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Addressing competitiveness issues over Environmental regulation

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1. Introduction

In the recent years there has been a resurgence of interest regarding the effects of environmental policies on competitiveness. The reason of the debate can be that previously environmental regulation and economic policies were viewed as in opposite. The inherent trade-off between the economic growth and the strict environmental regulation was presumed by the traditional economic paradigm. Nevertheless, there has appeared the contradictory opinion suggesting the possible synergic effect of stringent environmental regulation on economic development. This revisionist view sometimes called *Porter hypotheses* presumes that the possible beneficial influence of the environmental regulation may occur through effect of regulation on innovation. In this sense the environmental regulation might trigger such an innovation, which would discover cost saving and environmentally friendly solutions. Such an innovation would be beneficial both for the firms and the environment. The traditional economic approach usually underestimates the possibility of dynamical qualitative changes introduced by the innovation, thus, induced by regulation.

The aim of the work is to outline how in general environmental regulation can impact on the competitiveness of firms, industries or whole states. The empirical and theoretical arguments are summarised to introduce the reader to the broad topic of the relation between environmental regulation and its possible economic impacts. Later, to expand the revisionist reasoning, the nature of the relation between regulation and technological change is discussed more deeply. Finally, the situation in the Czech environmental regulation is briefly discussed focusing on the environmental expenditures and energy efficiency of the whole economy and single sectors of industry.

The *chapter 1* is introducing the reader to the core issues of the environmental regulation. There is mentioned the nature of the externalities- the external cost in form of pollution and the possible way how to deal with them via environmental regulation. The possible instruments of environmental regulation are being briefly tackled.

The *chapter 2* deals with theoretical description of the possible impact of environmental regulation on competitiveness. Firstly, different definition is being mentioned; because the meaning can differ whether we look at single firms, single industries or whole states. Then, the different theoretical approaches are being described. The Pollution havens and pollution halo hypothesis deals with the possible relationship between FDI and the regulation, Porter hypothesis focuses on the possible regulation impact on technological change and cost

saving regulation and the classical view claims that there will always be significant cost which cannot be disregard. Finally, the empirical findings question the evidence of Porter hypothesis are discussed.

The possible regulation impact on technological change is being questioned in the *chapter 3*. There are mentioned both the theoretical and empirical findings of different types of responses of technological change to environmental regulation. The chapter is also deal with the specificity of R&D investment and various impacts of different types of regulation instruments.

The last *chapter 4* briefly shed some light on the current situation in the Czech environmental regulation and is current instruments. The emphasis is given to the issues of energy efficiency of the whole country and also of the single industrial sectors. The energy efficiency per sector of industrial manufacturing production and its development over the decade is computed. There are identified the energy-intensive sectors, which may be possibly mostly influenced by the environmental regulation imposing taxation of energies.

2. Short introduction to the issues of environmental regulation

2.1 Externalities as a market failure

The economic activity is always based on the cost-benefit calculations of the economic agents. The efficient solution to undertake certain economic decision – to buy and consume or to produce something would occur when the possible benefits would outweigh the related costs. Such a situation would raise the utility of all economic agents involved in the activity.

However, the problem occurs when some costs are hidden and they are missing in the cost-benefit calculations of the agents. It does not mean that such costs would disappear totally – they are just imposed on somebody who is not involved in the action but has to cope with these costs. In the economic literature such external cost are usually named *negative externalities.*[1] As far as the environmental issues are concerned the pollution, depletion of natural resources and overall worsening of the environment represent these negative externalities. When the cost of pollution or resource use are not reflected in prices and therefore they are missing in the internal calculations of the economic agents, market inefficiencies cause excessive production or consumption of products and amount of those activities.

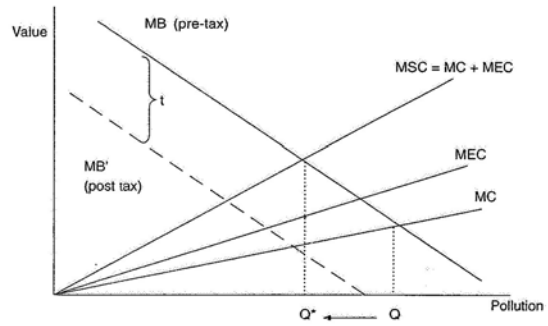
The problem of the negative externalities is the crucial topic for the whole environmental economics which tries to find effective and efficient ways how to *internalise* those external costs, i.e. to place them truly into the price system. The use of the economic instruments is generally preferred by the environmental economists for their cost-effective character. It was already A.C. Pigou who firstly introduced the issue of taxation of the pollution activities – in form of imposing so-called *Pigouvian tax* it in 1928 (???). However until now the main problem of the issue of taxation of the polluters remains unsolved: how big the tax levy should be? In other words: *what is the socially efficient level of taxation*?

The profound debate over this topic is not the goal of this work however the figure 1 can briefly show how the externalities can affect the pricing system and how the socially efficient level of taxation can be attained at the theoretical level. The MC curve represents the marginal private costs, which the economic agent has to bear without any regulation. The level of the production and therefore the level of the polluting activity (Q) is reached were the

[1] The opposite to the external costs there are the external benefits – *positive externalities* when the others which are not involved in the action gain without bearing the costs

marginal cost of production are equal to the marginal benefits from emitting an additional unit of pollution.

Figure 1. **The socially efficient level of taxation**



Source: OECD (2001)

The MB curve can be seen as a marginal benefit from polluting an additional unit but also as a possible marginal abatement cost which we would have to pay if we wanted to restrict pollution by an additional unit. According to this explication the MB curve is assumed to be down-wards sloping because the marginal abatement costs are said to be lower at high polluting levels and later increasing when the pollution level is lower.[2]

In the presence of external costs, the entire costs of production would be represented by the marginal social cost (MSC), which consists of the private marginal cost (MC) and the marginal environmental costs (MEC) that are imposed to the society. Therefore the true optimal level of production would be at Q* where the total marginal costs equal to the marginal benefits.

The Pigouvian solution would be to reduce the level of pollution up to the social optimum level Q* by imposing tax at rate t per unit of production. The tax rate should represent the difference between the marginal social costs and marginal private costs of pollution at Q* (measured by the marginal environmental costs at Q*).

2.1. Regulation as a solution

Politicians and economists usually call for government intervention to solve the problem of market failure represented by the occurrence of externalities. It is assumed that the marketplace cannot provide public goods or handle externalities sufficiently because it leaves

[2] For example with the heat power plant emissions: it is cheaper to decrease the level of pollution by 20 % than by 80% compared to the initial state

the economic agents to calculate with unreal costs and therefore to produce excessive amount of pollution. The government can act using two strategies: through better definition of the property rights or through regulation.

The government could define more clearly the property rights so that all relevant resources are somebody's private property. The stronger and clearer property rights are, the more likely the price system will be efficient (and sufficient) solution. Ronald Coase (1960) showed that the governmental regulation was not necessary if the people influenced by the externality and the people creating it could easily get together and bargain. However, there are assumptions to be fulfilled to attain such a situation – properly defined property rights and zero transaction costs. In fact, to apply Coase's theorem in environmental issues is not very feasible, as we never reach the point of ideal distribution of property rights (e.g. it is impossible to set the property rights of air or water) and apart from that the transaction costs are also never negligible.

Coase also does not deal with the distributional problems of the property rights – to whom will be the property rights given and who will have to negotiate to change the situation. It may happen that after the negotiation the efficient solution with different outcomes can be attained: one part may be paid for stopping the polluting activity (if the property rights were given to polluters and the others would pay them not to pollute). The second possibility of efficient solution is reversed: one part pays for additional polluting unit (if the property rights were given to people influenced by the externality and polluters would have to buy their right to pollute. Nevertheless, the final level of pollution would be different in both mentioned possibilities.

The state regulation can be introduced in the presence of the unclear defined (and definable) property rights. The regulation can be done through the direct environmental standards or by market-based incentives such as taxes, charges, tradable permits or subsidies. Furthermore, the latter market-based incentives are commonly more preferable solution according to the majority of economists because of their non-disturbing influence on the market price mechanism. We will speak more in detail about the different types of policy instruments in the following section.

What effect should have to regulation on polluters? The goal of the regulation is to internalise the externalities, which commonly means to impose additional costs to the pollution producers. Accordingly, regulation may increase the firm's total average costs in the short run (e.g. because of installing new equipment, costs of treatment with the hazardous waste, investing in R&D). It could also mean an exit of the firm from the industry in the long run (as

the previously marginal firm with the average total costs equal the market price now turns into sub-marginal firm). The same would happen not just for the total average costs but also for the marginal costs of production because the regulation is also likely to raise the costs of producing every extra unit of output.

On the other hand, such an external shock as a stringent environmental regulation could decrease the inefficiencies and failure within the firm (X-efficiency argument). According to this, the modernisation and downsizing of the firm due to the strict regulation may push company towards its production possibility frontier and increase the productiveness.

Thus, this implies that research and development (R&D) of a new technology can be also influenced by the direction and the stringency of an environmental regulation. Many economists (e.g. Porter (1995), Kemp (2000)) claim that this should be one of the most important function of the environmental regulation: not only to improve the imperfections in the pricing the natural resources and the harmful polluting activities but also to set the dynamic incentive to both researchers and businessmen to gear the technological change in an ecologically sound way.

2.2. Instruments of environmental regulation

There are several types of instruments used by environmental policy nowadays: traditional pollution standards following the command-and-control measures, economic incentives such as environmental taxes and charges or tradable permit rights and quotas, subsidies or voluntary instruments (e.g. environmental management system and auditing or covenants – voluntary agreement between industry and government).

There is not a single ideal instrument, which would by efficient and sufficient policy tool in all the cases. It is advisable to combine all instruments and benefit from their synergistic effects (Kemp, 2000). The table 1. summarises the main pros and cons of the most important instruments.

While the **environmental standards** can be applicable in most of the cases, their efficiency may be limited. They are form of direct control; their biggest advantage is rather certain outcome as the polluter's compliance is obligatory and often accompanied with sanctions for breach of the standards. On the other hand, the biggest drawback is their inflexibility and static approach. They do not take into account that each polluter faces different abatement cost instead of this they treat everybody with the same measure. They focus only on the present state-of-art but they lack the dynamic incentive effect. Once the polluter reaches the

required limit or standard there is no encouragement for further improvement. Moreover, in the most cases such a command-and-control regulation is technology dictating so that it does not leave any space for new innovative approach.

The **market-based instruments** such as environmental taxes, charges, subsidies or tradable permits represent the decentralised indirect incentive system. The majority of economists favour them for cost-efficiency. In the presence of the bounded rationality the regulator does not know the real abatement costs of the individual firm, therefore the intentions of the regulator are transmitted via changes in price system. The environmental benefits are expected to achieve the abatement costs at the lowest level – polluters will pollute up to the point where the marginal abatement costs (MAC) are equal the *taxes/charges* levied on them. If the cost of abatement activity is less than the emission tax they can abate another unit of pollution. On the other hand, if the MAC is higher than the tax, it is cheaper to pay the tax. Finally, those firms with lowest abatement costs will undertake the most pollution abatement and firms that reducing emissions it in more costly way will choose paying tax.

The similar approach is used in case of *tradable permits*. Here the regulator also does not need to know the real abatement costs of the individual polluters. (S)he just set the desired amount of pollution and than spread within the polluters the allowances to pollute certain amount of tonnes pollution (e.g. of carbon dioxide or sulphur dioxide) per year. The permits can be spread initially for free (grandfathered permissions) or sell them on the auction. The latter possibility can bring some revenue to the regulator, the former possibility rise the problem to whom it should be given. Because for example it is given according to the current situation the less effective producers will benefit from it as they would obtain more allowances to pollute.

Consequently, the polluters start to bargain. Polluters with less effective way of abatement may buy more permits as it is cheaper for them to buy the permit than to abate. Polluters with more effective abatement technique can rise profit from selling their allowances to pollute. They will increase their production on expense of the heavily polluting firms so that the whole production will not need to decrease ,however, the total amount of emissions will not grow or will decrease.

