Doctoral School of International Relations and
Political Science

THESIS ABSTRACT

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Institutional challenges of environmental policy

PhD Thesis

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1. The background and the relevance of the research

In the paper, I will assess what is an effective environmental policy that can reduce environmental pressures while maintaining stable economic growth and the standard of living of society. What kind of institutional framework could contribute to the effectiveness of environmental policy instruments and what kind of new institutional solutions should be developed in order to meet climate targets.

The issue of sustainable development and the need to reduce pollution, to measure it and to develop solutions have already appeared in economic thinking since the 1960s, and even mainstream economic theory has included externality and the issue of public goods its theoretical framework. (Varian, 2010)

Pigou envisioned state intervention, taxation of production and achieving an optimal level of pollution, while Coase proposed a market solution. (1920) The green growth theories, the green Solow model (Brock & Taylor, 2010) stress that if the pace of technological progress in climate-neutral technologies precedes the growth rate of conventional technologies, a gradual reduction of environmental pressure can be ensured in addition to GDP growth. This is in line with Kuznetz's results, the Environmental Kuznetz Curve theory, which concludes that, once a certain level of development has been reached, economic growth and pollution reduction can be ensured simultaneously in the national economy. (Kuznetz, 1955) The question remained open, however, how to promote these processes by means of environmental policy instruments, on what depends on the success of each policy?

I used the concept of the 'impossible trinity' of environmental policy to present the problem of sustainable development. I used this term as a conceptual framework to analyse the necessary trade-offs among the economic policy objectives mentioned before.

In my analysis, I will use the theoretical framework of institutional economics and behavioural economics to examine the institutional means by which the trilemma could be solved. Firstly, we need to explore the efficiency problems of the existing institutional structure. We need to find an explanation to why the steps already taken to reduce current pollution cannot be effective in combating climate change. This approach can be considered novel and it is a little-researched subject of environmental policy. Dasgupta's synthesizing work provides a detailed analysis of the institutions of environmental policy in the literature, in which he provides a

synthesis of environmental economics and institutional approach in the literature. (Dasgupta & De Cian, 2016)

I would like to flash some theories on the relationship between environmental performance and institutional factors, without the need for completeness.

The most important factor in Turnheim's socio-technological approach is the quality of decision-making processes, the role of civil society, the capacity for conflict, the mechanisms of operation of networks, which can effectively help to achieve environmental policy objectives. The authors focus on the actors , organizations and institutional structures outside the government sector. Turnheim et al., 2015)

There is no single position in the literature on the extent to which democratic institutions help to reduce pollution. The nature of governance, i.e. the way in which political institutions exercise power to a large extent, (Kaufmann et al., 2010) also influences the prevailing model of stakeholder management, and how decisive the cooperative strategy will be in the interactions between companies and the government sector. In addition, the stability and predictability of the legal framework creates a favourable institutional environment for investment, thereby facilitating the international positive technological spill-over effects.

Several authors have found a positive link between the stability of democratic institutions and lower environmental pressures in the literature (Neumayer, 2002) (Binder&Neumayer, 2005) (Barrett&Graddy, 2000). (Scruggs & Rivera, 2008 quotes Dasgupta & de Cian,2016)

In my thesis I will analyse both formal and informal institutions. In North's theory, institutions are the rules of the game, while economic and social actors (corporations, organizations, individualities) are the game's players. (North,1988) Institutions may be formal, such as constitutions, laws, property rights, treaties, or informal, such as customs, traditions, patterns of conduct. In my opinion, an effective environmental policy should take into account the potential of formal regulation (environmental law, taxes and quantitative regulations, standards and subsidies) and, in addition, the same emphasis should be placed on informal institutions (consumer behaviour, preferences, corporate behaviour), thereby attaching a major role to behavioural theories in the analysis of consumer and corporate decision-making. If these drivers are understood, environmental policy regulation can take into account the potential of informal institutions and bring about change on the demand side as well as on the supply side.

Existing legal and political institutions, such as the democratic system, democratic channels and the quality of civil society, 'good government', can be an incentive to achieve better environmental performance. Similarly, the need for savings and the tendency to innovate are also determinants of the development of an environmentally oriented growth model.

In my paper I will also talk about the literary debate around the optimal carbon price and its international political economic aspects. I am aspect of the existing aid schemes in terms of the extent to which these support structures can be considered harmful to the environment.

