, 2014).

### **Porter hypothesis**

In 1991 – M.E. Porter, and in 1993 – C. van der Linde, started to endorse, independently from each other, the view that environmental regulations do not have to deteriorate competitiveness of enterprises as far as the enterprises know how to implement the right product and process innovations, which can even fully offset the costs of regulations. In 1995, the researchers jointly presented their thoughts on the issue which from then on are known in the literature as the strong Porter hypothesis (Porter and Linde, 1995). Already at the very beginning, Porter and van der Linde state that the relation between competitiveness and the environment is, as a general rule, erroneously situated, i.e. in a static system of technologies, products, processes and customers of companies, which causes environmental regulations to generate costs for companies and, as a consequence, reduce their international competitive advantage. What is needed instead, according to Porter and van der Linde, is a dynamic approach. If companies respond to rationally designed and carefully implemented regulations with starting the process of introducing innovations, then it is possible that they will be able to more than offset the incurred costs of adjustments to the environmental requirements. This will certainly take place most often when – as a result of innovations – the costs of pollution emissions drop, which in fact will be tantamount to better productivity and efficiency and this will, in turn, translate directly into higher international competitiveness. This improvement can actually be even faster if the environmental standards are more stringent or were introduced earlier than in other countries. Undoubtedly, it is a very debatable assumption, contradicting, for instance, the phenomenon of environmental dumping. Porter and van der Linde argue, at this point, that only strict regulations stronger encourage companies to more in-depth analysis of the entire business model and supply chains, and to generate value with a view to create and implement more ambitious fundamental innovations. But it is still fairly added that in the area: environmental regulations – innovations – competitiveness, there is no automation and various trade-offs can take place.

The Porter hypothesis is formulated in the three following versions as:

1. **Weak.** Environmental regulation leads to a growth in environmental innovations aimed at minimisation of costs of respective inputs/products being the object of its impact. Higher expenses on the entirety of innovation activity are not required, simple transfers within their structure will suffice.
2. **Strong.** Cost savings obtained as a result of innovation and better production processes, and also work organisation, i.e. the so-called innovation offsets, surpass the costs linked to adherence to regulations, leading to higher productivity, profitability and competitiveness.
3. **Narrow.** More flexible environmental policy instruments, aimed, first and foremost, at results rather than organisation and run of production processes, increase the probability of their translation into greater innovation effort and better results of an economic entity (Ambec, Cohen, Elgie and Lanoie, 2011; Ambec, Cohen, Elgie and Lanoie, 2013; Lanoie et al. 1997; Porter, 1991).



Indications: PHW – weak version of Porter hypothesis, PHN – narrow version of Porter hypothesis, PHS – strong version of Porter hypothesis.

Fig. 1. The causal chain under the Porter hypothesis (PH).

Source: own study on the basis of: P. Lanoie, J. Laurent-Lucchetti, N. Johnstone, S. Ambec (2011). Environmental Policy, Innovation and Performance: New Insights on the Porter Hypothesis. *Journal of Economics and Management Strategy*, vol. 20, no. 3, p. 809.

Porter and van der Linde emphasise, in the hypothesis at stake, the significance of well-designed and implemented environmental regulations. They should be essentially targeted at the following six goals:

1. Signalling to the enterprises the possibility of inefficiency of resources use and the possibility of reduction thereof.
2. Improving the environmental awareness of companies as a result of gathering relevant information and meeting their respective reporting duties.

3. Reducing uncertainty linked to environmental investments and other physical and even financial investments.
4. Exercising pressure on finding and implementing innovations and technical and organisational progress.
5. Equalising conditions of competition and depreciation of costs at the stage of transition to innovation-based competition.
6. Guaranteeing the process of improving the status of the environment, before the innovations start to bring full reduction in the costs of adjustments to the requirements of the regulator or the reduction will never be complete.

On the basis of the aforementioned goals, Porter and van der Linde put forward three requirements regarding regulations stimulating innovations, which are:

- favouring innovations of companies to the maximum, i.e. their goals have to be clear and flexible;
- stimulating continuous improvement of companies achievements, i.e. their openness to new technologies and processes and dissemination of environmental innovations;
- coordinating regulatory operations, so as to create and leave as little uncertainty as possible among the regulated entities.