Currently, there are several examples of such trading in the USA, where the cap-and-trade system of tradable rights to emit sulphur dioxide was introduced in the beginning of 90ties. Nowadays, EU is putting in practice the system of permit trading with the emissions of carbon dioxide as a part of fulfilment of Kyoto protocol (we will speak about this later in the

Table 1: Comparison of different instruments

Policy instrument	General characteristics	Where they may be applied
Technology-based standards	▪ Effective in most cases (when adequately enforced) ▪ Uniform standards give rise to inefficiencies in case of heterogeneous polluters	▪ When differences in the marginal costs of pollution abatement are small
Eco-taxes	▪ Efficient – lowest abatement costs ▪ Uncertainty about industry response –danger of weak stimulus ▪ Tax revenues can be "recycled" by lowering other taxes (e.g. employer's social contribution)	▪ In case of heterogeneous polluters that respond to price signals ▪ Possible also for small and mobile sources of pollution
Tradable permits	▪ Efficient and cost effective ▪ The price for trading is unknown thus the costs are more difficult to predict that for taxes ▪ When grandfathered (set for free)there is no state revenue	▪ Same as for taxes ▪ For stationary sources of pollution ▪ Costs of monitoring and transaction should not be prohibitively high. The market to trade the permits should be sufficiently large.
Covenants	▪ Uncertainty about whether industry will meet agreements ▪ There should be penalty for non-compliance ▪ Low administrative costs	▪ When monitoring env. performance is expensive ▪ In case of many polluters
R&D subsidies	▪ Danger of funding second-rate projects ▪ Lowering the uncertainty between regulators and the firms	▪ In case of large social benefits and insufficient private benefits ▪ When markets for env. technology do not exist and when there is uncertainty about future policies

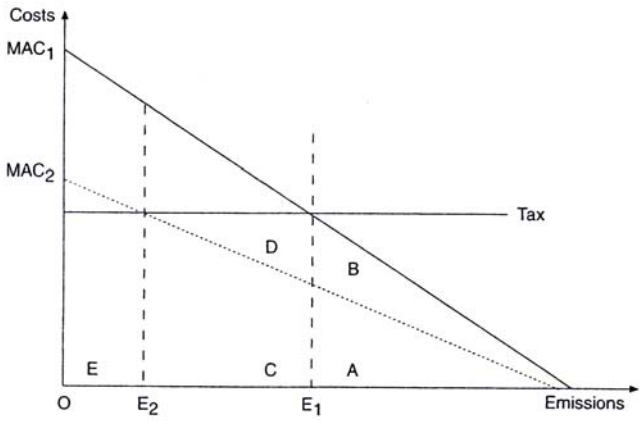
part dedicated to the situation in the Czech republic because the Czech rep. will be also involved in this trading)

Generally, the incentives of the market-based instruments that are transmitted via price system can be beneficial and dangerous in the same time. It is effective to use them in case of heterogeneous polluters that respond to the price signals – especially for recycling and material and energy saving. However, in the same time there is a danger that they may provide too weak stimulus so that the industry response is uncertain.

The market-based instruments differ from the direct regulation in their inherent orientation at the dynamic incentives – they create a continual incentive for firms to further reduction of polluting emissions beyond the set limits. Accordingly, there is constant stimulus for the better polluter's performance.

To compare the influence of static impact of classical command-and control standards and the dynamic efficiency influence of economic instruments we can look at Figure 2. The MAC_1 represents the initial marginal abatement cost curve which is down-wards sloping because the more emissions we try to reduce more we have to pay for abatement. If we impose the tax on certain level, the firm will abate till the point E_1 because the MAC_1 curve is below the tax level. The areas A and B represent the abatement costs, whereas the areas C, D and E show the tax payment for remaining emissions (0,E1)

Figure 2. **The dynamic efficiency of taxes**



Source: OECD (2001)

The technological progress lowers the cost of marginal abatement at all levels from MAC_1 to MAC_2, so that the areas B and D will be always saved. If the tax remains the same it will be profitable for the polluter to reduce the emissions up to the point E_2. The area C

represents the reduced tax payments and area E stands for residual tax payments. If there were applied classical emission standard set at E_1 there would be no incentive to abate more than to that point E_1 because it would not bring any additional revenue to the polluter.

Apart from it, due to the imposed cost, relative prices are changed. This may be partially or fully (it depends on consumers price elasticity) reflected by increasing the consumer prices on goods and services that are harmful to the environment. This encourages the consumers to substitute away from such outputs to other substitutes that are less environmentally damaging.

The advantage of the market-based incentives is also that they influence the non-targeted activities which contribute to the pollution as well (e.g. where there are levied taxes on the coal mining it also influence all other who are using coal as their input). The sum up, those indirect effects, economic incentives will bring gains to the substitutions producing sector and losses to those sectors producing complements and those sectors which are dependent on the inputs from those taxed sectors.

Subsidies are other economic instrument which can be applied e.g. in the case to support the environmental friendly technologies for which the market has no been established yet and which need long-term development. Their impact on the innovation is rather restricted according to the empirical evidence, e.g. Kemp (2000) negatively summarises almost all programs of subsidies in the Netherlands as weak support of the policy of environmental subsidies. They can be applied in case of high social benefits together with smaller private benefits of the producer, however, there is a danger if financing non-adequate projects which will bring just windfall to the subsidy-takers. Commonly, we can also see counter-productive subsidies which are working in the completely opposite direction supporting environmentally harmful activities due to other, especially social concerned reasons (e.g. coal power station subsidies).

The *voluntary incentives* such as agreements between the industry and government (covenants) can be just the additional instrument. However, indeed that those negotiations are also important to facilitate the process. The industry promises to reduce the environmental burden of its activities according to certain targets and time horizon. In case of fail in meeting the targets, they will be subject to regular licensing procedure. E.g. UK and Denmark have offered energy tax rebates (in UK up to 80%) to energy-intensive industry and firms on the conditions that they meet negotiated energy efficiency agreements or carbon dioxide emissions (OECD, 2001). The covenants provide greater freedom and reduce the administrative burden.

Nevertheless, there is a danger of free-rider behaviour of the firms, which would strategically exploit the agreements

Other example of voluntary instruments can be several types of quality certificates. For example certificates rating the total quality of managing the company and its resource use (EMAS : eco-management audit scheme), Eco-labels for environmental non-harmful products or international standards of quality (ISO 14001). All those certificates can help to company to improve its brand and goodwill among its competitors and consumers.

3. Competitiveness and the Environmental Regulation

3.1. The origins of the Concepts of competitiveness

The concept of competitiveness was firstly stressed out in the economic literature in the work of Adam Smith and his Wealth of the Nations. The concept itself was the part of the trade theory -the idea of the competitiveness always went hand in hand with the concept of free trade among the nations. Smith dealt with the idea of *absolute advantage* as the reason for trade – it was the natural endowment as passive factor, which was of the main influence.

The same idea of the passive influencing factors was followed by many others. The most important for the further development of the free trade were the ideas of David Ricardo. His principle of c*omparative advantage* broadened the Smith's intentions. He assumed the economy will always have comparative advantage in some line of production so that there will always be reason for the mutual exchange.

He was followed by others. The extension of the model of comparative advantage was made by Heckscher-Ohlin model assuming that the comparative advantage is based on different factor endowment (labour-capital). Here again, we have assumption of passive factors that the country will export that commodities relatively more intensive in the abundant production factor than the other country.

However, we still speak about the natural endowment as a passive factor. This natural- endowment- feature of these concepts refers therefore more to the sector of primary production such as agriculture or mining of mineral resources. It is also more relevant when we are speaking about the whole economy than of single firms.

Quite different approach chose Michael Porter in his analysis of competitiveness (1990) His model is know as a *diamond model*, where more factors influencing the competitiveness are incorporated: factor conditions which are also incorporated in previous models (such as labour or infrastructure), demand conditions, related and supporting industries and finally firm strategy, structure and rivalry.

According to Porter's view the national prosperity is not inherited by the natural endowment or diversion of capital and labour. The comparative advantage is replaced by the competitive advantage witch depends more on the behaviour of the firm and it can be fostered by the government public policy and the company's own policy (e.g. by the level of the R&D which leads to innovation development)

3.2. Different Definitions and of Competitiveness

The concept of competitiveness becomes nowadays one of the most important prosperity measures. Why is the concept so relevant today? Over the whole 90ties of 20th century, the tendencies of the market liberalisation and the free trade promoted by the international organisations such as OECD, WTO or IMF together with the end of the Cold war broke the traditional bipolar economic concept "W*est*" versus "E*ast*". Now there are just single countries competing on the world's market

The term itself can have broad dimensions that it is referring to. Not only it can be understood on the level of the whole country, but also on the level of the industry and single firms. However, we should have in mind that not in all of these levels mentioned above the term means the same.

On *the Firm level* the concept is easy to understand. Here it refers to the firm's ability to produce and sell products, which are cheaper, and/or of better quality than the rival's ones. At the firm level we can use profitability (e.g. returns on sales, returns on equity), market share or (factor) productivity as proxies for the measure of competitiveness.

The similar approach can be applied for *the Industry level,* here the relative performance between the other industries in the same country or the same industries in the different country is important. The similar measures of competitiveness can be used even here.

However, the different situation occurs on the *level of the state*. The state itself never behaves as a single firm (or industry). On the level of the firm and industry, there always will be both losers and winners. The market power will chose the most successful ones and the losers will go bankrupt. In the case of the industry, other industry may take its place. Nevertheless, countries simply cannot go totally bankrupt, it is social impossible. The country also cannot be a clear exporter – it focuses more on its own production. Here the concept is not so clear. Some economists e.g. P. Krugman even doubt its validity –because if the definition is based just on the trade performance it does not say anything about the productivity of the economy linked with real quality of living standards.

Commonly used definition of country competitiveness was defined in an OECD report on technology policy (OECD, 1992) as:

" *the degree to which it can, under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the longer term*."

Other definition brings also Boltho (1996) who differs between the short-term and long-term competition. In the short term it can be regarded as a real value of the exchange rate and in the long term as a trend productivity rate (p. 6). Indeed, there is a problem to differ between the long term and short term, but it is quite interesting to look at the competitiveness in these two views. A country in the short term can enhance the national competitiveness by depreciating its currency (if there is not binding fixed ex-rate regime..), however, this policy will not be sufficient in the longer period. Appreciation-depreciation policy can simply be crowed out by the same policy of other currencies and more important is that although firms and products become more price competitive as a result of depreciation, the quality performance in terms of non-price competitiveness is not addressed.

When analysing the impact of any regulation – in our case the environmental one- on the competitiveness we should treat carefully these short-term changes in competitiveness due to exchange rate policy. E.g. Jaffe (1995) pointed out that as an ideal measure of regulation effect on competitiveness would be the effect that the policy would have on net exports holding the real wages and exchange rates constant. However, in the real world in such a situation where others variables stay constant is almost impossible. Therefore we have to use more indirect methods as indicators of changes in competitiveness.

In practice we can use several less satisfactory but more practical methods (more in Jaffe (1995) or OECD (2003)). We can look at :

- Changes in net exports of goods subject to more and less stringent regulation
- Shift in the location of production of pollution intensive goods away from countries with the most stringent regulation
- Shift in the pattern of investment away from location with stringent regulation
- Effect on the measured productivity

The following section is dedicated to shed some light to these methods.

3.3. Competitiveness and the Environmental regulation – theoretical approaches

In the recent years there has been an academic debate over the impacts of environmental policy on competitiveness. In general we can differ between conventional economic approach and revisionist view. The conventional economic approach criticises that in general such regulations will impose more costs on production, e.g. for building and maintaining the pollution control equipment. On the contrary, the revisionist view (sometimes called "win-win" view or the Porter hypothesis) suggests that the stringent regulation could be in fact beneficial for the firms themselves and that it could create double dividend: the improvements of social welfare by better conditions of environment as well as private net benefits of the firms through improved competitiveness.

More concretely, there are three possible theories dealing with the impact of environmental regulation (e.g. in Albert, 1998). Industrial-flight and pollution-haven hypothesis. The last possible hypothesis dealing with the impact of the environmental regulation already discussed above is so-called *Porter hypothesis* that assumes that efficient regulation may stimulate innovation productivity and competitiveness.

3.3.1. *Pollution havens and pollution halo – FDI and environmental regulation*

The *pollution-haven hypothesis* questions the possibility whether the differences in the environmental regulation would influence the industry location.. There are two variants of the hypothesis. The "industrial flight" indicates that pollution intensive industries would move their business into the countries where the compliance costs are lower. The other variant look at the less-developed countries and ask if they would use "softer" environmental regulation to attract multinational industries to locate their plants there.

The idea of *pollution halo* hypothesis does not deal with the industry location, it compares the performance of foreign relative to domestic firms. The firms from well developed countries set their business in less developed countries however they already have newer, cleaner technologies and well developed environmental management systems. Commonly, they are also big enough to run further R&D investment compared to the smaller local firms. Such a location of international company therefore can facilitate the diffusion of new technologies and processes. The hypothesis assumes that the domestic firm can learn from them and copy their

performance. Thus consequently, the country environmental performance will tend to approximate towards the level of well-developed countries. However, there is also a contradictory possibility that new incoming firms will not maintain the same standards as they have in their home country and they will derive benefit from the presence of lax regulation.

The importance of FDI flows has grown very significantly during the last decade. The trend was to move FDI from public sourcing towards private sources and to invest more into developing and transition countries. However, the idea to set any global and regional social regulation of investment has not succeeded yet. On the other hand, there is a growing tendency of corporate self-regulation by voluntary systems (e.g. ISO 14000 and EMAS] or company's code of conduct.