I assume that the demand approach is as important as the supply approach, despite the fact that influencing consumer behaviour is a significantly longer process than introducing a tax. I further assume that, in addition to tax or quantitative restrictions that are negative incentives, it is also essential to maintain positive incentives. For both, however, the economic-distorting consequences must be taken into account. Positive environmental performance should also be taken into account in the restructuring of the tax system, thereby increasing the motivation of the private sector to achieve better environmental performance not only through punishment but also through reward. Government spending should move towards increasing environmental R&D spending, thereby allowing for a cleaner growth trajectory and, in the same way, shifting technological development in the private sector towards more energy-efficient and thus more environmentally efficient innovations.

My research questions:

What is the reason why the environmental policy instruments currently in use are not having the desired effect?

Why can't we achieve uniform international climate regulation?

What factors influence the effectiveness of environmental policy instruments?

What causes significant differences in environmental efficiency in EU countries, despite an otherwise similar environmental policy, partly regulated by Community law?

I am looking for the answer to which factors determine the success of each environmental policy intervention using the available statistical data. In my analysis, I use the toolbox of institutional economics to assess, in a qualitative approach, to what extent do system characteristics (economic and political structures) determine a country's environmental performance.

My hypotheses:

1. Traditional instruments of environmental policy cannot efficiently address the externality problem.
2. The quality of economic and political institutions determines the innovation performance. (The quality of economic and political institutions determines their capacity to create a favourable market environment that kickstarts incentives for private sector R&D activities.)
3. Institutions have an impact on environmental performance through their innovation-promotion role.
4. The environmental quality of EU countries is essentially determined by the innovativeness of the private sector.
5. Tax and subsidies cannot stimulate innovation individually, but only when they are implemented together taking into account the policy synergies.

In my paper, I will first assess the effectiveness and optimisation possibilities of formal institutions, and then I will examine the possibilities for the global institutionalization of environmental policies. At the conclusion of the chapter on formal institutions, I will present the extent to which the environmental policy stringency indicator correlates with environmental performance and, if there is no robust correlation, what may be the reason. Finally, I will study the role of informal institutions in developing an effective environmental policy. My aim is to point out the efficiency problems of the instruments currently used, in a critical approach, embedded in an institutional framework and give suggestions.

In my empirical research, I aim to explore the link between institutional stability, innovation and environmental performance.

2. Methodology and the theoretical framework

In my hypotheses, I rely on theoretical models. In the conceptual framework I have incorporated and applied the already well-known literature on green growth, innovation and institutional economics to assess the existent environmental policy instruments in order to identify potential efficiency problems and making proposals for solutions. My assumption, which I would like to

demonstrate, is that the preconditions for green growth are created by the efficient functioning of the economic, political and legal institutions.

Institutions can provide improvements in environmental performance by creating an environment that stimulates innovations and ultimately impacting the improvement of environmental indicators through an increase in the innovation performance of the private sector. I have examined theoretically the institutional mechanisms of each environmental policy instruments and the mechanisms of action through which they can make a difference in the behavioural mechanisms and structures of the supply and demand side.

With a stable political institutional system, as market competition is institutionalized, stakeholders can effectively assert their interests both through interactions between market participants and through democratic institutions. Economic rationalisation and the growing environmental awareness of the demand side can create the potential for environmentally efficient growth.

I intend to confirm my first four hypotheses both theoretically and with empirical research.

I examine my fifth hypothesis in a theoretical approach and by assessing the cost-effectiveness of each environmental policy instrument in a microeconomic and institutional economics approach.

In my paper, I combine quantitative and qualitative analytical tools. I consider it essential to elaborate a qualitative analysis of the existing institutional system and possible institutional changes relevant to the effectiveness of environmental policy options. In addition, I intend to use quantitative methods to test the robustness of the relationship between environmental policy stringency and environmental performance, and to find a link between environmental performance and other economic factors.

In order to measure environmental policy standards, the so-called Environmental Policy Stringency has been quantified in several different ways in the literature, approaching the interpretation of the rigours of environmental policies on several sides.

In my analysis, I will use the OECD-developed EPS (Environmental Policy Stringency) indicator to measure environmental rigour and will examine the correlation between this indicator and the environmental performance.