As evident, regulatory policy should be more focused on the growth in the general economic and environmental productivity and efficiency, which would be followed by achieving a relatively permanent competitive advantage, than simply on pollution reduction. To make this happen the very enterprises should also undergo a fundamental change. First of all, they have to start treating the natural environment as a source of competitive advantage and not a troublesome cost, which can be lowered, e.g. by lobbying to relax regulatory regimes or even by failing to meet them. This needs, e.g., a detailed environmental cost and benefit account and a system of external and internal stimuli encouraging or even forcing to constantly improve efficiency and productivity, largely through implementation of broadly-conceived innovations.

Porters's and van der Linde's papers of 1991 and 1993, respectively, met with criticism. Their opponents advocated four issues:

- (1) although innovations can, theoretically, offset the growth in costs on account of implementing environmental regulations, in practice it is rarely the case;
- (2) costs of adjustments of companies to the environmental requirements are often fairly high, which causes a continuous trade-off, a form of tension in the area of regulations and competitiveness, and a lot of issues still await a more straightforward settlement;
- (3) even if environmental regulations favour innovations, then – on the other hand – they are disadvantageous to competitiveness by crowding out other, potentially even more profitable investments and types of innovations;
- (4) there is no reason to claim that strict environmental regulations positively and universally result in innovations and thus in better competitiveness.

The same issue of the “Journal of Economic Perspectives”, which published the paper by Porter and van der Linde, contained a thorough criticism of the Porter hypothesis by K. Palmer, W.E. Oates and P.R. Portney (Palmer, Oates and Portney, 1995). It is based on the concept of environmental economy methodology and research tools. The discussion by Palmer, Oates and Portney, hereinafter referred to as POP, is focused on a simple graphic model, presented in Figure 2. On the vertical axis there are different levels of pollution reduction recorded, while the vertical axis is intended for the marginal costs of the very reduction and, possibly, for environmental charges incurred for the regulator. The *MAC* line stands for the current behaviour of the marginal costs of emission reduction by one unit, while the *MAC\** line defines their course in the conditions of more rigid environmental standards. Both cost functions are raising, although in the case of the *MAC\** the marginal cost on account of environmental charges translates into a higher pollution reduction. But then again, a shift to the *MAC\** line is linked to higher expenses in a company for implementation of more innovative technologies. Moreover, it is assumed that a company maximises its profit in risk and uncertainty free conditions.

If the rate of environmental payment is  $P$  then at point  $A$ , on the horizontal axis, the pollution reduction level maximises profit. Point  $B$ , on the *MAC* cost function, corresponds thereto, because at this point the marginal abatement cost equals the payment rate. Exceeding this point would stand for a decision of a company that it is more profitable to incur the charges than to further reduce the pollution emission. A shift to the *MAC\** cost function might be an alternative, but it requires additional expenses. This means that the profit from innovation achievable at point  $C$  has to be even higher. The latter equals the area of the *OFCB* shape. But, if a company had not chosen the *MAC\** function, it should be concluded that the costs of a more ambitious environmental orientation would be higher for the company than the set *OFCB* profit.

