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Green Taxation in Germany:
European Best Practice for Fiscal Adaptation to Climate Change
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Summary:
As the private consumption does not change alone for mitigation in the climate change problem, the public finances must be proactive and motivating. One of the fiscal items is the taxation to reward and punish the lower and higher CO_2 emission, thus prevent the potential change of temperature. To understand the motivation via tax, Pigou's approach must be overviewed as the theoretical background, when the polluter pays through tax burden. The focus is on the application opportunities of carbon emission tax. The purpose is to estimate the impacts of introduction of carbon emission taxation in EU countries, implied by climate change mitigation and adaptation. The paper overviews the German practice, and refers to theoretical models of optimum taxation to create a possible framework for green taxation.

Keywords: climate change, fiscal policy, taxation, green tax, carbon tax, Germany.

Ekologické daně v Německu:
Evropský příklad dobré praxe fiskální adaptace na klimatické změny
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Abstrakt:
Protože soukromá spotřeba se nemění jen pro zmírnění problému klimatických změn, musí být veřejné financování proaktivní a motivující. Jedním z fiskálních nástrojů je zdanění, které odměňuje a trestá nižší, resp. vyšší emise CO_2, a které tak brání potenciálním změnám teploty. K porozumění daňové motivace je třeba vycházet z Pigouova teoretického základu, kdy znečišťovatel platí prostřednictvím daňového břemene. Pozornost je soustředěna zejména na využití daně za uhlíkové emise. Cílem článku je odhadnout dopady zavedení zdanění za účelem zmírnění či přizpůsobení se klimatickým změnám v zemích Evropské unie. Příspěvek poskytuje přehled německé dobré praxe a odkazuje k teoretickým modelům optimálního zdanění, čímž vytváří možný rámec ekologického zdanění.

Klíčová slova: klimatické změny, fiskální politika, zdanění,

JEL: H23, H21, Q52, Q54, Q58

Content

"The reform is far from satisfactory, but it is not as bad as critics claim."
Kohlhaas (2000)

1. Fiscal Aspects of Climate Change[1]

The global warming expected from climate change might be prevented by a restriction on carbon emission. This mitigation can be realized by several market friendly or discretionary institutional ways. A market friendly pricing of externalities is the carbon emission tax. The EU emphasizes the importance of environmental sustainability in relative outstanding extent in global comparison. The EU has been an initiator of international cooperation for the mitigation of climate change and has essential role in the creation of the Kyoto Protocol for example. The international cooperation can cope more easily with quantitative regulations like permit trade (namely quota trade), since taxation is part of sovereign fiscal policy. But therefore, green taxation is absolutely a national and a little bit single market responsibility to foster the mitigation. Therefore, it is important to check carbon tax practices of EU countries, whether are they so enthusiastic in national competence level as in global representation.

As it is written by O'Hara (2009), "[…] global warming hypotheses have been a contested terrain as advocates sparred with critics, resulting in controversy and analysis, but no firm resolution either way at the level of public debate. All this has suddenly changed in the light of the 'global warming' thesis gaining the upper hand. The influence of […] publication of the IPCC Report (2007a, b, c, d), the Stern Review (2007), the UNDP Report (2007), and the Garnaut Report (2008) […] have meshed with the election of more moderate governments in several continents to change the public view of these matters. 'Climate change', as it is now called, has become an accepted institution, even by most of those who previously argued against 'global warming'." Climate change is a long-term challenge for the Earth, as action for prevention should be started very soon before the impacts, while it is very uncertain to forecast the exact far future damages of different regions when exact scale of regional warming is an unsure variable in the equation of economic impacts. The scenarios and action plans have been developed, but there is an important factor that makes the execution questionable: the hesitation of decision making stakeholders. Hesitation is rooted both in uncertainty and in the expectations on each others' strategy.

In most industrialized countries, there are many factors that could ruin fiscal sustainability before any mentioning of the cost of climate change. The aging population, the welfare state reform, the recovery from global crisis, the tax competition, the rigidities of labour markets already have resulted robust debt

[1] The author was supported by TAMOP-4.2.1.B-09/1/KMR-2010-0005 project in the research for this paper.

levels.[2] The determining debt level warns for an important constraint in the beginning: The fiscal cost of mitigation and adaptation cannot be financed simply from public debt. Even a new type of taxes is not risk free in a very bounded fiscal room for manoeuvre.