The OECD EPS indicator measures the standards of environmental policy in each country. The multi-factor indicator includes both market and non-market instruments. Among the market

instruments are taxes, emissions trading, feed-in subsidies (Feed-in-Tariff) and assesses the glass redemption system. It calculates with environmental standards (emission standards) and R&D subsidies among non-market instruments. (Botta & Kozluk, 2014)

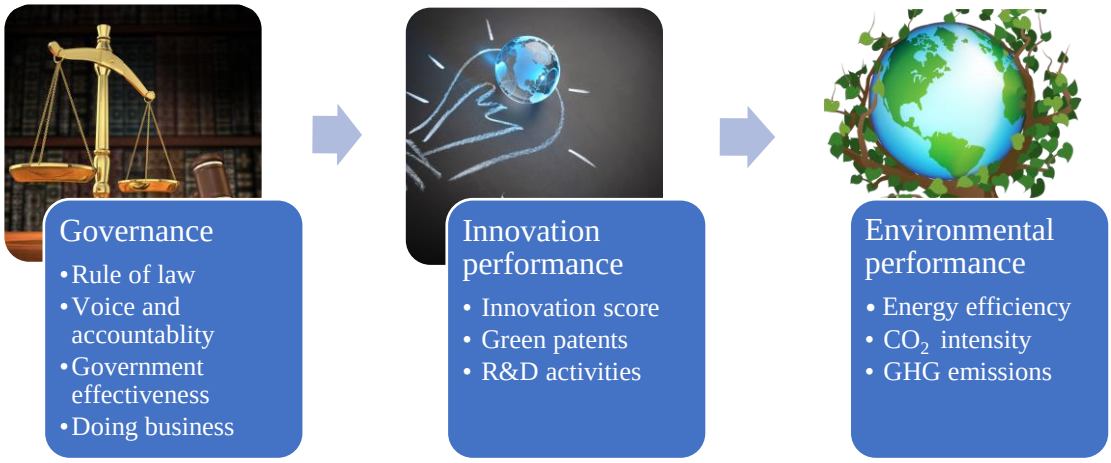
In my statistical analysis, I will examine the relationship between institutional factors, innovation and environmental performance.

Institutional characteristics are incorporated into the model as an explanatory variable. Their quantification is very difficult. The most obvious is the use of World Bank's Worldwide Governance Indicators (WGI), from which I will use indicators of rule of law, voice and accountability, regulatory quality and government effectiveness. I will also examine how public policy makes it easier for businesses to operate, based on the World Bank's Doing Business report. There are a number of indicators that we could incorporate into our model, but their robustness is doubtful, which is why I have chosen the statistics compiled by the World Bank, while acknowledging that all indicators are "soft".

In my empirical model the intermediate variable will be innovation performance, which I measure with the following indicators: world bank innovation ranking, number of patents, business R&D activity. The result variable is environmental performance measured by GHG emissions (in CO_2-equivalent) per capita as a share of GDP and production-based CO_2-emissions (greenhouse gas emissions) and CO_2-intensity. I chose carbon dioxide emissions as a dependent variable taking into account that many theories exist which would introduce a global CO_2 tax, or other policy measure equivalent to it, in order to internalize the externalities. In my thesis I would like to contribute to the huge debate on possible new global institutions of environmental policy (the Nordhaus-Weitzman debate). In addition, I will examine the possibility of integrating the change in energy efficiency and the share of renewable energy sources in environmental performance indicators.

There are a number of analyses published in the literature to study the relationship between democracy and pollution discussed in the literature review. I would like to refer here to Dasgupta's synthesizing study, in which he summarised the indicators used in the literature analysing environmental economics from an institutional point of view. (Dasgupta,2016) Dasgupta points out that although environmental economics literature is very broad, there is currently a lack of empirical research in examining environmental performance through the impact of institutions on innovation , not only by measuring CO_2 emissions, but also taking into account energy efficiency.

The model aims to explore the following relationships between variables:



1: Contexts examined in the empirical analysis, Source: Author, (illustration: Microsoft Word built-in images)

Using World Bank data, I will create a governance composite indicator to estimate the quality of the institutional environment. Each indicator: legal order (1), voice and accountability (2), government effectiveness (3) and regulatory efficiency (4) will each be weighted at 25%. In a cross-sectional analysis, I will additionally use the Doing Business indicator (as there is not enough data from the latter indicator to perform a time series analysis).

I have carried out a multifactor analysis to assess the relationship between political institutions and innovation performance and quantify the impact of innovation performance on environmental performance. Among the innovation indicators, I chose for my analysis the number of green patents, the proportion of green innovations in total innovation and the R&D performance of the private sector. I used the World Bank's innovation rankings for the cross-sectional analysis. Among environmental indicators, CO_2 intensity indicator, as well as the CO_2 emissions, the per capita greenhouse gas emissions as a share of GDP and.