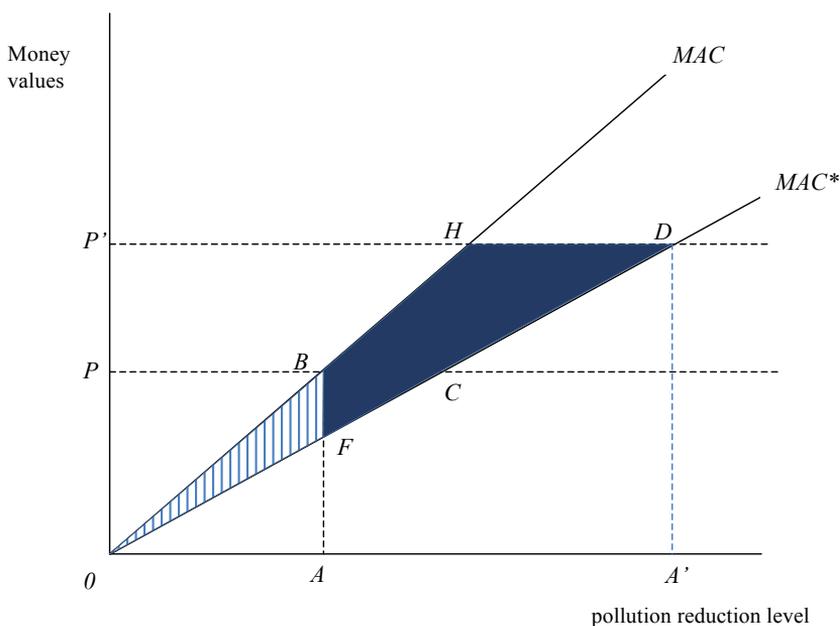
Such a situation can change when environmental standards are made more strict; hence, the option of Porter and van der Linde is followed. This will be manifested by higher payment rate for the use of the environment to  $P'$ . If now the company stands by the *MAC* cost function, it can achieve the  $H$  emission level. Choosing the new *MAC\** cost function it can increase emission reduction even more (the  $D$  point corresponding to the  $A'$  point on the horizontal axis). This would be beneficial in a social dimension, but for a company this would be unprofitable. Because in both cases profits at the two points:  $C$  and  $D$ , are lower than at the  $B$  point.

This is quite understandable, since the marginal cost functions are growing. Despite that, payments for the use of the environment should be treated as a price of the input “pollution emission”. The literature considers it as an equal component of the inputs’ vector. In line with the above, if the prices of the input “pollution emission” grows and its quantity drops (more severe regulations),

then the profit and production have to fall. All in all, there comes a conclusion that more stringent environmental standards result in a drop in profits, even if the companies chose new technologies, more environment-friendly. This is quite contrary to the Porter hypothesis.

It is quite interesting that the POP findings are still valid when moving on to the dynamic approach and introducing the uncertainty factor, and using – instead of present profits the future discounted values. The model would behave according to the Porter hypothesis, i.e. profits would grow along with more stringent environmental regulations if:

- (1) the strategic deliberations had covered the behaviour between companies and the regulator or between the regulators in different countries;
- (2) the companies had found another, not yet recognised, possibilities of improving the financial results.



MAC – function of marginal cost of emission reduction

Fig. 2. Incentives to introduce environmental innovations in the conditions of applying charges for using the environment.

Source: own study on the basis of: K. Palmer, W.E. Oates, P.R. Portney (1995). Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm? *Journal of Economic Perspectives*, vol. 9, no. 4.

Even then the Porter hypothesis would hold its ground quite rarely, usually with rather rigorous assumptions. The issue of Porter's and van der Linde's innovation offsets for implementing environmental innovations needs to be added to that. POP estimated that in the case of the US, in 1992, they amounted to only ca. 1.7% of the total costs of environmental regulations and pollution emission reductions. This account would have to be additionally supplemented with the opportunity costs of expenses linked to environmental protection.

In 2014, S. Rexhäuser and Ch. Rammer published the results of a research devoted to verification of the Porter hypothesis (Rexhäuser and Rammer, 2014). The two researchers assumed that environmental innovations stand for new or significantly improved products (goods or services), processes, organisation or marketing methods, which will provide various environmental benefits in relation to alternative solutions. It was not important, however, whether this benefits were the primary or additional goal of the environmental innovations or at what stage of value-generation chain they were created. For the needs of Porter verification the above-mentioned innovations were divided into four groups:

- induced by environmental regulations and other innovations;
- innovations leading to better efficiency of use of materials and energy and innovations bringing other results.

The empirical material was gathered as a special survey and covered data from 3,618 German non-agricultural enterprises for 2009, but the group covered also food processing companies. Their profitability was measured with the use of return on sales as the quotient of price margin (differences between price and costs) and the obtained price. It was a dependent variable in a precisely ordered probit regression model, also called interval regression model. Apart from the four types of environmental innovations the set of independent variables covered also various types of market, finance, technical and organisational and location characteristics of the researched units. In total, the set included 20 variables. The empirical models, four basic ones and three under robust analysis, were estimated with the use of the maximum likelihood methods.