The mitigation and adaptation to climate change means any private or public action to prevent the change of temperature or adjust to a changed climate. Aaheim & Aasen (2008) distinguish autonomous and planned ways. The autonomous adaptation is the case, when private individuals do something for adjustment in uncoordinated way. This could have been a cheap way for public finances, but also results suboptimal solution because of bias for individual free riding, emergence of common pool resource problem, or uncertainty. That is why planned adjustment, namely fiscal adaptation is necessary, too, to motivate the private sector for (pro-)action. Nevertheless, the autonomous adjustment also has impact on tax revenues and public transfers. E.g., energy saving means less pollution-related tax payment, or direct investments in renewable energy equipment can create right to get public subsidy.

The modeling of fiscal impacts shall be examined in the frame of temperature change causing damages or benefits, and cost of mitigation or adaptation. If climate change got realized globally, it does not mean a generally same extent of change of temperature in every region and territory of the Earth. (It is possible more or less warming in temperature or even cooling is a likely outcome in certain regions.) As warming may be so different, the physical impact can be various. The uncertainty is very high in regional view, thus the determination of reaction function is quite difficult.

Besides high uncertainty, the economic actors should agree in the distribution of financing between public and private players. The economic motivation for participation can be established, if the participants can get at least so much benefit from mitigation and adaptation actions as much cost they invest. Nevertheless, there are private actors (or maybe even state actors in the international relations), who are not able to finance themselves the adaptation. Thus, the public decision makers must determine the extent of equity toward poor economic actors (CEPS & ZEW 2010). This aspect raises the equity vs. efficiency trade-off dilemma, whether the fiscal resources should be used for subsidizing rich or poor actors (by direct spending or tax refunding). To resolve the dilemma, the economic theory knows the utilitarian approach and the Rawls approach. In case of climate change mitigation, the specific carbon emission per household of different social groups can guide the balancing between equity and efficiency. However, equity is not just a dilemma in dimension of social classes,

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[2] The approximately debt to GDP ratios have been the followings in 2011: USA 100%, Japan 225%, France 80%, Germany 75%, Britain 70% etc. Source: Eurostat.

but in geographical view, too. Which are the populated and industrial areas deserving protection against higher sea level or other natural damages?

The policy making – in relation to market motivation – must decide another dilemma between short-term profit and long-term supply what can be called supply security dilemma (CEPS & ZEW 2010). In which territories should the state sustain the supply of energy, food, transportation, safe water and sewage system, pipelines? The prices and the (in)elasticity of the (network) service markets, the intensity of destructive competition[3], will decide the short-term profit. When the profit is negative, the state may force the service companies to supply – or maybe not.

In case of climate change, the likelihood of irreversibility is important determinant. Although an early mitigation action can look like unworthy because of high uncertainty and low probability of occurrence of damages far before the forecasted warming or disasters, an overdue mitigation cannot reverse the natural, environmental changes. In this case, only adaptation remains as option (CEPS & ZEW 2010). The economics of decision theory suppose to use the net present value (NPV) to choose the more worthy option. In climate change relation, the comparable options are the NPV of an earlier mitigation or the NPV of a later adaptation.

There are dilemmas of the fiscal government related to climate change and taxation. The first dilemma is the following: As there is no satisfying room for issuing more debt to cover the fiscal climate adaptation, the two options for fiscal policy are the redistribution among the items of taxes and spending or levy as much cost as possible on the private sector through perfect markets, like a sophisticated insurance sector. However, the two horns of the dilemma demand balancing. If the private sector with limited time horizon got no fiscal (public) impulse at all, the private perception on net present value of adaptation will be considered to be negative, as individuals of the private sector cannot optimize for the endless future, or more than a few generation (see the paradox of Ricardian equivalence[4]). In the contrary case, getting excessive fiscal

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[3] Destructive competition: In such service markets, (1) where the fix cost (exit cost) is high, (2) the competition is intensive and presses the price to low level and (3) the demand is very volatile (sometimes much, sometimes few), the three characteristics together cause frequent bankruptcy what endangers the supply security.