My hypothesis stems from the realisation that the Environmental Policy Stringency Index (EPS) does not correlate with the environmental performance. Even if there's some correlation, it's not a robust one. If environmental performance is not determined solely by the environmental policy instrument system, then there are other factors that influence the success of the implementation of environmental policy.

The study will be carried out in the EU28 (including Britain) as well as norvégia and Switzerland. I have an inkling that, even among countries with very similar economic and political structure, there are substantial institutional differences that explain the differences in environmental performance.

3. The reasoning of my hypotheses

3.1. Traditional instruments of environmental policy cannot efficiently address the externality problem on their own

I used the OECD environmental stringency indicator, as described in the methodology, to measure the combination of environmental policy measures. When measuring environmental performance, I used CO_2 emissions as a proportion of GDP (GDP in purchasing power parity on 2015 basis) and productivity-based CO_2 emissions.

The analysis of the data shows that the EPS indicator does not strongly correlate with CO_2 emissions data. If we look at the relationship between EPS and CO_2 emissions in a given year (2012), the R^2 indicator will take a value of 0.174. If we compare the EPS indicator for 2012 with the CO_2 emission data of 2017 the R^2 will be of 0.165.

Relationship between CO_2 emissions and EPS indicator

Model Summary

Model	R.	R Square	Adjusted R Square	Std. Error of the Estimate
1	.406[a]	,165	,121	,05499

a. Predictors: (Constant), EPS 2012

22: Model summary of the relationship between CO_2/GDP in 2017 and EPS in 2012 in SPSS.

A similar result (R^2 of 0.011) is obtained when linear regression is performed on the CO_2 intensity of production and the EPS indicator, calculated as EPS 2012 and 2017 productivity-based CO_2.

This concludes that the quality/nature of the formal environmental policy institutions in the countries included in the analysis is not the main determinant of environmental performance.

3.2 The quality of economic and political institutions determine the innovation potential

I assumed that the stability of economic and political institutions would have an innovation-enhancing effect by launching investment promotion mechanisms in the market environment. To measure the stability of economic and political institutions, I have prepared a composite indicator with a weight of 0.2 for the following variables: rule of law (rule of low), government effectiveness, voice and accountability, regulatory quality, and Doing Business ranking.

I wanted to analyse the relationship between institutional stability and innovation for the countries listed above. I measured innovation with the Global Innovation Rankig scores. I did a cross-sectional analysis for 2016. On this basis, I have received the result that the R^2 indicator is 0.73, which suggests that institutional quality has an explanatory power for innovation not only in comparison between developing and developed countries, but also among developed countries.

Model Summary

Model	R.	R Square	Adjusted R Square	Std. Error of the Estimate
1	.855[for]	,731	,722	1.39186

a. Predictors: (Constant), governance

3 3: Relationship between Governance indicator and innovation, SPSS analysis

The figure below shows the extent to which the value of private sector R&D investment as a share of GDP determines greenhouse gas (GHG) emissions. We can see that the actual observations are in the line of linear regression. In the case of GHG (greenhouse gas) emissions as a share of GDP and private sector R&D investment, R^2 indicator is of minus 0.7. Therefore there is a clear negative correlation between the increasing level of private sector R&D activities and greenhouse gas emissions.