As Rexhäuser and Rammer openly admitted, the constraints contained in the gathered source material did not allow them to verify the strong version of the Porter hypothesis. Despite that, it would be necessary to divide environmental innovations in a highly detailed manner and to accurately connect them with environmental regulations. The fact that it was the right research strategy was evidenced by their basic conclusion, namely that only environmental innovations yielding better, be it only partial, technical efficiency (the use of materials and energy) were able to improve the return on sales. The result did not depend on whether the above innovations were a response to the imposed regulatory requirements or were they implemented for other reasons. In other words, the costs of adjustments to the statutory standards will not be too heavy a burden for an enterprise, if it continually raises efficiency and productivity. From the above

it does not follow that a growth in efficiency will automatically, fully offset the costs of adjustments, as envisaged by Porter and van der Linde. What is to be rather expected is that more often the weak version of the Porter hypothesis holds good, i.e. the incurred expenses are partly recovered.

Also other environmental economists state that the relations between environmental regulations and competitiveness of enterprises, especially in the international aspect, are considerably more complex than those adopted by Porter and van der Linde. In the context, the following issues are taken up most often:

- No consensus has been reached as it comes to understanding the strictness of the regulations and measurement thereof. Regulations, in the literature termed as “command and control”, the CAC instrument, are only one of several tools to achieve the environmental policy goals with a specified scope of validity and having only a relative advantage over the others in the set conditions.
- Responsible and reasonable use of the CAC requires the regulator to know, e.g., the individual marginal costs of pollution emission reduction and their distribution. Whereas the regulators have problems with structuring such curves even for the dominating groups of emitters under the aggregated concept.
- Environmental standards remain in exchangeability/substitutability relations also with the traditional taxes, especially the tax on enterprises and capital. Consequently, milder environmental requirements may be linked to higher taxes and vice versa. It comes as no surprise that countries use diverse strategies in the field to attract foreign capital. Sometimes they even take part in the so-called race to the bottom, which means a far-fetched environmental liberalism but in conjunction with a wider stream of inflowing capital. The location decisions of foreign investors consider, at the same time, highly extended set of variables, circumstances and conditions.
- The second best paradigm, the transaction costs of using environmental instruments, information asymmetry along with its derivatives in the form of negative selection and moral hazard, the risk and uncertainty, diversity of pollution emissions are among the key factors making, in practice, the actual effects of regulations hard to predict.
- Environmental regulations can have an endogenous character. This circumstance has a major impact on the measurement of their efficiency, both in the convention of partial analysis versus models and simulations in the conditions of general equilibrium, and in short- versus long-term. Thus, it is important whether the research and experiments held are static or dynamic (Endres, 2010; Fees and Seeliger, 2013; Kolstad, 2011; Perman et al., 2011).

### References to the food sector

Environmental issues in agribusiness are a derivative of changing preferences of consumers, which are in turn reflected, above all, in the growth in the per capita income and operations of interest groups (Batie, 1997). In case of the latter it is very difficult to decide to what extent they are directed by the will to correct the externalities and other market failures, and to what extent these are a manifestation of simple rent-seeking behaviours. These encompass various political economy mechanisms, because of which agriculture started to be covered also by national environmental regulations. The interaction between preferences of consumers and interest groups result, after all, in a slow growth in importance of the environmental and sustainable approach in agribusiness to the determinant of the traditional, simple nature protection. If to the above we add the use – in some countries (Canada, the Netherlands, New Zealand) – of the so-called green plans, the impact of foreign countries, environmental self-regulation in agribusiness and companies shifting to more advanced generations of environment management and market- and motivation-oriented national environmental regulations, then Porter hypothesis has a chance to hold good here. It is perfect when the regulated entities have a chance to implement flexible strategies of adjustment to regulation which can make them more profitable, increase competitive advantage and improve the environmental reputation in the environment.