Empirically, those hypothesises can be tested by focusing on the international capitals movements and allocation of foreign direct investment. Generally, here the empirical evidence is inconclusive. Therefore there has not been any universal race to the bottom in setting the environmental regulation however some economists argue that lack of global regulatory framework has inhibited a race to the top and caused environmental commitments to be "stuck in mud" (Zarsky, 1999).

Apparently, the differences among the national environmental regulations may not the main determinant inducing the investment decisions. More important parameter for the FDI location decisions seems to be differences in taxation (taxation of labour or corporate taxes), unionisation of labour (Jaffe, 1995) or quality of infrastructure and proximity to markets. Important is also the general stability and atmosphere of the political situation of the country.

Another fact denying the pollution heaven hypothesis is that there is a growing tendency of internationals to apply abroad the same safety and environmental rules as they have in their home country.

It is true that in developing countries there is greater share of "dirty" industry, however, this may be because it is part of their further development it is expected that the income increase will cause the pollution intensity to fall. This relationship is sometimes depicted by so-called *Green Kuznets curve*, which has inverted U-shape. There are number of studies which have found rising emissions in the early stage of development and improving environmental performance in the higher income levels.

3.3.2. *Revisionist view – Porter Hypothesis*

"The properly designed environmental standards can trigger innovations that lower the total cost of a product or improve its value"

Michael Porter (1995, p.99)

The main ideas of the revisionist view were stated in the works of American economist Michael Porter in 1990 (Porter, 1990) and more profoundly together with Claas van der Linde in 1995 (Porter et al., 1995). They opened hot debate among economists, business people and government criticising the prevailing static view, which assumes that there is inherent and fixed trade-off ecology versus economy. Porter and van der Linde assume that the whole previous debate has been framed incorrectly because "policymakers, business leaders and environmentalists have focused on the static cost impacts of environmental regulation and have ignored the more important offsetting productivity benefits from innovation" (ibid. p.97). Consequently, they believe that the stringency of the certain type of environmental regulation can be beneficial for the both environment and companies because it forces the firms to look for innovative cost-saving solutions which are also environmental friendly.

In general, in the revisionist view the time horizon is of great importance. Contrary to static conventional approach the Porter's view stresses out the dynamic approach. In their reasoning they usually mention several endogenous factors, which can defuse or even offset the negative impact of environmental regulation on firms competitiveness. The most important is the influence of innovation, which can come up with the new effective and profitable and environmentally friendly solution.

Porter et al. focus mainly on two important points in their analysis: the nature of innovation and certain types of regulation, which would spark innovative responses. They try to define characteristics of efficient environmental regulation and differ between two broad categories of innovations.

The first type of innovation minimises the cost of copying with pollution. Once the pollution occurs there should be the innovative approaches which intent to turn the resources embodied in the pollution into something valuable (e.g. by recycling, utilisation of by-products).

The other kind of innovation is improving the resource productivity. The core idea behind this is that pollution is costly and it is form of economic waste, too. It is simply a sign of ineffective production. Our goal should be to use the sources more efficiently (e.g. by lowering

energy consumption, material savings, reducing unnecessary packaging). Accordingly, we manage to decrease the costs or even raise further revenues. Porter regards this kind of innovation as more important in the competitiveness issues as he states: "using the resources productively is what makes for competitiveness today" (ibid. p.101).

The concept of innovation offsets is crucial to the Porter's argumentation. The innovation offsets can occur either in *product offsets* (higher quality, safer products) or *process offsets* (increased resource productivity). Porter et al admit that stringent regulation can rise the compliance costs at the beginning, however, "while the potential for innovation offsets may rise even faster…the net cost of compliance can fall with stringency and may even turn into a net benefit (ibid. p. 100).

The debate among economists over the Porter's concept of innovation is quite ambiguous. What does his hypothesis exactly say? Sometimes it is interpreted in two versions (e.g. in Jaffe, 1996). The "*weak*" version of the hypothesis assumes only that regulation places constrains on profit opportunities of firms so that the firms are forced to run their business differently than they would have done without the constraints and this leads to stimulation of certain kinds of innovation. However, these innovations do not necessarily exceed the costs (we will speak about the induced innovation by regulation in 4.1)

On the other hand, the "*strong*" version expects that the regulation induces innovation whose benefits overweigh its cost. Due to the lack of information under normal operating circumstances the firm does not use all the possible opportunities for the new products or processes – this implies that the firms may be operating under its production possibility frontier. The external shock in form of more stringent regulation can force the firm to move towards the PPF curve, which will have positive influence on the firm. This is sometimes called *X-efficiency argument* (e.g. Xepapadeas, A. and de Zeeuw,A, 1999).

Another factor can be the demand-side, where the raised consumer awareness increases the demand for the environmentally more friendly goods (e.g. for bio-products or energy saving appliances). The firms which response quickly to the new consumer needs can obtain profits due to the *first mover advantage*, e.g. R. Jenkins (Jenkins, 1998) mentioned that the competitiveness may be increased if the firm is able to obtain a niche market by producing "greener" products. The product differentiation makes possible to producers to charge higher prices in comparison to less environmentally friendly products. Various certificates of the environmental performance such as "Eco-label" or ISO certificates of quality or environmental management systems (EMAS) are also good examples. There is evidence that such programs have allowed firms to capture market share and/or charge a premium price. Accordingly, we

can expect that the environmental *green image* can have greater importance in the attracting the consumers in the future. (e.g. the company Body Shop can be the example that it is happening now).

If we broader our point of view from the single firm to the whole economy, there is another factor which can contribute to the positive impact on competitiveness. It can also trigger the origin of a new industry specialised in developing environmental friendly technologies, which will become fast growing opportunity to raise great revenues.

This relationship between the polluting industry and the industry specialising in new abatement technologies stressed out for example Greaker (Greaker, 2003). He gives other explanation of so-called weak interpretation of Porter hypothesis. The environmental regulation is supposed to influence different industries that have similar pollution abatement needs. Those industries will therefore demand new abating technologies. This increased demand will positively influence the up-stream market of those producers of abating equipment and technologies. Consequently, the tough environmental regulation will increase the entry into the industry of abatement equipment and environmental R&D. This may lower the price of environmental R& D and make also the polluting industry increasingly competitive because the costs of abatement will be lower.

The country where the clean technology is "good business" is for example Germany, which still has the leading position in supply of clean technologies. The German share of the world market for environmental technologies and services was 17.1% in 1998 – second largest. The first were USA with 20.9% The turnover on the world market for environmental technologies and services was some € 550bn in 1999 (UBA, 2003) Between 1998-9 market growth in industrialised countries was 7%-9%.

Germany or more correctly previous West Germany has a long tradition with the proactive approach of the environmental regulation and protection. Between 1975 and 1989, Government and private sector expenditure on environmental protection in West Germany was € 195bn (UBA,2003). E.g. during 1976-81 the introduction of variable charges for effluent discharge was followed by rapid development of clean water technology – perhaps, this can be regarded as a proof of the revisionist view.

The revisionists do not say that the regulation is good per se. However, they assume that both the companies and the customers are still inexperienced and unaware in the area of environmental issues. Therefore, the regulation can serve as an information mediator creating the pressure on firms to innovate, raising the probability that the innovation will be environmentally friendly, educating companies about their resource inefficiencies, creating the

demand for environmental improvements. Perhaps, we should stress out the possibility of demand-side influence of the regulation impact. The growing consumer awareness can increase the demand for the greener (more environmentally friendly) products. Consequently this could compensate for the increased firm's costs.

On the other hand, indeed, the regulation itself can have negative influence on the firm's innovation efforts. E.g. Porter et al. disapprove of the current system of US environmental regulation for deterring innovative solutions and try to give the condition of innovation-friendly regulation (ibid., p.110) : the regulation should give the clear goals, with flexibility which allows firms to attain their own innovative cost-effective solution (the best available technology approach discourages the innovation). The regulation should use market incentives (e.g. ecological taxes or tradable permits) to create not only the regulation-push but also market-pull situation. Last but not least, the regulation should be better co-ordinated between industry and regulators and between regulators themselves at different levels to make the process more predictable and stable.

3.3.3. *Classical view*

"Responding to environmental challenges has always been a costly and complicated proposition for managers…with little economic payback in sight"

Noah Walley and Bradley Whitehead

(p. 18, 1995)

The traditional economist's view on the positive influence of environmental regulation on the firm's competitiveness is rather sceptical. In general, they do not argue that the win-win situations do not exist at all. However, they assume that their evidence is very anecdotal and does not prove revisionist hypothesis systematically. Accordingly, more common situation is increased environmental spending due the regulation, which impose more costs on the firm production.

Jaffe et al (Jaffe et al., 1995, p.139) focus on the taxonomy of the possible costs of environmental regulation: from the most direct and obvious ones represented by government administration of the regulation (e.g. monitoring, enforcement), costs of the private sector and costs of broader social impacts from the transition period (e.g. higher unemployment due to plant closing and firm restructure).

Let us pay more attention to the costs of the private sector. There can be losses of profits due to disrupted production. Firms are forced to pay for something, which used to be free (waste, pollution). Implementing new pollution abatement equipment is also very costly. Many authors also mention the costs of shifted management focus. Firm's responses to the environmental regulation draw the attention of the managers on other topics, which may not bring much revenue to the firm. Firms would not undertake these actions without regulation because the managerial cost of searching for the new technologies are too high. Therefore, we have to count also with the opportunity costs of profitable actions, which have not been undertaken. On the other hand, non-compliance may have significant costs, too, due to possible fines and criminal enforcement.

We have to stress out that the market structure can also influence the final effect of the firm's costs. Firms operating in a perfectly competitive market with homogenous products will be price takers. Therefore they will have little chance to pass these increased cost to customer by increasing the prices. As a consequence, the impact on the firm's competitiveness may be more crucial. Such companies can end up with reduced profits or even they will be forced to exit from the market.

On the other hand, enterprises operating with some degree of market power (e.g. because they are selling differentiated products, or selling homogenous products within the situation of oligopoly or monopoly) can pass certain amount of additional cost to their customers so that the total impact on the firm will be softer.

To show the example of sceptical argumentation, we can mention the work of Palmer et al. (Palmer, K. Oates, W., Portney, P., 1995) that analyses the Porter's approach critically.

As Palmer et al. depicted in the figure 1., the MAC curve represents the marginal abatement cost function and MAC* curve is the same but of the "innovated" function with reduced costs of abatement. To move to the new MAC* curve, firm has to invest into R&D activities to find an innovative solution.

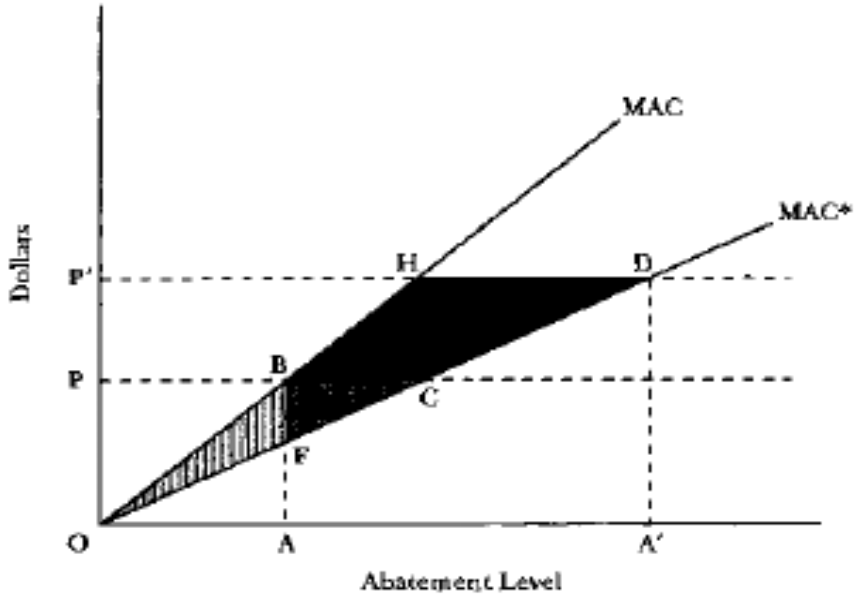
If there is imposed an effluent fee at the price P, the profit maximising firm would abate till the amount of pollution A because he choses its profit-maximising level of abatement activity because there are the marginal abatement costs in the point B that equal to effluent charge. If the firm prefers the "old" MAC function to the new one, it means that the level of abatement at point C would be less profitable than at the point B. In other words, the gains from moving to MAC* (triangle OCB), in other worlds costs of undertaking the R&D would be higher than the possible gains.