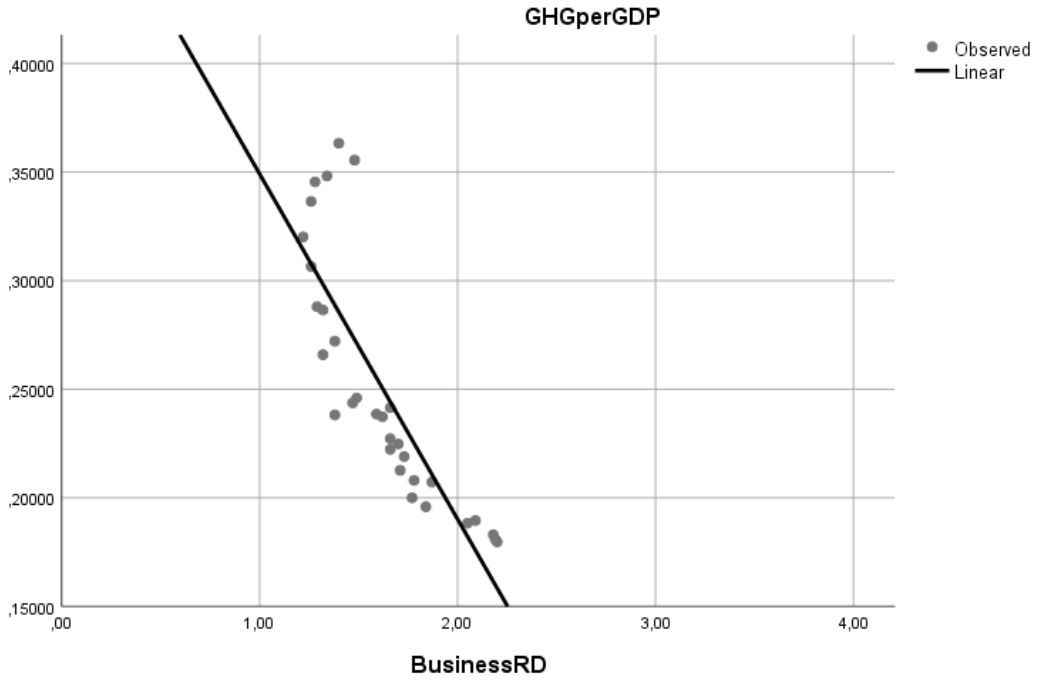


Figure 4: Link between private sector R&D investment and GHG emissions, Source: author'compilation based on OECD data, analysed in SPSS

3.3 Institutions have an impact on environmental performance through their innovation-enhancing role

After examining the theoretical framework, I have come to the conclusion that institutional frameworks play a decisive role in the innovativeness of a country and , through innovation-promotion, formal and informal institutions can enhance environmental efficiency. In my empirical research, I wanted to analyse the correlation of these factors, limiting my study to formal institutions, since the quality of informal institutions cannot be examined with time series statistics.

I included the following variables in my multifactor time series analysis:

- Independent variable: Governance composite indicator (or I tested the relationship for each component individually)
- Intermediate variables: private sector R&D investment as a share of GDP and the number of technological innovations
- Dependent variables: GHG emissions as a share of GDP, CO_2 intensity of production and the share of renewable energy production in total energy production.

I encoded the sample of countries according to whether they are EU15 countries or new Member States or candidate countries or developed non-EU European countries. I grouped the time series data, and formulated clusters based on this. Finally, due to the lack of data and the outlier nature, Ukraine and Turkey were not included in the analysis, so no candidate country was included in the final sample and Britain was included in the EU15.

Due to multicollinearity several variables had to be merged (in order to resolve the governance indicators, i.e. a composite indicator with a weight of 0.25 on indicators of rule of law, regulatory quality, voice and accountability, and government effectiveness, and among the intermediate variables, private sector R&D investment had better explanatory power explanatory, so I kept that one.)

The R^2 indicator for the overall explanatory power of the model was of 0.783 .
It is interesting to observe (although it is actually a logical observation) that in case of new member states there is a breaking point in the years around the date EU accession, i.e. there is a significant improvement in both governance indicators, innovation performance and environmental performance. This can be attributed to the fact that during the years of preparation for the EU accession and after accession, the implementation of *the aquis communautaire* and economic restructuring took place. This recognition does not weaken, but rather supports, the hypothesis that formal institutions, economic-political institutional stability, facilitate the transition to a more environmentally efficient development path.
I also examined the relationship between the impact of government R&D incentives on investment and environmental performance.

Essentially, government R&D incentives have six government efficiency indicator, but there is less strong link with environmental performance.

By contrast, private sector research and development activity showed a robust negative correlation with GHG emissions (-0.837 Pearson index). There is also a strong positive link between the legal system and private sector innovation activity, as the Pearson indicator in this case is of 0.658.

With regard to the savings rate, although it has shown an increase in most of the observed countries after the 2008 economic crisis, the analysis also showed that there is seemingly no correlation between savings rates and environmental performance. In the linear regression analysis, the ratio between the savings rate and GHG-to-GDP was of an 0.019 R^2 and the R^2

ratio for the value of renewable energy sources as a proportion of total energy production was of 0.004. On this basis, we cannot support the possible assumption based on the Solow model that marginal propensity to savings will determine the possibility of making environmentally efficient investments through capital accumulation.