Writing about generations of environment management strategies Batie, differentiates between three cases. The first generation is a case when the regulated entity tries to abide only by the minimum environmental requirements, perceiving them mainly as general costs that reduce profits. In the second generation the case changes slightly, because the company slowly starts to embed the environmental issues into the overall implemented processes. Finally, the third generation economic entities treat the environmental variables as a significant component of building a fairly stable competitive advantage and a constituent of an actual strategy for consumer reorientation and meeting the expectations of other stakeholders. It is the third generation that should be used as grounds for the practical examination of the strong version of Porter hypothesis. To make it even more specific, the following four conditions should be met simultaneously:

1. More flexible, result-oriented regulations should translate into a drop in costs of meeting them and getting the innovation offsets. However, such regulations cause a growth in transaction costs of environmental policy, which will in return result in its mitigation. Therefore, the policy has to accept higher pollution emissions (Permann et al., 2011; Kolstadt, 2011).
2. Information measures minimising pollution emissions are necessary to adequately reflect the *ex-ante* costs of meeting the more stringent regulations.
3. Information on innovations reducing the initial growth in costs on account of the new regulations has to be broadly available to all entities in the given sector.

4. Regulation or even the very threat of its introduction are expedient to continually force the regulated entities to innovation-oriented actions.

The deliberations of E. Alpaya et al. are riveting as they concern the impact of economic integration under the NAFTA and consolidation of environmental standards in the Mexican food sector (Alpaya, 2002). They can be helpful, for example, in the analysis of the effects of the possible conclusion of the Transatlantic Trade and Investment Partnership (TTIP). The aforementioned three researchers applied the profit function to examine its components in the form of induced technological change, price movements and adjustments on the path to achieving equilibrium. Further on, the short- and long-term productivity rates were assessed under a traditional concept and considering the costs incurred for pollution emission reduction in the food sector. It turned out that the productivity growth rate in Mexico was, under both variants, higher than in the US. This conclusion should not be very surprising, because it largely reflects the convergence process, i.e. it is the result of the so-called catch-up effect. The second conclusion is more interesting, though: clear tightening of environmental regulations in the Mexican agribusiness increased its productivity. This is a strong proof that the Porter hypothesis is true. But then, this contradicts the hypothesis of the so-called safe harbour, in line with which the foreign capital, choosing a location for its investment, is driven primarily by cheap labour force and loose environmental standards. After all, upon setting up the NAFTA the American capital continued to flow in a wide stream to Mexico.

As highlighted by S. Ambec and P. Lanoie agribusiness in general, and agriculture in particular, creates varied possibilities to transform environmental restrictions into new opportunities and chances to increase efficiency and productivity, thus competitiveness, in a more sustainable manner (Ambec and Lanoie, 2008). Limiting the discussion to agriculture only, it can be stated that optimisation of technology and processes in crop and livestock production allows to reduce, at the same time, pollution emissions and water use, i.e. costs, and to improve efficiency. Precision agriculture, which should be considered a fundamental innovation, offers enormous possibilities. Organic farming also has a huge potential.

L. Srivastara et al. (Srivastara, Batie and Norris, 1999) approached the Porter hypothesis in a very comprehensive manner. The three economists assumed that changes in the preferences of consumers, actions of interest groups and broadly-conceived technical progress lead to a new institutional structure, which is manifested as understanding ownership rights also in terms of an obligation of regulated entities to internalise, at least partly, externalities. If these are costs, then they cause a growth in production costs due to adjustments to the more rigid environmental regulations. The key method to counteract them is implementation of extensive innovations, which could yield – the already discussed – innovation offsets. This does not have to result in lower profitability of an

organisation. Mechanisms leading thereto are presented in Figure 3. It clearly follows therefrom that an organisation, as a result of Hicks innovations and innovations induced by environmental regulations, has to move from the curve of production possibilities  $PPP_1$  to the higher located  $PPP_2$ . The entire trajectory of the shift covers the stages from point  $A_1$  to  $A_2$ , when although the profit falls but the condition of the natural environment improves, and stage  $A_2 - A_3$ , when both the profit grows and the condition of the environment continually improves. However, it should be noted that the movement along both the curves of production possibilities is equivalent to the existence of competitive relations between profit and the quality of the environment, i.e. the improvement of the latter has its opportunity cost in profit reduction. Therefore, for the innovation offsets to be possible the company has to act in the conditions of full information and overcome the phenomenon of limited rationality of people managing it and, what seems to be the most important, it has to follow the profit maximisation criterion. Otherwise, it may go to point  $A_4$ .