The possible gains can be split into two parts. The first part is related to the present level of abating activity (0-A) that will become cheaper under the new MAC*curve. Here the possible gains are represented by the triangle OFB. The second part of the possible gains is related to the increase abating activity due to the lower abating costs. It will increase the abatement level to the point C where the new marginal abatement costs are equal to charge P. Doing this the firms avoid paying the pollution charge on that additional pollution (B-C) that would amount to B-C times P. The real cost in this case would be given by the MAC*. Consequently, the gain in this second part would be triangle BCF.

The total gains to the polluter from the innovation would be the whole area OFCB. If the firms does not choose the option of MAC*, it must be that the cost of the R&D moving firm from MAC to MAC* outweigh the area of possible gains OFCB

figure 3:

The incentive to innovate under an Emission Fee (according to Palmer et al.)



Source: Palmer, K., Oates, E. , Portney P. (1995, p. 123)

Palmer et al. further assume that the increase of the charges would unambiguously impose higher costs on firms. If the firm stays in the MAC, the production at point H would generate lower profits than in B (because it is paying more to abate pollution than under the previous lower effluent charge). Similarly, they expect that the production in D would be more costly than at the point C. Thus, as they state (Palmer et al., 1995, p. 125): "by transitivity, if profits at B exceeds C and C exceeds D then it must be true that the higher effluent charge

reduces profits.. even if it adopts a new technology ". In other words, if the investment into technology was not profitable at the lower level of emission fee, its benefits will not be sufficient to increase firm's gains with the stringent regulation, either.

Furthermore, Palmer et al. say that this outcome will not change even with implementing dynamism and uncertainty into the model. They support their opinion with the US evidence – in the comparison with the annual costs of US environmental compliance, the estimates of BEA (Bureau of Economic Analysis) of cost offsets amount just to 2 percent (1,7mil $ in the year 1992)of total estimated environmental expenditures.

Another argument of the sceptics deals with the ability of the regulators to impose such effective regulations that are necessary for the possibility of win-win solution. The (economical) effectiveness of the regulatory instrument is one of the core determinant, which M. Porter and many others stressed out. For example, Romstad (Romstad, 1998) pointed out that it has to be assumed that regulations are efficient, since if this condition is not met, each empirical rejection of the Porter hypothesis could be based on increased costs from inefficiency of regulation, instead of a direct negative effect of regulations on firm's competitiveness. Thus, the market failure of external cost would be just substituted by the state failure of inefficient bureaucracy.

Jaffe et al. also tackle the issue of so-called negative costs that represent the non-environmental benefits as improving working conditions for the employees. They also mentioned the stimulation of innovation following the same idea as Porter hypothesis.

They admit that "…specific instances of cheap or even free lunch may occur (Jaffe et al., 1995, p.155) They do not rejects that the regulation in some cases can spur cleaner and profitable innovation, provide some firms with the first mover advantage, bring the revenues to the sector of environmental services. However, they conclude (p.157) that "..the literature on the Porter hypothesis remains one with a high ratio of speculation and anecdote to systematic evidence." Finally, he assumes that in fact neither the very sceptical nor exaggerated positive point of view is correct: (p.159) " just as we have found little consistent empirical evidence for conventional hypothesis ….there is also little or no evidence supporting the revisionist hypothesis."

3.4. Competitiveness and the Environmental regulation - empirical evidence of Porter hypothesis

When analysing the impact of environmental regulation empirically we should treat carefully the level of the point of view. It can significantly change the outcome whether we chose the level of firm or industry or compare the whole states. The clearest impacts of the regulation we can see indeed on the single firms. The more general view we take, less visible the results will be, because as was already mentioned the pollution abatement costs do not represent major part of the total spending.

The empirical findings on the firm level we can show on the study of Porter et al. (1995). In this study they introduced the so-called Porter hypothesis, which was already deeply discussed above. They supported this hypothesis by several case studies of firms from electronic manufacturing, pulp and paper, cell battery or refrigerator industries. They found the positive results concluding the general improvements of firm's competitiveness due to: substitution with cheaper materials or improved process efficiency and also due to possibility of charging premium prices and creation of new markets for environmentally sound products.

Of course such case studies of individual firms cannot provide us with the sufficient proof of the positive relationship between regulation and competitiveness. We should move to the more generalised level – on the level of the whole industry. On the more general level of the specific industry we can mention another study, which tries to cope with the methodological problem that the environmental costs do not take significant part of costs and they are mask in the aggregated costs. Albert (1998) stressed out that one of the reason of the poor evidence of the impact of the regulation may be because the used methodology is not optimal – to expect that all industries can suffer significant export losses as a consequence of stringent regulation would be too strong assumption. Therefore he looked only at specific industries/products.

More concretely, he focused on the impact of the introduction of Montreal Protocol on Ozone-Depleting Substances on the main CFC-using manufactures (e.g. refrigerators, freezers, and air conditioning) [3]. He examined the changes in the bilateral trade flows within the years 1989 and 1995. To implement the stringency of the regulation into the model he used the dummy variable taking 1 for USA and Denmark (as countries with stringent and pro-active

[3] Albrecht pointed out that the Montreal Protocol was very suitable for studying such an regulation effect on the competitiveness because there were implemented almost in the same time and similar in many countries – therefore all countries faced similar technological substitution costs.

regulation) and zero for all other countries (France, Germany and Japan that hesitated more about the phase out of CFCs). Such an analysis proved significance of the dummy variable in almost all regressions therefore he found out that at the level of the specific sector final products, the proactive stringent regulation implemented according to the Montreal protocol generated clear benefits. So finally he concluded that there is more than just anecdotal evidence supporting the Porter hypothesis (Albtecht (1998), p. 28).

The crucial study dealing with the regulation-competitiveness issue is the work of Jaffe et al. (1995). It is a broad review of many empirical studies mainly from the US based data. It s great positive is that it tries to summarise all different approaches to this issue starting with the effects on the net exports, international trade in pollution intensive goods, FDI flows, domestic plant location and finally the productivity effects. They found little evidence to support the hypothesis that environmental regulation would have had a large adverse effect on competitiveness (bid, p 157), however, they can neither prove the opposite Porter hypothesis in general terms.

Other study, which brings the broad summary from the one branch of studies, is work of Mulatu et al (2001). They are summarising the regulation impact on international trade using a meta-analysis technique[4], which is operating with the findings of other 13 studies analysing the impact on trade. In general similarly as Albrecht (1998), they also conclude that such an analysis should be based on the industrial level date rather than on the country level.

Interestingly, Mulatu et al are dividing the studies of the regulation impact on trade between the three minor groups according to the approach – in the *explanatory* approach the impact of env. policy is captured by a stringent and non-stringent dichotomy, e.g. between developed and developing countries focusing on the share of "dirty" industry or by revealed comparative advantage (share of a specific industry in a country's total exports as a fraction of the share of the industry in total world exports).

To mention an example of such an approach, e.g. Low and Yeats (1992) made distinction between industrial countries (EEC –10 and North America) and the other countries (Eastern Europe, Latin America, south-east and West Asia) to look at the international trade in pollution intensive goods (between 1965 – 1988). They conclude that the developing countries increased their production in dirty industries and that for example in North America the share of pollution-intensive products in world trade fell from 21 to 14. From the first view this seems

[4] A meta-regression is based on OLS estimation where as a dependent variable is taken a specific effect measure observed in a series of studies dealing with the similar topic. (Mulatu et al. (2001), p. 3)

to be a proof of the pollution heaven hypothesis – however we should have in mind that the whole development path of the country's economy goes hand in hand with the increasing demand for goods of heavily polluting industries. So that such a movement of polluting industries towards the less developed countries cannot be explained only just the regulation impact.

Other approach that Mulatu called *Leontief* approach, is based on comparison of the pollution abatement content of products (as did Leontief in his attempt with the labour and capital intensity). E.g. Robinson (1988) examined the impact of the environmental cost of abatement on the US trade with Canada and the rest of the world for the years 1973, 1977,1982. He found that the US imports of relatively abatement intensive goods grew up from the rest of the world but the trade pattern between Canada and US remained the same (it can be also due to similarity in the environmental regulation stringency). Here raise the same problem as in the previous approach that such a trend cannot be simply explained only by one determinant of the environmental regulation.

To conclude, these two approaches suffer from the lack of conclusiveness (Mulatu, 2001) because they are unable to control for other possible relevant factors.

The last approach of measuring the regulation impact on the trade Mulatu et al. summarise as *econometric* approach which is based on either the extension of Heckscher-Ohlin model or of the gravity model examining the bilateral flows. Here an operational environmental variable is usually added to set of existing variables in the case of H-O model the raising environmental stringency can be seen as barrier for firms right to pollute, hence the firm is loosing its comparative advantage of producing goods. However, again the majority of studies imply no sever negative effect on the firms trade pattern. For example Tobey (1990) examining by H-O framework the 5 pollution-intensive industries (mining, chemicals, steel, paper and metals). The analysis contains trade flows to and from 21 countries in 1975 and found no statistically significant determinant of net exports.

Interestingly, Van Beers and Van der Bergh (2000) use the same Tobey`s data for their gravity test. In their results there is no effect only for the chemicals and steel industry, however for the mining and non-ferrous metal there is a significantly negative effect whereas for the paper industry there is even positive effect. To conclude, it is clear that the chosen methodology itself can also notably influence the results.

3.5. Revisionist versus traditionalist – summary of the arguments and empirical findings

In general, there is no theoretical view, which would entirely describe the reality. There can always be plurality between the different approaches so that it depends more on the valour-attitude of the reader which view will chose. It can be seen as a problem of half-full-half-empty glass of water: sceptics see different reality from the optimist's point of view...

Many **traditional economists** distrust the possibility of situation, which would be beneficial both for business and the environment. They doubt the existence of the free lunch – situation when the innovation and improved production efficiency would offset the increased spending on the environmental issues. Figuratively speaking, they claim that if there were a 10$ bill on the street (in form of such efficient innovation) somebody would have picked it up before.

The traditionalists claim that such a belief can create unrealistic expectations among the managers, which can be even dangerous for the company. Having in mind that the environmental actions are necessary to undertake even with the high cost, they suggest to focus on the weighting the real trade off between the environmental benefits and firm's value destruction value that is likely to be caused by environmental cost. In the sceptical point of view the innovation offsets do not play a crucial role as in the revisionist view. They regard the evidence of the huge innovation gains as an anecdotal and not systematically one.

The revisionists pointed out several possible reasons way the relationship between environmental regulation and the firm competitiveness may not be so negative – or it is even positive one. We can differ between strong version of their arguments (strong Porter hypothesis) where they expect that the regulation induces innovation whose benefits overweight its cost, and the weak version (weak Porter hypothesis) where the regulation can induce some innovation but does not necessarily outweigh the costs.

According to revisionist view, innovation gains from introduction of new environmentally friendly technologies and the gains from the first mover advantage are what can help firms to face the additional production costs. The raised demand for the environmental-friendly goods can also act in the favour of the firm's profits. If we look from the whole economy point of view – the increased stringency of the regulation may give birth to new sector : industry with environmental-friendly technologies which can also help to the whole economy competitiveness.

To sum up the revisionist view: in the dynamic and longer-term perspective the ability to innovate and to develop new technologies and the production approaches is very important determinant of the firm's competitiveness

3.5.1. Summary of the empirical finding and its difficulties

Generally, in the empirical findings, there is no universal relationship between the stringency of the environmental regulation and the competitiveness whether on the state, industry or firm's level. As far as the possible Porter hypothesis, the results are quite ambiguous and they can neither support nor deny it. Thus, presumable we may not expect severe impact of environmental regulation on the competitiveness issues. The simple example proving that the systematic harmful negative cost cannot be expected, we can see at the case of Finland. The Scandinavian countries are known for their environmental regulation stringency, even though Finland has been several times ranked as the most competitiveness country in the world.

There are several reasons for such unclear evidence. The foremost problem is with the poor data availability about the firms and industry performance related to pollution abatement, other thing is the difficulty in defining the stringency of the regulation, which is quite relative term. Apart from this, the difficulty to measure the stringency raise also from the fact that on average the compliance costs take just small part (1-2 % of turnover) of the total cost of production. The last difficulty lies in the low comparability between the different results because the most of the studies differ in methodological approaches, e.g. Jaffe et al. (1995, p.135) pointed out "...it is possible to identify more than one hundred studies potentially capable of shedding some light on the relationship. However, no two of these studies ask the same question or even examine the same problem."

Last thing we should pointed out that most of the studies are examining the data from the period where the command-and-control directives was prevailing way of regulation so that the result mind be quite different if more market based instruments had been used.

4. Environmental regulation and Technological Change

The issue of technological change was introduced to the economic theory by Josef Schumpeter (1942) who described three stages of the new technology development towards the marketplace utilisation. All is beginning with the *invention*, which is represented by the first development of the technically new product or process. Indeed, there are many of those inventions but just certain number of them is patented and further developed into the *innovation.* The innovation takes place when the new product/process is commercialised and it is available on the market. The last stage of the technology change is *diffusion* when the successful new product or process becomes widely spread and available for the increasing number of firms.