The model has a reliable explanatory power in comparison between the EU-15 and new member states, as the change in governance indicators for the latter group of countries is an even greater predictor of innovative private sector performance and environmental efficiency.

On the basis of the empirical of analysis, it has been confirmed that economic and political institutions play a decisive role in creating market incentives for companies. Government R&D incentive policy and the introduction of negative environmental incentives do not appear to be able to significantly reduce air pollution, while the private sector innovations and private R&D investments have a major contribution to reducing pollution.

On this basis, I see my hypothesis as justified, with the restriction that for several indicators, which I had to omit) sufficient data was not available, so it was not possible to carry out a more complex analysis.

Summing up these considerations, we can conclude that the efficient, predictable and transparent functioning of the economic and political institutional system promotes innovation and, consequently, the uptake of new, more efficient green technologies, which will improve the competitivity of the national economy and provide an opportunity for more cost-effective and environmentally efficient economic growth. The functioning of democratic institutions, the good governance, is a prerequisite for innovation. There is a positive link between the composite governance indicator and the innovation performance, as well as between innovation performance and environmental efficiency. My hypothesis, assuming that institutional stability determines environmental performance to a greater extent than environmental stringency seems to be justified. This means that environmental policy instruments can only function efficiently if the economic and political institutions themselves are functioning properly.

This may be one of the reasons why an effective international environmental regime has not been established yet.

Due to substantial differences in the institutional framework, (good) governance practices between developing, emerging countries and developed countries, I do not consider the formation of a global environmental regime viable. (In addition, differences in economic

development level and economic structure should be also highlighted with regard to developing-advanced dichotomy)

The bilateral climate agreement system and the resulting leakages, like free trade agreements, can create a system of contracts that is much easier to enforce and whose monitoring can be achieved at much lower transaction costs. In addition, of course, it may be necessary to create a new international organisation with wider sanctioning powers than the UN, thereby making its position decisive in the settlement of disputes. However, the development of a new international institution takes a very long time and involves very high transaction costs, i.e. it cannot solve the current climate change challenge.

In my opinion, in smaller groups of countries and regions, it is much easier to reach consensus and to develop an effective, or at least less suboptimal, regulatory system. In this case, however, global emission reduction costs will reach a higher level.

In addition to supply-side instruments, in order to promote their effects and mechanisms of operation, a strong emphasis should be placed on the wider dissemination of environmentally conscious consumer behaviour that is currently emerging. To do this, it is worth applying "framing" solutions that can shape preferences and helping to move towards real, cost-efficient alternatives by delivering information more effectively to consumers. As consumers are not fully informed and access to information is costly, tools should be used to make access to information easier for them, that is, to reduce information asymmetries. It may be important to prioritise the demand aspect, as companies face a significant degree of uncertainty whether there will be consumer demand for more environmentally friendly products and to what extent the market will reward a more environmentally conscious production method. Therefore it is of crucial importance to create the necessary incentives for the supply side by 'shaping' demand.

If environmental performance of goods became more expressed in the total economic value and thus in the reservation price for consumers, a more stable demand could be emerge for environmentally friendly products.

Changes in informal institutions and habits is a rather slow process, but once an environmentally conscious form of behaviour has been established, individual actions will be characterised by the follow-up and application of community-accepted patterns of behaviour and the avoiding of deviance.

3.4 The environmental quality of EU countries is essentially determined by the innovativeness of the private sector

Based on the results of my empirical research, I have come to the conclusion that private sector R&D investments have twice as much impact on improving environmental performance as governmental innovation-promotion activities.

In the correlation analysis, the impact between greenhouse gas emissions and government R&D investments the Pearson correlation indicator suggested a medium strength negative correlation. In contrast, private R&D investments are more able to reduce environmental pressures, in this case we got a -0.837 Pearson correlation index. This concludes that, although government investments have a significant environmental impact, government can best promote a shift towards carbon neutrality by fostering an increase in the research and development potential of the private sector, notably in innovations that reduce environmental pressures. Present analysis does not provide an insight into the multiplier effect of government investments. A recent research published in the literature in 2021 showed that government green investments have a greater multiplier effect than investments in traditional (non-carbon neutral) technologies. (Batini, 2021) I might extend my research in this direction in the future.

The government has a wide range of tools to guide economic development in a sustainable direction, which I will discuss in detail in the next subchapter.