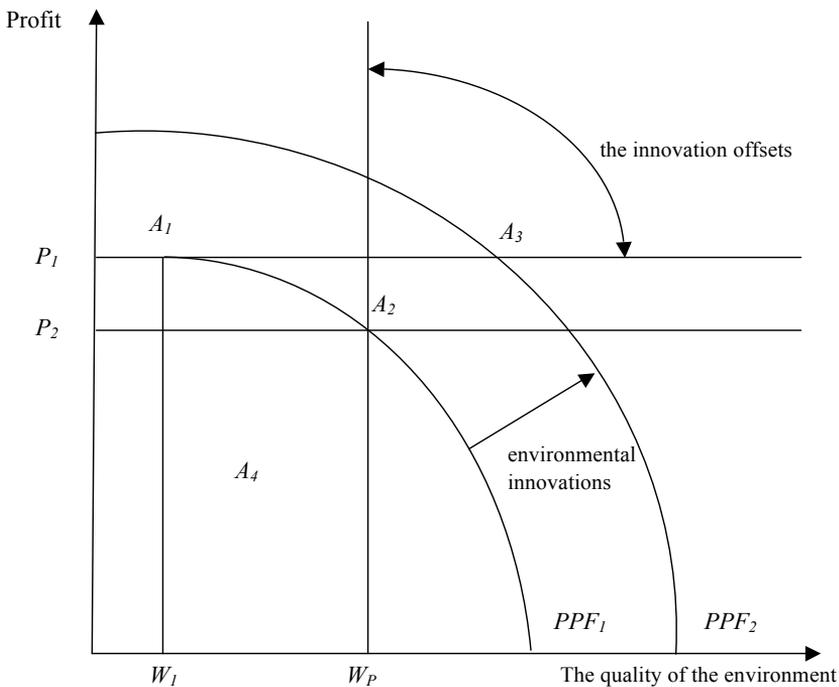


Fig. 3. The essence of the innovation offsets.

Source: I. Srivastara, S.S. Batie, P.E. Norris (1999). The Porter Hypothesis, Property Rights, and Innovation Offsets: The Case of Southwest Michigan Pork Producer, Submitted for the Annual Meeting of the American Agricultural Economic Association, Nashville, Tennessee, August 8-11, p. 6.

A. Ferjani researched the impact of four agri-environmental characteristics per 1 ha in fixed prices (costs of mineral fertilisation and other chemicals, stocking density, cost of energy consumption and purchased feed concentrates) per total productivity of production factors for 152 Swiss dairy farms in 1993-2001 (Ferjani, 2011). Source data were taken from the Swiss FADN. Productivity was estimated via the cost-oriented DEA method and it was presented in two variants: exclusive and inclusive of agri-environmental characteristics, which were treated as the so-called undesired inputs. The geometric mean value of the first Malmquist index for the entire researched period was 1.018, while in the second – 1.021. However, the breakdown of the entire population into six clusters showed that agri-environmental characteristics improved productivity in half of them, but deteriorated to exactly the same extent. On this basis, A. Ferjani stated that there is no strong evidence that these characteristics can increase productivity, but then again the Porter hypothesis cannot be fully overruled either.