Accelerating technological change turned out to be the driving force of the socio-economic development of the 20th and 21st century. It constantly creates pressure on both scientists and businessmen together with politicians to adopt themselves to a new reality. Because what was brand new yesterday become obsolete today. Therefore, the ability to innovate - to keep the pace with the rapid speed of the technological development is one of the core determinants of the firm's competitiveness.

Having this in mind, we should change our static reasoning of the impact on stricter regulation on firm's costs where the costs are just simply growing due to the increase of the pollution abatement activities and look more deeply at the impact of environmental regulation on technological change. In this chapter, we first describe the factors influencing the level of innovation (as regulation, consumers preferences or firm's size). We mention the specificity of R&D investment and its nature of positive externality. And later we introduce reader to some empirical results questioning the influence of regulation on the level of R&D investment.

4.1. Induced innovation and the specificity of R&D investment

What are the conditions for the occurrence of the innovation? For example Ashford (2002) interestingly pointed out that there should be willingness to change, opportunity to change and the capability to change. Willingness is determined by the firm's attitude towards possible changes in the used technologies – therefore it depends how much the firm is *locked into* the current way of production process - and by its risk-awareness to undertake the unknown activity. The opportunity to change is determined both by the "supply pull" which

expresses the availability of a new technology and also by the "demand push" which can be represented by the requirements of regulations or the motivation to possible cost saving and additional profits. The capability of change is finally influenced by the sources available for the investment improvements in the knowledge and skills for finding the cleaner technologies.

How can be the *demand-push* represented by the regulation impact? From the economical point of view the goal of environmental regulation is to induce changes in the price system by making the environmental harmful activities more expensive. If the pollution is more costly, the firms should look for other more effective solutions, which are generating less pollution. or they will work on the production cost efficiency. If there is no suitable technology available, the increased demand for a new solution will act as stimuli for the research and development (R&D) investment of the firms. We can call such a response to the increased regulation as an *induced innovation* (e.g. in Jaffe 1995, Jaffe 2002) because the direction of the research activities is partly determined by the intentions of the regulator.

There can be two ambiguous effects of increased stringency of the regulation on the level of R&D (Ulph, 1998) – apart from direct effect, which is forcing the firm to look for the new cost-saving methods and therefore raising the R&D investment; there may be the indirect effect. If the stringency of the regulation forces the ineffective firms to close down the production or reduce the product output it would therefore reduce the overall investment and also R&D investment. Thus, the level of R&D investment would depend on the firm's ability to face new price conditions

Indeed, the environmental regulation is not the only factor influencing the direction and the level of the environmental oriented innovation activities. The administrative directives in general have the role, but also changes in consumer's preferences and firm's internal effort to capture greater market shares. Another determinant of the level of innovation is also the availability of information flow between universities, scientists and business sector.

Apart from that, the size of the firm may be also important factor. The large firms, which do not face such a narrow budget, constrain compared to smaller ones so that they have more resources to support R&D investment. E.g. Hemmelskamp (2000) in his study of 2,500 German firms concludes that companies with the most environmental oriented innovation were large ones mainly in the primary industries (paper, chemical or wood processing) and in consumption industries (food or beverages).

As far as the R&D investment is concerned, we should mention its important features distinguishing it from other investment (e.g. in plant equipment). The R&D investment is very costly and risky activity and nobody can be sure that it brings revenues. Thus, the risk

behaviour of company's decision making is also important determinant. This high uncertainty about the future return together with intangible value of outcome usually causes that the R&D investment suffer from under-investment. Why the outcome is so intangible?. Commonly, it is new knowledge, which is being discovered, and there is no measure of quantity and quality of such an outcome. It is also rather difficult to exclude others from using it. In other words, its benefits for the whole society exceed the private ones. Therefore, such discovered information can be regarded as a positive externality, which is another factor together with the future uncertainty contributing to the under-investment of research activities.

4.2. Technological responses to the regulation

As was already mentioned, the environmental regulation can be one of the factors, which triggers or at least supports the technological change. The possible technology reactions to imposed regulation can vary form the diffusion of the existing technology, incremental changes in processes, product substitution and finally the development of completely new processes and products – radical innovation (Kemp, 1998).

It is mainly the diffusion of the existing technology or the incremental innovations, which are the most common responses. For example the incremental innovations can take form of so-called *end-of-pipe* technology, which does not change the production process itself. It just "adds" something to the end of the whole process. The real life example can be the catalytic converter used in the car's exhaust to reduce the emission of the polluting substances. On the other hand, as more radical change, where the whole production process is modified, can be seen the *clean technology.* e.g. the use of hydrogen engine instead of petrol engine.

How can technology response influence the firm's cost? The time horizon can play a significant role in this issue. Thus, it is advisable to differ between the short and longer time period. In the short time, to implement end-of-pipe equipment will indeed raise of the costs. The installation adds further costs to the total production cost, however, the adjustment costs of end-of-pipe technologies are relatively low compared to the one of radical change innovations. Such radical changes need to alter entire production routines, apart from that, firms also faces lower technical and economic risk of a potential failure of experiment. It is so-called *lock-in effect, which* makes the changes in the production even more expensive and less easy to implement. In other words the dependency on the current state-of-art determines the future outcome. We can see the example of such a lock in effect in the case of implementation of

vehicles with hydrogen motors. All the infrastructure of gasoline station inhibits any wide quick spread of such new technology.

The radical change needs longer time horizon for its realisation. Therefore it is also the credibility of the regulation, which can have influence – if the firms believe that the trend of the policy will continue for longer period they can undertake more radical action.

As far as the longer time horizon is concerned, which type of innovation can bring the higher revenues? As we said the end-of-pipe technology would just add costs to the production so that we cannot expect any further savings in future. Whereas the radical change rises the possibility of future savings in using less resources and less energy during the production and producing goods of higher quality.

4.3. Environmental Regulation and Innovation – The Empirical Evidence

The relationship between the regulation and the level of innovation is examined in different ways. The level of innovation can be for example defined by the number of patents (Jaffe, 1996) or (Lanjouw and Mody, 1993), or by the total expenditures on R&D (Jaffe, 1996). Other studies do more qualitative investigation by asking sample of firms about their innovative actions (Hemmelskamp , 2000). Another distinctive approach tackling the evidence of induced innovation is focusing on the response to changing energy prices.

The common difficulty which all have to face is how to define the stringency of the regulation. It is hardly measurable and observable because the regulation stringency does not exist in absolute term – it is just more/less stringent to the previous action or to different country. Therefore, to assess the stringency of the regulation we have to use indirect proxies, e.g. expert judgements about relative regulatory stringency (Hemmelskamp, 2000), total compliance expenditures (Jaffe, 1996), number of enforcement actions. Other studies assess the impact on concrete specific regulatory actions on the innovation – e.g. impact of introduction of Clean Air Act regulation in the USA (Burtraw , D. ,Palmer, K., 2002). We can find more concrete summary of recent studies dealing with this topic e.g. in Jaffe (1996). Here we would like to introduce briefly to reader several empirical studies mainly to show the different points of views in practice.

For example Jaffe (1996) in his empirical analysis examines the relationship between environmental regulation and total private expenditures on research and development. In this part he proved the positive relationship between growth in R&D and growth in pollution control expenditures. His second examined relationship was one between the stringency of

environmental regulation and the number of successful patent applications by domestic firms in an industry. However, here he did not find a significant positive relationship. One of the explanations why these results are quite contradictory is that either the induced incremental R&D by regulation is unproductive, or produces results that improve the state-of-art, however, they are not suitable for patenting (ibid., p.18).

Lanjouw and Mody (1993) also come with the similar empirical evidence. In their study they also found that the increases in environmental compliance expenditures lead to growth in patenting of new environmental technologies with one or two year lag.

Interestingly, contradictory outcome concludes Hemmelskamp (2000) in his qualitative and quantitative analysis of nearly 2,500 companies in Germany. In his research he found that the importance of environmental innovation objectives falls as R&D intensity rises. He explains this different outcome by prevalence of end-of-pipe technologies. The incremental innovations, which are attained by using such technologies, do not require huge amount of R&D because usually they build on currently used processed.

More concrete study assessing the impact of a single regulation bring Burtraw and Palmer (Burtraw , D. ,Palmer, K.,2002) in their analysis of implementation of the Clean Air Act in the 90ties in the USA concluding that "there is an ample evidence that allowance trading has achieved cost saving" and that the program also triggered experimentation and innovation through changes in organisational technology and organisation of markets (ibid., p. 25)

They show that by the new regulation of the Clean Air Act there were also influenced not only the final suppliers but also the intermediate industries (e.g. scrubber manufacturing, coal mining companies or railroad transportation) which were competing in finding the low cost compliance strategies for the electricity generating industries. This resulted in price fall of low sulphur coal by 9% (when the sale of low sulphur coal increased be 28%) and fall of the high sulphur coal by 6% (with the 18% decrease of sales) mainly for the improved efficiency of the transport and scrubbers.

Another approach use Newell at al. (1999) that is dealing with the influence of changing prices on the energy efficiency of the set of home appliances between 1958 and 1993 in the USA. They found that great amount of improvements were introduces autonomously, but significant amounts of innovation were due to changes in energy prices and changes in energy-efficiency standards. They further assume that the energy efficiency in 1993 would have been about one-quarter to one-half lower in air conditioners and gas water heaters, if energy prices had stayed at their levels before the energy shocks in the 70ties.

To sum up, there is empirical evidence proving the slightly positive correlation between the level of R&D and the environmental policy. The finding is consistent with the weak form of Porter hypothesis that the environmental regulation will stimulate certain level of innovation. Of course, this policy is just one more parameter for the company's decisions to innovate apart from it other drive can be the (e.g. in Ashford, 2002) (1) motivation to increase the market share and possible cost savings and additional profits, (2) size of the company, (3) firm's risk taking behaviour or the possibility of informational flows (e.g. from universities and research centres), (4) community or public demand for less polluting and safer products and (5) workers demands and pressures (because they want to work in the healthy environment..).

4.4. Innovation and Instruments of Environmental Regulation – the choice of instruments matters

We have already focused on the relationship between the environmental regulation and the level of innovation and R&D. However, we should point out that not all the regulation instruments have the same influence on the development of technological change. In fact, the choice of the instrument may be even more significant than the stringency of the regulation per se.

There are several types of instruments used by environmental policy nowadays: traditional pollution standards following the command-and control principles, economic incentives such as environmental taxes and charges or tradable permits, subsidies or voluntary instruments (e.g. environmental management system and auditing or covenants – voluntary agreement between industry and government).

As far as the possible innovation impact is concerned the more suitable seems to be the economic instruments because they leave the space for finding a new way of solution so that possibly the incremental innovation can easily occur. As was already mentioned important is the dynamic effect of those instruments which creates the constant demand for innovation.. There is also debate with ambiguous results regarding the different influences of different economic instruments. E.g. Greaker (Greaker, 2003) mentioned the opinion that taxes can be more effective in spurring new innovation than tradable emission quotas (permits). The motive can be that with the new innovation the abatement cost may be decreased. This leads to a drop of emission quota prices. Thus it gives less incentive for further innovation. But there are other opinions, which assign the same innovative influence to the tradable permits (mainly the auctioned tradable permits) as to taxes – (e.g. Baker et al., 1998).

The very important issue related to the influence on innovation is the time horizon. If the regulation sets to pressing deadlines for the compliance firms will not have sufficient time to search for anything new and we be pressed to use current "best available technology". In this sense certain pre-announcements that would inform the firms about intended regulation changes and tax increases can help to overcome uncertainty between the government and firms. Therefore firms would be able to make planning for longer time period and to invest into long-term research projects[5]. The voluntary instruments may also help with decreasing the uncertainty. They may promote further diffusion of current technologies as well.

[5] those pre-announcements are used in Denmark, France, Germany or United Kingdom (OECD, 2001)

5. Current situation of the Czech environmental regulation

The Czech republic has passed through the peculiar transition period in which all the economical and social institutions had to be entirely rebuilt. The situation of industrial development in the post communistic era cannot be seen as a continual development due to the numerous exogenous effects of the transition period. As far as the environmental regulation is concerned its impact on the competitiveness cannot be separated from other exogenous effects which influenced the outcome of the environmental regulation – mainly due to the deep industry structural changes, the end of the entire state ownership together with the privatisation phase and the prevailing presence of distorted prices.

The author supposes that would be more useful to chose more qualitative way of investigation into the present situation in the Czech republic. Therefore, in the following sections development of the Czech environmental regulation and its current instruments will be described briefly.