[4] In the economics models, it is a reasonable assumption, that the states as actors are immortal, so they should be considered as infinite ones. That is why, the Ricardian equivalence can presume, that it is indifferent for the state to finance a new item of spending either from raising tax or from public debt. If it was true, this aspect gives opportunity for infinite Ponzi game for states, and just always accumulate higher and higher debt by promising higher and higher future tax revenues. However, O'Conell & Zeldes (1988) and also Buiter (2004) emphasized, that it is not possible because of the finite or limited horizon of individual households as buyer of public bonds. As the buyers are thinking in finite future and they are in limited number, the assumption of public bonds with infinite maturity is

subsidies, the community of individuals of the private sector will expect any adaptation from the state, thus remain passive.

The second dilemma rooted also in the limited room for issuing debt. The fiscal decision makers are forced by indebtedness to select among private actors, and create preference lists. Who should be compensated for damages, and who not? If rising sea level swallows coastal real estates, should the owners get subsidies, and how much? If productivity of agricultural lands were ruined by desertification, should the state bother with ensuring alternative income for rural workers and entrepreneurs? Should the ski parks get public or EU subsidies for snow guns if climate warming means too high temperature for snowing? Etc.

The increasing green tax burden, bond issue and funding for mitigation and adaptation raises the third dilemma whether does it worth to increase the fiscal crowding-out effect in the capital markets or not. This effect is very regional market specific because of the interest rate elasticity and marginal propensity of saving and investment. Of course, less investment can mean less carbon emitting production growth, but also slower technological development in carbon reduction, too.

To adopt the debt sustainability aspect into the frame of climate change aspects, the long-term solvency, the budget constraint, the primary gap indicator has been applied. Besides indebtedness, refocusing fiscal spending and resetting the extent of public budget invoke the Keynesian fiscal crowding out impact.

The Brundtland Report on sustainability of development issued in 1987 has early explained the responsibility of human activities for transition of natural environment. Peter S. Heller's book, the 'Who will pay?' (Heller 2003) set one of the first milestones in thinking about fiscal impacts of long-term processes of the 21st century global economy, among others the climate change. Since 'Who will pay?', the relevant particular economics literature has been enlarging. This study focuses on application opportunities of carbon taxation. The purpose is to estimate the impacts of introduction of carbon emission taxation implied by climate change mitigation and adaptation. The paper overviews the German practice, and refers to theoretical models of optimum taxation to create a possible framework for green taxation.

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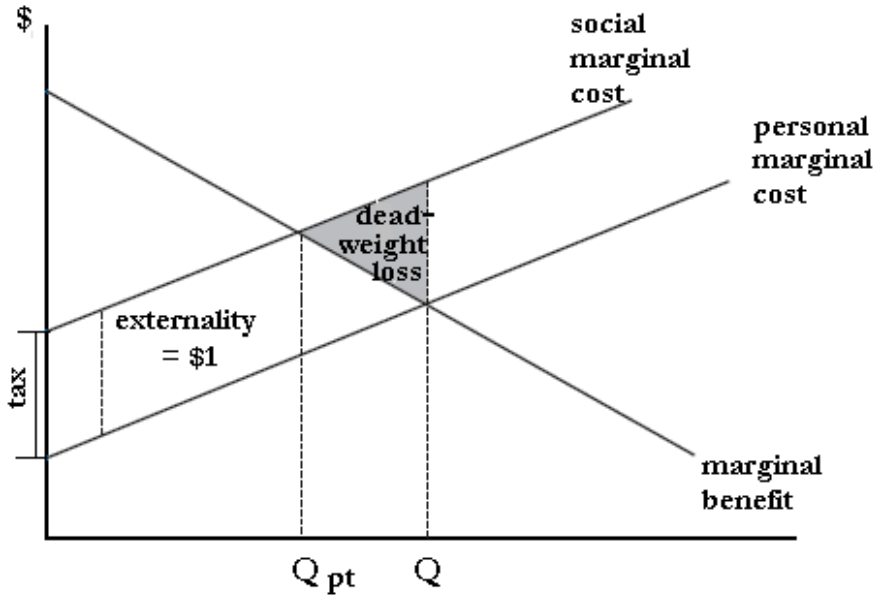
unrealistic. Besides, the imperfection of capital markets can not treat perfectly the uncertainty of the future. That is why it is expectable from the state to pay all the debts in the unseen future, namely what is expressed in the form of PV (debt + future expenditures) = PV(future revenues).