A.P. Thurow and J. Holt also dealt with the issues of environmental regulations in dairy farms from Texas and Florida (Thurow and Holt, 1997). The researchers considered that despite varied reservations and restrictions, the Porter hypothesis constitutes an interesting conceptual framework for analysis and perfection of the agri-environmental policy. They, moreover, proved that selective decentralisation of the latter – based on solid scientific facts – would be a much better solution for the process of inducing innovations than the simple centralisation of composing its instruments. As it is clear, this concerns adjustment of environmental regulations to regional or even local differences in conditions of functioning of agriculture. This specific bottom-up approach extends the range of available options of adjustment to the implemented regulations, which affect the behaviour of farmers and specific obligations taken up by them, thus also having a reverse effect on the shape of the future agri-environmental policy. Such an approach creates more stimuli to experiment, fostering policy-induced innovations. Regulations oriented at environmental effects, due to their flexibility and motivation to seek innovations, allow for greater reduction in investment and current costs of the necessary adjustments thereto than the appointment of artificial standards of recommended technologies, maximum emission limits or the best practices. At this point, it needs to be strongly emphasised that distribution over time and composition of all the instruments is very important for the desired actions of farmers and maximisation of the set of adjustment options to the signals generated by environmental policy. A huge challenge is the fact that it is practically impossible to estimate in advance the costs of necessary adjustments. As for the cross-section of the entire agricultural sector it would have been undoubtedly lower if agricultural policy-makers had treated all farm types equally. But, at the same time, small and medium-sized facilities are treated more leniently than large ones, which generally are more competitive and subject to stricter environmental regimes. Such an approach most definitely reduces the sectoral environmental efficiency of environmental policy.

## **Conclusions**

Environmental regulations are a constituent of economic regulations. They consist in involvement of public authorities in encouraging the pollution emitter to act in a socially desirable manner. They can be analysed from different points of view but the paper mostly focuses on their rigidity/severity. Traditionally, we treat them as an additional, undesirable cost, which lowers competitiveness of economic entities and the entire sectors. Porter hypothesis, which elaborates on the Hicks theory of induced innovations, assumes that tightening the environmental regulations should encourage economic entities to use simple reserves of improved efficiency and productivity and to implement more fundamental technological, product and organisation innovations. As a consequence, competitiveness does not have to fall and it can even grow. But in order for this to happen, the very regulations have to be well structured, they should prefer market tools and foster competitive actions. The entire legal and institutional context has to also promote the continuous improvement of efficiency and competitiveness. It is difficult to meet all these conditions at the same time. Thus, empirical research rarely confirms the veracity of Porter hypothesis, especially its strong version. Such a conclusion is also justified in case of the food sector and agriculture itself, which was evidenced in the paper.

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## REGULACJE ŚRODOWISKOWE I INNOWACJE A KONKURENCYJNOŚĆ

### Abstrakt

*Regulacje środowiskowe wpływają na dobrobyt i zrównoważenie organizacji oraz gospodarstw domowych. Według tradycyjnego poglądu stanowią one dodatkowy, niepożądany koszt, który obniża konkurencyjność podmiotów gospodarczych i całych sektorów, chociaż mogą być one pożądane społecznie. Na problem powyższy spojrzeć można jednak inaczej, korzystając z koncepcji innowacji indukowanych J.R. Hicksa z 1932 roku, dalej rozwiniętej przez M. Portera i zaprezentowanej w 1991 roku, nazwanej później hipotezą Portera. Orzeka ona, że firma poddana ostrzejszym regulacjom środowiskowym bywa często zmuszana do wykorzystania prostych rezerw oraz do wdrożenia fundamentalnych innowacji technologicznych, organizacyjnych i produktowych, które w sumie mogą zrekompensować wzrost kosztów przestrzegania zaostrzonej polityki środowiskowej. W konsekwencji jej konkurencyjność nie musi wcale się obniżyć, a niekiedy może wręcz wzrosnąć. Hipoteza Portera została już solidnie podbudowana od strony teoretycznej, ale weryfikacja empiryczna jej prawdziwości wciąż nie jest rozstrzygnięta. Ogólnie dziś przyjmuje się, że sprawdza się ona w pełni (czyli w tzw. wersji mocnej) tylko w niektórych, dosyć rygorystycznych sytuacjach. Wniosek taki, co udowodniono w artykule, odnosi się także do sektora żywnościowego, a w tym również do rolnictwa.*

**Słowa kluczowe:** hipoteza Portera, innowacje indukowane Hicksa, konkurencyjność, polityka środowiskowa, regulacje środowiskowe.

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