The energy efficiency can also stand for the measure of the competitive ability of the economy, industry or firm. Therefore the we will look on the development of energy efficiency of the whole economy. And we will discuss the factor that can influence this development. In the recent years there has been opened the debate about the introduction of environmental tax reform in the Czech republic. As far as the discussed increase of taxation of energy and natural resources is concerned, author tries to investigate into the development of the industry energy efficiency to detect where the possible effect of the implemented environmental tax would be the most significant.

5.1. Development of the environmental regulation policy from the 1990

In general we can differ between few basic phases of the development of the environmental regulation policy. The initial period of the transition till the year 1997, the EU pre-access period 1998 – 2003 in which the whole EU environmental *acquis* had to be implemented and the recent EU period in which all the previous trends are followed.

The first generation of the new legislation was implemented within so-called "Rainbow program" during the 1990-1992. They created the core institutional basement (laws on waste treatment, air pollution, assessment of the environmental impact). This program also

counted with the implementation of the real environmental taxes – however this idea was not realised.

During the following years the creation of the new laws was slowed down and the attention was stress on making the existing legislative framework working. The whole environmental regulation had mainly command-and-control character, which gave little space for regulative economic instruments.

The environmental policy of the pre-EU period was mainly driven by the current state in the Union because the Czech republic was obliged to make its institutional framework compatible with the EU standards before the accession. The existing laws were changes or there were implemented new ones according to the *acquis.* The following principles were implemented into the Czech legislative system : preliminary caution, prevention, risk reduction directly at source, economic liability ("polluters pay"), joint and differentiated liability, subsidiary, integration, the use of the best available technology (BAT) and cost-effective solutions,

This process was finished in the June 2003. There were given 3 transitional periods for some areas of implementation of the EU standards (areas of waste treatment, municipal water treatment and sulphur dioxide emission of certain number of combustion plants).

In this period the debate started among the experts and politicians over the implementation of more profound ecological tax reform. The law proposal dealing with the ecological tax reform was prepared during the year 2000 and later discussed in the Czech government, however, without further outcomes. The new Czech government, which became to power in 2002 also incorporated the intention of implementing the environmental tax reform into its Program statement. However until now no important governmental action in this from area has been seen.

What would be the goal of such reform? The environmental tax reform is intent to be tax revenue neutral so that the total tax burden should not be increased. The aim would be to increase the existing taxes of fossil fuels (e.g. increase of tax rates for light fuel oil and high sulphur fuel oil, tax rates increase for gasoline and diesel) in the first phase and later accompanied by introduction of new taxes from electric energy.

On the other hand these tax increases should be relieved be lowering the taxation of labour. E.g. Chevassus (Chevassus, 2002) suggests some of such a tax revenue "recycling" : lowering the social contribution both of employees and employers, or to softer the more negative impact for the lower-income group by lowering the social contribution or income tax for the lower-income households.

5.2. Current situation of the instruments of environmental regulation

Currently the system of environmental regulation instruments is composed of both command-and-control instruments, economic instruments in form of taxes, charges and levies and also voluntary approaches such as internationally wide standards of quality (ISO 14 001) or standards of environmental management (EMAS – environmental management assessment system). Currently, within the year 2005 other new complementary economic instrument is being introduced EU wide - and it should work in the Czech republic as well : the tradable pollution permit system which is the part of the fulfilment of the Kyoto protocol of lowering the total world's emission of carbon dioxide.

The command-and-control instruments should be compatible with the EU-level directives. They set the environmental and health quality standards –as far as the area of air, water and soil quality together with the specification of waste treatment and the protection of biodiversity are concerned. If the pollution activity of the company exceed the certain maximal limits of the regulation. The should be penalised according to the amount discharged. However, fees by themselves do not provide an adequate incentive to reduce pollution. For example the maximal amount of the fines are 10 million CZK for waste generation, 5 million for production of various chemical substances 10 million CZK for the air pollution or 50 million for the packaging.

Economy-wide abatement costs could be lowered by a greater use of economic instruments, which are already present in the Czech environmental regulation system. We have already discussed the task of the market-based instruments use in the previous sections – with their several advantages and disadvantages.

The Czech environmental regulation also consists of the economic market-based instruments mainly represented by the environmental charges and taxes. There are four main group of environmental taxes connected to environmental protection, taxation of road transport sector, heating fuels used in energy sector and finally taxation of motor fuels used in transport sector which take the main part of the whole revenues form environmental taxes.

The environmental tax revenues currently take around 6% of total tax revenues. The rates of "typical" ecological charges are in the most cases too small to change consumption and production behaviour; they were introduced mostly to get money for the state environmental funds.

One new instrument is going to be implemented within this year. The Kyoto protocol is going to be put in practice this year. The Kyoto protocol was sign up in the UN conference in 1997 where around 141 participants sign up a document to reduce its emission of carbon dioxide. In total the participants singed up to reduce in total the emissions of carbon dioxide by 5,2 %. Concretely, for the Europe it means the reduction by 7%.The Kyoto protocol became the part of the legal system of EU this year. Simultaneously it was allowed the emission trading system within the European countries. The permits to pollute (to produce tonne of carbon dioxide) were spread among the companies on the national level. It should be spread around the permits to around 12 thousand sources of pollution (436 lies in the Czech rep.)

The Kyoto protocol should be implemented within the round : 1. Period 2005 to 2007 and second one 2008 till 2012. In total, to the system of tradable permits cover 40% of EU emission of carbon dioxide. The industries such as steel, paper chemistry were included.

For the Czech republic : in total there were spread 96,7 mil of permits. They will be spread for free for the existing firms. For the new entering firms it will be auctioned At the moment, the most pressing issue is to implement the EU emissions trading directive by putting in place the necessary infrastructure and by establishing a national allocation plan which is still missing even though the EU wide trading has already started. The actual price for 1 tonne of carbon dioxide emissions is around 16 EUR.

The EU directive requires that a minimum proportion of the permits should be issued free of charge: 95 per cent for the first trading period (2005-2007) and 90 per cent for the second period. The EU emissions trading scheme will cover more than three quarters of emissions in the Czech Republic

Currently, the Czech republic performing below the level agreed in the Kyoto protocol. This however does not mean that we are performing so well. As a starting point for reduction it was taken the level of emission of 1990. Due to the quite radical structural changes the level of pollution decrease because the Czech republic changes the industry orientation from heavy industry to softer one. Therefore now it is on the 91% level of the agreed emission level, which allows to start to trade.

As far as the voluntary approaches are concerned, they also play the significant role of the environmental policy – as supporters of information diffusion and improving the entire relationship between the state and the private sector. Currently, there are about 611 firms certified by standards of environmental quality (ISO 14 001) and around 10 firms got the certification for eco-management audit scheme, which is related to the entire company

governance. Apart from that companies can get the certificate for ecological friendly product. At present, there are around 310 products having these certification. All these certified quality valuation can contribute to the whole company goodwill and help to attract the consumer's attention.

5.3. Economic development and the pollution control expenditures

The fall of the communism worked as an exogenous force to the whole direction of the industry orientation. During the nineties, the average economic growth has been 0.4% per year, with 4 years of recession in this period (1991, 1992, 1997 and 1998). The deepest drop in GDP was recorded in the year 1991 (-11.6%).

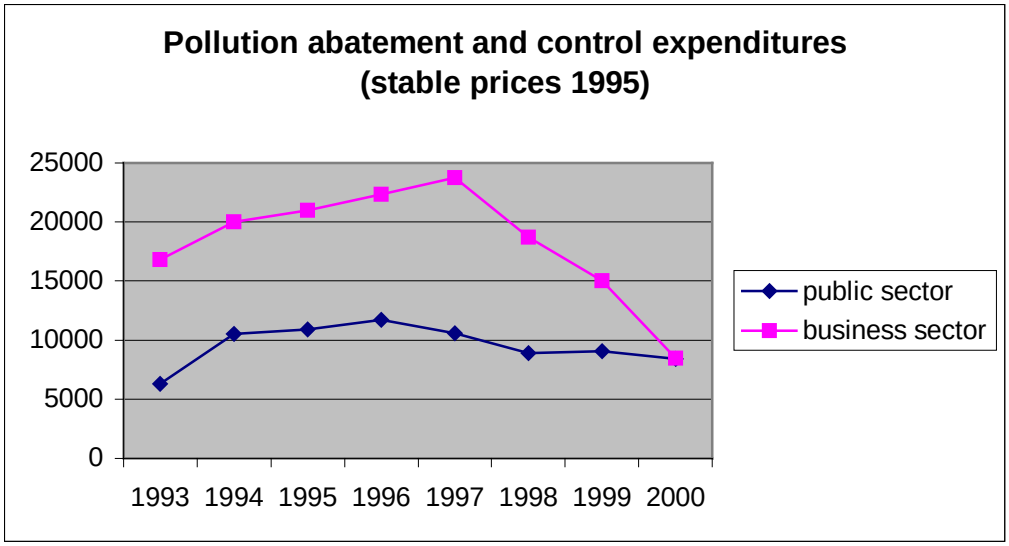
The switch from the significantly pollution heavy industry to the "softer" ones, market exit of the significant number of the ineffective and heavily polluting firms influenced positively the environmental conditions of whole area of the Czech republic. The total level of pollution was decreased. During the period 1990 –99 the emissions of the greenhouse gases decreased by 27% (137,7 mil tonnes per year), the emissions of SO_2 by 86% (265 thousand p.a.) and NOx by 54% (397 thousand p.a.). (Bursík, 2002).

However, this situation is not sufficient state. If we look at the figures comparing the level of emissions to the number of population or GDP production, our level of emissions still exceeds the EU-15 average.

The whole economy started less industrial and more services oriented development with the fast increasing private consumption. Over the whole period 1992-2001, the final consumption of energy decreased at the rate of 0.4% per year due to structural changes in the economy and also due to implementation of energy saving measures in all sectors and fuel switching.

In the first year the investments into the reparation of the old environmental damages and also investment into the new technologies were enhanced. It culminated during the years 1996 –1998. It is clear explanation why those years were so significant in case of investment into the environmental protection. The new environmental regulation that was set up after the break of communism prescribed the tougher regulation emission limits. These binding limits were compulsory to comply by the newly emerged firms till the year 1992. However, for already existing firms the deadline of fulfilling the regulation requirement was the end of 1998.

Figure 4: Pollution abatement and control expenditures



Source: data from OECD (2003)

In this period the PAC (pollution abatement and control) costs took the 2-3% part of the national GDP and they formed around 6 – 8 % of total gross fixed capital formation. The table 1. gives the comparison of PAC expenditures of the public and business sector in the stable prices of 1995. The participation of municipalities and private entities in the total volume of environmental investment has significantly increased (from 27 % in 1992 to approximately 90% in 1998).

The major part of the whole expenditures (e.g. around 38 % in the year 1997) took the expenditures of the sector of electricity, gas and water supply. Namely, they were aimed at the improvement of air quality (desulphurisation, reduction of solid emissions, denitrification of power plants and large heat-generation plants). These radical investment into the electricity generation industry significantly reduced the level of produced pollution – mainly the production of sulphur dioxide (e.g. in 1990 the emissions of SO2 in the sector generating electricity emitted were 1,808 million tonnes whereas in 2003 it was only 0,218 million tonnes of SO2)

After 1999 environmental protection investments were mainly aimed at water quality (construction or renovation of waste-water treatment plants) because the Czech rep. had to implement rather tough water quality standards in EU pre-accession phase.

The second and third sectors with the highest expenditures in the 1997 were the public administration (28%) and manufacturing industry (22%), respectively.[6] Table 1 : Total investments for environmental protection in the real prices

However, those expenditures in the recent years have falling tendency because the main pollution problem were not so striking already and both the firms and state do not have the sufficient motivation to initiate further steps. Another point is that, for example in the energy generating industry there is the investment cycle around 10 – 15 years. Therefore we cannot expect that such similar investment will occur every year.

The ecological approach of the Czech transition – and mainly the privatisation was quite unique and uncommon compared to other transition countries. The part of the privatisation process was also the obligation to deal with the old environmental damages. In this process also the National Property Fund (NPF) had its significant role in providing the financial support for removal of certain number of old ecological damages during the privatisation project of the companies in privatisation.

During the past 14 years (1991-2005) there were set 276 ecological agreements between the privatised firms and the NPF. In which NPF has been obliged to pay the cost coping with the environmental damages up to the level of firm's nominal asset. This process, however, did not finished with the end of privatisation of major part of the economy. Till now, there were only 69 ecological agreement finished with the total cost spent 22 873 million CZK. The total obligation of covering the environmental damages is around 150 billion CZK This will become a cost burden for other institutions as the NPF will terminate its activity in the end of this year (2005).