3.5 Tax and subsidy cannot stimulate innovation individually, but only when used together

In my paper, I evaluated various environmental policy instruments in terms of cost-effectiveness, innovation incentives, technological spill-over effect, flexibility, and efficiency in managing market failure. I examined the effectiveness of CO_2 tax, cap-and-trade systems, command-and-control tools and grants.

In connection with my hypothesis, I will briefly present my results on the evaluation of taxes and subsidies.

	Cost-efficiency	Innovate incentives	Technology spill-over	flexibility	Whether it tackles market failures
CO_2 transmitter	***Relatively***	***yes***	***yes***	***yes***	***no***
R&D subsidies	***no***	***yes***	***yes***	***no***	***partly***

1: Assessment of environmental policy instruments, Source: Feierabend, I (2011)

I considered a CO_2 tax to be relatively cost-effective, as it is a source of revenue for the State, but at the same time there are high transaction costs, both in terms of collecting the tax and monitoring costs connected to its introduction. It can encourage environmentally efficient R&D investment by providing quantified externalities incorporated into companies' profit maximisation decisions (its effectiveness also depends on the efficiency of the market, i.e. the competitive market environment). The imposition of a tax (and the introduction of ETSs) will necessarily lead to an increase in consumer prices. (It depends on institutional characteristics of the market, on the nature of the competition and on the existence of perfect and close substitutes to what extent do consumers pay the tax burden.)

Another risk of tax introduction is that if we restructured the tax system, systematically carried out an ecological tax reform, eliminating the taxes that were previously proven and meant a stable source of income, the stable tax revenue could be at risk. Furthermore, if the purpose of the levying of the tax is to improve environmental performance and not only to internalise externality in the form of a tax (i.e. to pay for external emissions), in this case, if environmental performance improves, then the eco-tax has achieved its objective, which is very welcome, however at the same time, tax revenues will decrease. (Kutasi&Perger, 2014)

In case of monopolies and oligopolistic sectors, the most likely scenario is that companies will be able to levy a larger share of the tax on consumers, thus decreasing its incentive to innovate. However, there are industries where, due to sector-specific features, there is no possibility of significant emission reductions. (e.g. oil refining). Therefore, companies will not be able to achieve significant improvements in environmental performance by implementing larger, more costly technological innovations.

In this case, a pollution tax can only encourage companies to introduce end-of-pipe technologies, due to the fact that it is not possible to gain a competitive advantage with

outstanding environmental performance. End-of-pipe technologies will also be introduced if the primary objective is not to increase performance through technological change (since it cannot be used to gain market advantage unless there is fierce competition in the market), but the main priority is to reduce the tax burden, which may be remedied by technical changes but does not require a change in technology. (Allan et al., 2014)

If the tax burden cannot be or only partially can passed on to consumers, (i.e. they would lose their consumer base and thus their market share as a result of the price increase), companies will face a new profit maximisation problem.

As a result of the introduction of the tax, input costs will increase, so the total cost of the product will increase , which in most cases will result in a social deadweight loss.

The company has the following decision options:

1) Transfers the tax to the consumer. If this is not possible,

2) Chooses an end-of-pipe technology to reduce pollution, or

3) Changes its processes (production and other organisational processes) or

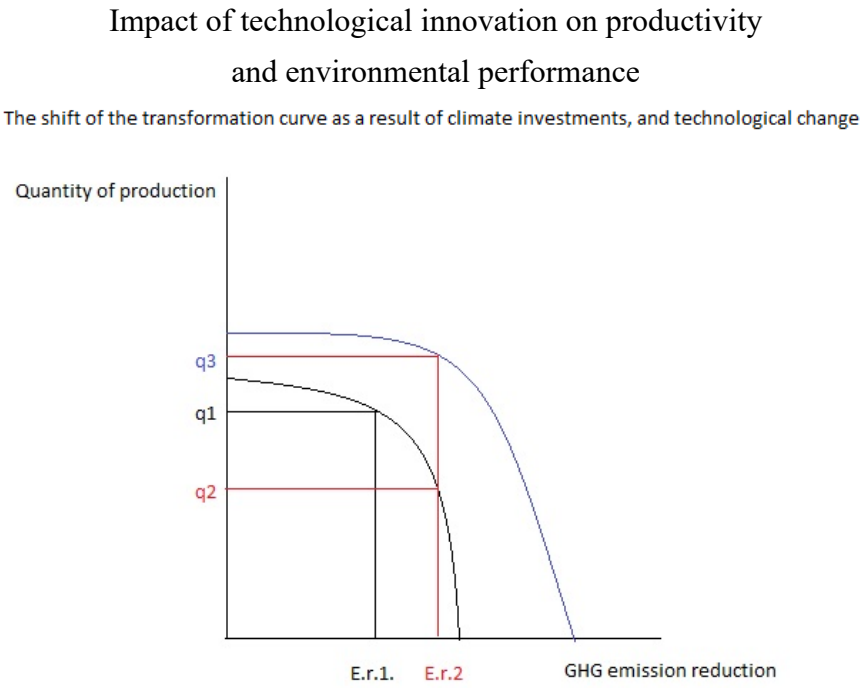
4) Adapt or develop new technological innovation