5.4. Development of the prices of energy

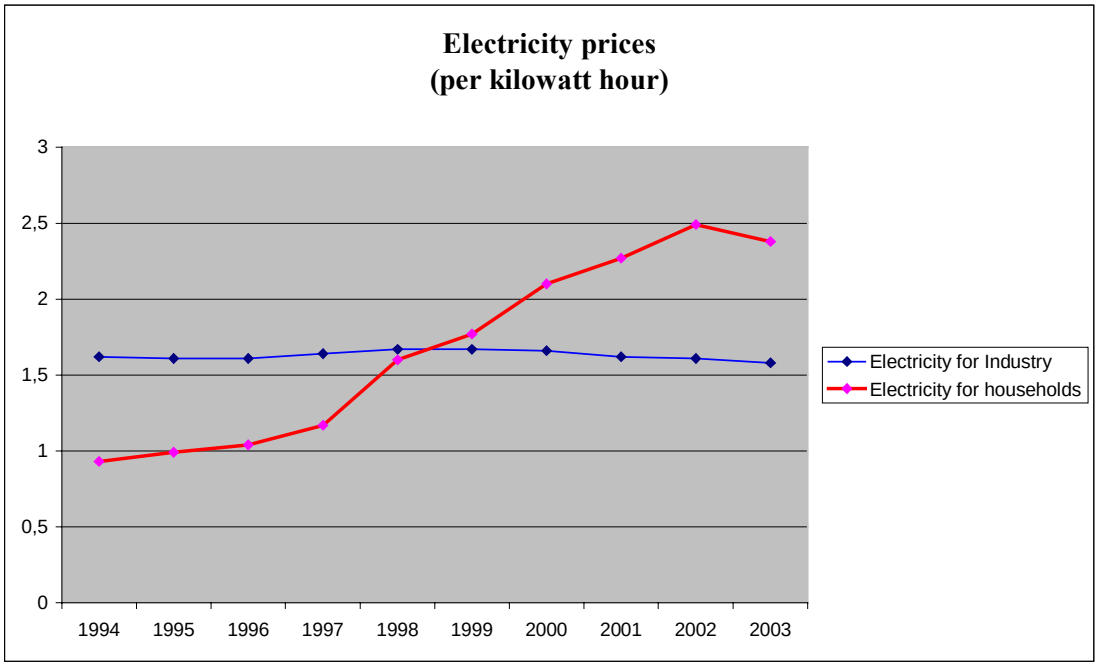
The energy prices for industry and housing were increasing over the whole period 1990- 2003. However, there was slight decrease in the prices for the electricity of industries was reaction on the electricity market liberalisation for large consumers. In case of households the price increase was much faster than in case of industry due to abolishment of cross-

[6] (table 1 in Appendix shows the situation of expenditures more concretely).

subsidies between industry and households in 2002. As a result domestic electricity prices jumped some 15 per cent.

However, the energy prices were still very low during the whole period. Many costs related to the negative impact on the environment have not been internalised during the whole time. Actually, they still worked as quasi subsidies so that it has been the most profitable for

Figure 5: Development of the electricity prices (in real prices)



Source: data from International Energy Agency

producers to use carbon-rich domestic brown coal for electricity generation. Thanks to very low extraction costs, this fuel has remained competitive even *vis-à-vis* natural gas without any production subsidies.

5.5. Energy efficiency

The energy efficiency of the whole economy can be measured by the ratio comparing the primary energy sources consumption to thousand CZK of the gross domestic product at stable prices. Within the years 1990 – 2001 the energy efficiency of the economy was improved significantly so that currently it is being used 25% less energy for unit of GDP compared to the 1990.

Energy inputs into the Czech national economy were permanently decreasing from 1990 till 1994. This falling tendency was stopped in 1995 and 1996, when primary energy sources increase occurred. In 1997, the primary energy sources decreased again roughly on their level in 1995. In 2001, after their drop in 1999 (to 78.1% of their level in 1990), the primary energy sources reached 81.6% of their level in 1990.

Table 2: Development of Energy efficiency and Primary Energy sources

Year	**Energy efficiency of the GDP in GJ/thousand CZK**	**Index 1990 = 100**	**Primary Energy Sources PJ**	**Index 1990 = 100**
1990	1.593	100.0	2076	100,0
1991	1.641	103.0		
1992	1.511	94.8		
1993	1.460	91.7		
1994	1.372	86.1	1684	81,1
1995	1.355	85.1	1749	84,2
1996	1.353	85.0	1823	87,8
1997	1.300	81.6	1745	84,1
1998	1.251	78.5	1659	79,9
1999	1.212	76.1	1621	78,1
2000	1.200	75.4	1657	79,8
2001	1.184	74.3	1693	81,6

Source: Czech statistical office (2005)

Part of the energy consumption changes were also caused “autonomously” by the profound structural changes of the economy where the decrease of energy inputs were influenced by the fall of energy-intensive industries and continual growing service orientation of the economy.

The structure of the consumption of primary energy sources has also changed significantly. The consumption of solid fuels was decreasing over the whole period. Its share of primary energy consumption decreased from 65 % (1990) to 50 % (2003). On the other hand, consumption of gas and nuclear sources went up considerably (from 10 and 6% to 18 and 10% respectively).

The final energy consumption of households followed the similar trend with decreasing importance of solid fuels. Here the change was even more significant. In the

beginning of the transition there was 44% share of consumption in coal and coke (the solid fuels), while the share of gas, electricity and heat on meeting households energy demand was much lower than now (15, 9 and 16% to 40, 20, 21% respectively). Switch from coal to natural gas, electricity and district heat was a part of a general increase of the standard of living and our convergence towards EU standards

5.5.1. Energy efficiency of industry

Industry together with mining industry is a major final consumer of energy in the Czech Republic (about 45%, including mining industry). Major energy carriers used in industry are heat, gas and solid fuels and electricity. Due to structural changes in industry, the structure of energy carriers has also changed in the period after 1990: the share of heat and solid fuels decreased while the share of electricity and oil products increased. The major energy consumption within this sector belongs to the manufacturing (about 78% of final energy consumption), followed by construction (about 17%). About 5% of energy is consumed in mining industry.

We may look at the industry consumption of fossil fuels and electricity more in detail because these energy carriers can be suitable for implementation of economic incentives to influence the effectiveness of their use. The manufacturing industry consumes around 30% of the total fossil fuels (e.g. the coal, gasoline, diesel or natural gas) and about 50 % of total consumption of electricity. The most energy demanding sectors of the manufacturing industry are manufacturing of metals and fabricated metal products with 10 % share on the consumption of fossil fuels and 9,4% on electricity and manufacturing of chemicals and chemical products that take around 4,9% of total consumption of fossil fuels and 9% of electricity.

More than half (54%) of the total consumption of fossil fuels is consumed in electricity generation industry . Electricity generation uses around 35% of total amount black coal and 83% of total amount of lignite consumption..

Manufacturing represents an important resource of the Gross Domestic Product (GDP) creation in any advanced economy. During the last decade it has gone through the significant structural changes. The major structural change in the Czech manufacturing was reduction of the share of primary metals production on total value added (VA) in manufacturing (from 11% in 1993 to 5% in 2003) and an increase of the share of VA in transport equipment production (from 5% in 1993 to 12% in 2003).

The share of branches with higher value added raised at the expense of manufacturing resources and energy intensive branches (heavy industries, metallurgy) or subsections with higher demands on workforce (textile, clothing and leather industries), the structure of manufacturing in our country is step by step beginning to approximate to structures common in European Union.

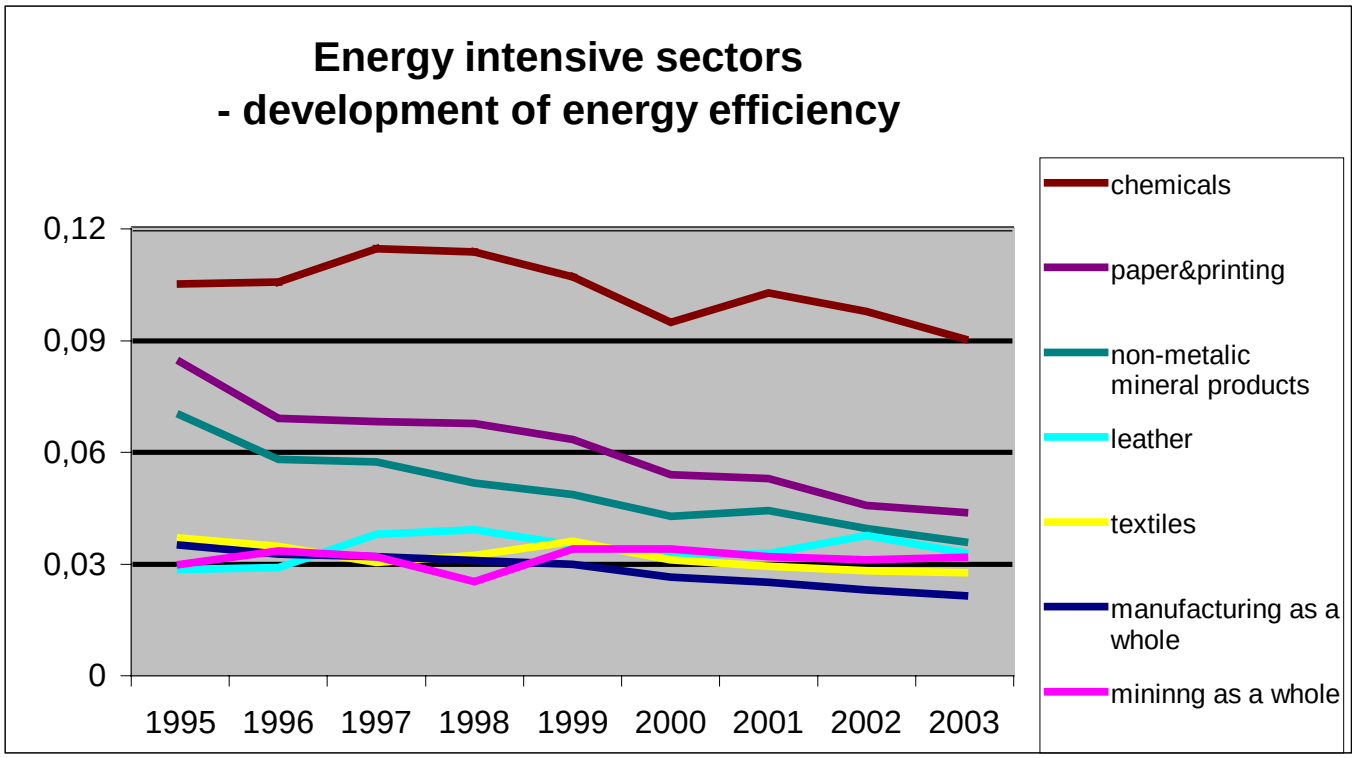
5.5.2. Computation of energy intensity

There are several ways how to compute the energy efficiency of the industry. In general we try to compare the energy consumption to the level of production or value added. We differ between the energy-intensive and energy-non-intensive industries according to their energy demandingness. The definition of an 'energy-intensive business' is expressed e.g. in the EC Directive (EC 2003/96) The EC Directive describes such a business as business entity, where either *the purchases of energy products and electricity amount to at least 3,0 % of the production value or the national energy tax payable amounts to at least 0,5 % of the added value.* (EC 2003/96)

We will use the first definition that compares the costs of electricity and heating energy within the industries with the industry production in real prices for each year in period 1995 – 2003. We will focus on the differences among the section of manufacturing industry using the data from the Czech statistical office and the European Energy Agency. However, we had to use just approximation of prices for heating because there are no official data for the average industrial heating energy prices. Therefore we approximate those prices by the average consumer prices but lowered by 1/3. This difference should represent the additional cost, which are added to the heat generation for regular households. In this case the heating has to be adjusted to certain temperature whereas in the case of industries these final adjustments are made within the firm.