I is clear that the cost structure of companies will change. Due to increased input costs, profit maximising companies will reduce labour costs, seek input replacement opportunities or reduce output. (Lintz, 1992, pp. 32-38) There is probably no doubt about the initial reduction in emissions, but the long-term change in emissions depends largely on the company's capacity to innovate and its willingness to innovate. If the firm carries out a technological innovation, it will be able to produce with higher productivity and will be able to achieve the same emission levels with lower pollution.

In the following figure (Figure 5), I would like to show how change in emission limit (be it by any environmental policy instrument) affects the company's production possibilities frontier and emission levels. $E.r._1$ (emission reduction) represents the current emission level while $E.r._2$ represents an additional emission reduction requirement.

Assume that the regulation is tightened and greenhouse gas emissions should be further reduced to GHG_2 level. If the company maintains its original production structure, the original technology, then stricter environmental regulations would result in a reduction in the level of emissions. If the company opts for investing in a technological change (transition to more

energy efficient and productive technology), the production possibilities frontier will move right and the company will be able to meet the same emission levels accordingly, at higher production levels.



55: Impact of technological innovation on productivity and environmental performance, Source: Izabella Feierabend (2011)

Technological change improves the production efficiency of the economy through improved energy efficiency, more efficient resource productivity and the reorganisation of processes to achieve a more rational corporate operation. It also gives the company the opportunity to enter the market more cost-effectively with environmentally sound products, while still being able to remain price competitive.

It is clear, however, that there is a time lag between the incurred costs and the emergence of benefits. It is this time shift that significantly increases uncertainty and it is therefore not clear whether the company will consider the investment to be carried out.

If the market in a given sector does not reward environmentally conscious behaviour, i.e. consumers do not prefer products produced with a lower environmental impact to traditional products, or if environmentally conscious corporate governance is not a requirement in partnerships, then the demand side will not motivate companies to make costly green

investments. Similarly, if there is limited competition in the market, with few players, typically an oligopolistic or monopolistic market, then the pressures of competitors will not exert an innovation constraint. If continuous innovation in the market is a condition for maintaining market shares and taking into account the environmental aspect leads to a competitive advantage that increases competitiveness from a demand point of view, then the negative incentive can achieve the desired effect and companies will innovate in order to remain competitive in terms of price and productivity.

The subsidy can address initial financing difficulties, reduce financial risk and shorten recovery time, i.e. it can solve the problem of market failure when the implementation of a socially beneficial but costly innovation fails in the cost-benefit analysis. In other words, positive incentives may also be necessary in order to reduce social deadweight losses and reduce the severity of market failure.

The effectiveness of the subsidy scheme and the environmental tax depends to a large extent on institutional factors. If the processes are not sufficiently transparent, there is not enough conflict capacity for individual stakeholders- the checks and balances are not working properly, then environmental policy will not achieve the expected efficiency improvements. One of the barriers to the emergence of innovations and the development of new technologies is the lack of capital and the high cost of access to finance.

If the institutional system cannot function enough efficiently, some sectors/companies may become overfunded, while other innovations may not be able to materialize precisely as a result of underfunding. The financing also shows the State as an essential player, as well as a regulator, as well as an investor, and can also have an effect on technological developments through redistributive instruments. The State can play a significant role as an investor and financier through state-owned venture capital funds. Precisely because of the deficiency of the political institutions, however, certain actors may receive significantly more funding sources (including state aid and public venture capital fund investment), even though their innovation would not be the most competitive.

To sum up my previous findings, I see the solution as prioritising the institution of the market, ensuring the functioning of market mechanisms and developing a set of incentives to promote the shift to carbon-neutral technologies.

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[1] Izabella Feierabend and Izabella Gyürüsi also refers to the same author.