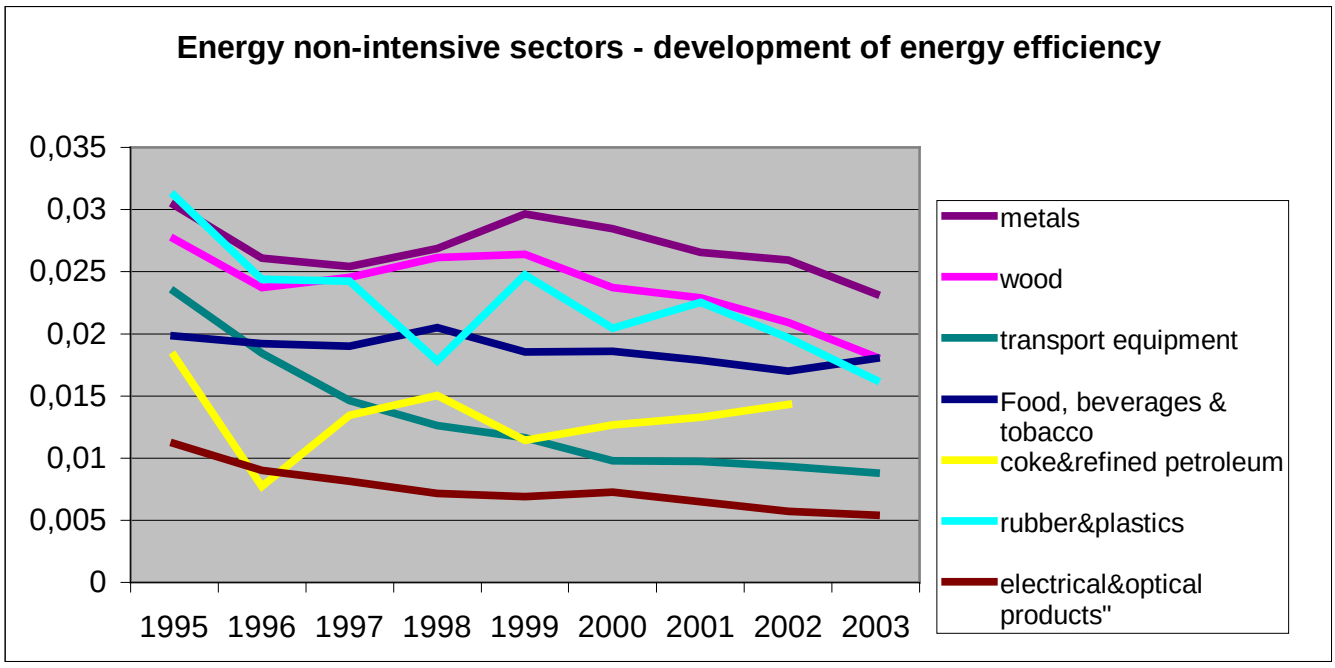
According to our computation we can identify as an energy-intensive industry several sectors of industry. First we will look at the average values of the energy efficiency for the whole period 1995 -2003. Here mining industry as a whole exceeds the 3% limit. The manufacturing industry as a whole has not exceeded the 3% level. However several branches of manufacturing industry were performing significantly above the 3% level. Particularly it was manufacturing of chemical and chemical products with average energy efficiency around 9%,manufactoting of paper, pulp and printing with 6% and manufacturing of non-metallic mineral products with 4,9%. There were several branches that were just around the 3% level as

Figure 5 : Energy intensive sectors : Development of energy efficiency



Source: data CSU with own calculations

Figure 6 : Energy non-intensive sectors : Development of energy efficiency



Source: data CSU with own calculations

manufacturing of leather, textiles ad manufacturing of machinery and equipment. (3,3%, 3,1% and 3% respectively). Last three mentioned are however already performing bellow the limit in the last 3 years.

As a energy non intensive there were identified manufacturing of food, beverages and tobacco, manufacturing of wood, manufacturing of coke, refined petroleum and nuclear fuel, manufacturing of rubber and plastic, manufacturing of electrical and optical products and finally monitoring of transport equipment..

It is also interesting to look at trends of development of energy efficiency among the sectors. In general, the entire majority of sector has significantly improved its energy efficiency. The most significant change by more than 60% in the were in a manufacturing transport equipment. The production of personal cars and automobile equipment became a dominant sector of production and it also represents the core of our export base. Indeed, that this cause the significant demand for improvements of energy consumption within the process

Another very significant changes were in manufacturing of non-metallic products and manufacturing of electrical and optical products. The energy efficiency improved by 50% over the whole period in these sectors. The similar situation was also in manufacturing of rubber and plastic and non-metallic products by 50 % the whole manufacturing industry improved by 38% and the manufacturing of wood improved by 20%

5.6. The current situation and its implication for competitiveness issues

The Czech economy has gone through the deep changes related to the transition period and had to cope with all the imperfections and mistakes of the previous central planned economy. The leading sign of the whole previous system was the endogenous inefficiency given by the absence of the real price system and the private ownership. This imperfections also influenced the situation of the worsening quality of environment. Therefore the initial situation of the environmental issues represented difficult task (e.g. critical situation of polluting emissions in the mining areas of Northern Bohemia, old environmental damages from the era of communism, the low productivity and excessive energy intensity of the economy). The competitiveness issues related to all economic sectors suffered from the same imperfections and general low productivity and the economy.

A part of these problems was solved or improved autonomously due to the profound reorientation of the economy towards less energy demanding service-based economy. However, it seems that most radical changes of the process of restructuring has already finished

therefore we cannot expect more autonomous improvements of the situation of environmental quality.

If we examine the absolute numbers of the level of emission and environmental quality, we are better off compared to the initial state of the transition process. However, focusing on figures related to per capita and level of GDP we are below the average of old EU 15 that signalise the need for the rethinking of the current situation of the environmental regulation.

We are still worse off mainly in case of level emissions related per capita and also in the energy efficiency of the economy and of the individual industrial sectors. For example in the Global Competitiveness report (Esty D.C, 2001) the Czech republic is placed on 65th place next to Romania and Lithuania in case of Energy usage related to unit of GDP where the leading countries are Denmark, Switzerland and Japan.

In the previous sections there were described the trends of energy efficiency more in detail showing the general increasing tendency of energy efficiency. This brings positive signals both to the consideration of environmental quality and also competitiveness issues as the firms would spend less sources in the production process. This beneficial trend of production processed were caused by several factors. The environmental regulation can be also counted among them, however, it may not take the most important part. As a driving force for those changes in energy efficiency is more correct to consider the opening of the economy towards international tough competition and growing inflow of foreign direct capital into the national economy. For example, the most significant change in the energy efficiency was observed in the manufacturing of transport vehicles and equipment. This sector was importantly influenced by the foreign capital investment that was focused mainly on the production of personal cars. Nowadays this sector become highly competitive even on the world market and it is stable driving force of our international trade.

In the case of improving the emission level the environmental regulation play more important role than in the case of energy efficiency. The most visible action was the setting of emission limits for the energy sector which resulted in huge investment into the desulphurisation of power plant mainly till 1998 when was the deadline for regulation compliance. Here the possible competitiveness were probably negative as the amount of investment into environmental protection was very noticeable.

The significance of the factors lowering the emission levels try to investigate Brůha and Ščasný (Brůha, J.,Ščasný, M., 2005) by the econometric model testing the importance of investment on the environmental protection, increases in factor productivity and

autonomous technology diffusion (which can be represented by already discussed restructuring) in the case of manufacturing industry. They find out that the environmental investments significantly influenced mainly the level of particular matters emissions and slightly also the sulphur dioxide emissions. As they conclude that the environmental regulation at least in the energy sector influenced the lowering of the emission levels. Apart form that, also the increases in the capital and labour productivity were important factor in the decreasing of emission levels.

In the section 3.3.1. we discussed views on possible relation between FDI and the environment. The author assumes that in the situation of the transition period of the 90ties can be seen as the example of *pollution halo hypothesis*. Because the increased inflow of foreign capital supported and facilitated the diffusion of new technologies and processes. It also generated higher requirements on the energy efficiency of the processes and productivity of labour force.

The environmental regulation has minor part in this case as the energy prices were not creating sufficient signals for increasing the energy efficiency. In the case of consumers there were introduced changes in taxation rates of VAT taxes of energies and electricity changing the 5% VAT to 22% VAT rate (later it was changes again to 19% due to the Czech republic accession to EU). Whereas the electricity taxation for producers is still missing and it is just the intention of prepared environmental tax reform.

The changes which will also influence the situation in the Czech republic are being introduced by the European Commission Directive (Council Directive 2003/96/EC). It sets the minimum rates of taxation applicable to energy products when used as motor or heating fuels and to electricity. Its aim is thus to improve the operation of the internal market by reducing distortions of competition between mineral oils and other energy products.

The table 7shows the minimal taxation rates which will be compulsory for the Czech republic in the 2008 as a new accession country can apply the transition period for introducing those new taxation without harming the price stability.

Table 3: The minimum levels of taxation applicable to heating fuels and electricity

	Current minimum excise rates	**Minimum excise rates from 1.1.2004 (business use**	**Minimum excise rates from 1.1.2004 (non-business use)**
Natural gas (/gigajoule)	0	0.15	0.3
Coal and coke (/gigajoule)	0	0.15	0.3
Electricity (/MWh)	0	0.5	1.0

Source: Council Directive 2003/96/EC ¨

The directive allow some tax reductions and alleviation to reduce the possible negative competitiveness effect on energy intensive sector. It also allows tax refunds, fully or in part, for taxes paid by businesses that have invested in the rationalisation of their energy use (up to 100% in case of energy intensive business).

In the previous section the author tries to define the energy intensive industrial sectors according to the Directive definitions in case of the Czech republic. The sectors as mining of natural resources, manufacturing of chemicals, paper and printing, manufacturing of non-metallic mineral products, manufacturing of textiles were characterise as energy intensive ones. For them the possible competitiveness impacts may be more significant that for other sectors where the energy consumption related to the level of production takes minor part. However, this competitiveness impacts can be altered by the possible tax exemption. Or by passing these additional costs on the consumers.

6. Conclusion

Our purpose was to introduce to a reader the broad topic of competitiveness concerns of environmental regulation. In general, the work focuses on the three main points. Firstly, it reviews the current theoretical and empirical literature discussing the possible regulation impacts on the firm's cost and the overall competitiveness issues. Then, it looks deeper into the possible regulation impact on technological changes and different types of innovation. Finally, it briefly discusses the current situation of the Czech environmental regulation and its development over the transition period emphasising its implication to the energy efficiency of the whole economy and single industries.

The possible regulation impact on the firm's performance is expressed by two contradictory approaches - the Porter hypothesis and traditional view.

According to revisionist view, innovation gains from introduction of new environmentally friendly technologies and the gains from the first mover advantage are what can help firms to face the additional production costs. The ability to innovate is seen as the core determinant of the competitiveness. The raised consumers attention and their demand for the environmental-friendly goods can also act in the favour of the firm's profits. The increased stringency of the regulation may also give birth to new sector: industry with environmental-friendly technologies, which can also help to the whole economy competitiveness.

The traditionalists claim that such a belief can create unrealistic expectations among the managers. They regard the evidence of the huge innovation gains as an anecdotal and not systematically one.

According to the empirical evidence, double dividend enhancing both the environmental quality and competitiveness cannot be expected systematically. On the other hand, the trade-off between competitiveness and environmental quality aims are also not so severe and significant as is often suggested. There are several reasons for such ambiguity of the empirical results. At first, the data informing about the polluters performance are usually of bad quality and it is difficult to measure the stringency of environmental regulation. Another fact is, that the on average the compliance costs take just small part (1-2% of turnover) of total production cost. Which can be another supporting fact that the possible negative impact of the regulation cannot be very significant.

The revisionist hypothesis tackled the relationship between the environmental regulation and technological change. The regulation can act as a demand-push factor that can influence the amount and the direction of the regulation. Therefore we are speaking about the

induced innovation that follows the direction of regulation. The empirical findings confirm that environmental regulation may be one of the stimulating motives for the firm's decision to innovate. The technology response may vary from incremental changes represented by the end-of-pipe technology inventions which does not change the production process itself or more radical changes, e.g. in form of clean technologies that are possible to decrease the firms cost in the long-run. As far as the different regulation instruments are concerned, generally the market-based instruments are supposed to be more innovation inducing as they give the operation space to the polluter to choose according to his/her needs.

Finally, the situation in the Czech environmental regulation is briefly discussed focusing on the environmental expenditures and energy efficiency of the whole economy and single sectors of industry. In general, this energy efficiency has been improved significantly during the whole period. This was caused by several influences: the autonomous factor of economy restructuring, the new technology diffusion enhanced by the inflow of foreign investment, investment into the fixed capital and possibly also by the environmental regulation

The energy efficiency may be further increased by introducing the taxation on energy and fuel that would incorporate a part of the real cost into the prices. This direction follows the Directive of European Commission, which tries to introduce and harmonize the minimal taxation level on electricity and heating fuels. The work tries to define those industrial sectors they may be most significantly influenced. It compares the industrial purchases on electricity and heating to production value.

The role of foreign investment in the transition period may indicate the evidence of so-called pollution halo hypothesis that was also discussed because it brought new technologies and processes and also increases the pressure on both energy efficiency and labour productivity. The more evident influence of environmental regulation is in the case of setting the emission standards that helped to decrease significantly the level of emissions and also induces the higher investment into the emission control, which was the most visible in case of energy sector.

To sum up, the environmental regulation may help to the firm’s competitiveness if it is able to stimulate sufficiently the innovation forces. However, the current prevailing presence of command-and control regulation give not sufficient space for such innovation. Nevertheless, in general the firm’s costs spent on pollution control and abatement always take only minor part of total costs, therefore the fears of heavy competitiveness losses due to the stringent regulation are mostly groundless.

7. References

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