2. Pigovian Tax for Mitigation

Carbon tax is a practical version of the theoretical Pigovian tax. The Pigovian tax is a solution for internalization of externalities. Pigou (1920) recognized that the market mechanism had failed to include external costs into market prices, which was why he recommended the implementation of a tax to solve this market failure. Baumol & Oates (1971) proved that tax is an efficient instrument to realize environmental goals, even in the case of unquantifiable externalities. The Pigou tax can be levied on the market activities creating negative externalities. The role of the tax is to correct the market outcome. In the case of CO_2 emission, the externality is the global warming and its geographical, social, health, economic, fiscal etc. impacts. The externality distorts the economy from the Pareto optimum, while the Pigou tax can have the economy return to the optimum. The tax should be equal to the marginal externality (Pigou externality) for the expected effect. The challenge of the tax – just as general taxation – is its fine calibration for the wanted impact, in the case of green tax to counterweight the externality of CO_2 emission. Wrong setting, institutional failures in legislation and execution, or the polluters' political lobby can ruin the real efficacy of Pigovian type taxes. As the Pigou tax does not pursue fiscal revenue purposes, fiscal charges are to be regarded as small as the enterprises as possible. However, putting a tax into practice always demand the analysis of marginal tax burden impacts on the business (see fig. 1).

Figure 1: Microeconomic externality and the Pigou Tax



Source: Nye (2008), Qpt = production with tax, Q = production without tax.

In the criticisms of Pigovian type taxes, there can be found an ignorance of whether the market structure is competitive or monopolistic, as in case of monopoly, the price is above and the quantity is below the competitive equilibrium. Thus, estimating optimum Pigou taxes ignoring the market structure could overestimate the rate of tax to impose. Buchanan (1969) and Nye (2008), for example, refer to the oil and gasoline market where suppliers can limit the production, and the impact of restriction on oil drilling or the impact of the alternative energy supply on oil based energy market price, which makes it difficult to calculate the exact tax. Nye (2008) also refers to the doubts written by Edlin & Karaca-Mandic (2006) on the case of heterogeneity. As for carbon tax, heterogeneity can mean different technological levels of production or different productivity levels and various value-added, not just in the sense of geographical disparities, but also in small versus big companies or inter-industrial aspect, too. One percent or one dollar tax will burden less an industry with high profit margin than another with low return.

As any type of tax, Pigou tax has a deadweight loss impact, too, on consumers' benefit (see fig. 1). The question is whether this deadweight loss or the damage from warming is bigger. The calculation of deadweight demands the knowledge of the price elasticity and the estimation of damage by warming needs the very uncertain probabilities of climate change. Thus, it is not simple to match the alternative losses.

Another critic on green tax is called the "green paradox" by Sinn (2008), who suggested that increasing emission taxes accelerate global warming because resource owners start to fear of higher future taxation and for this reason they start to increase near-term extraction. Edenhofer & Kalkuhl (2011) tested Sinn's model for increasing unit taxes on emission, and found that an accelerated resource extraction due to increasing carbon taxes (namely, the green paradox) is limited to the following specific conditions: "The initial tax level has to be lower than a certain threshold and the tax has to grow permanently at a rate higher than the discount rate of resource owners" (Edenhofer & Kalkuhl 2011: 2211). This means that most ranges of carbon taxes for warming mitigation is not risky for the green paradox. They suggest "quantity instruments" to avoid any risk of the paradox.

The expectation from implementation of carbon tax is to mitigate carbon emission by pricing the cost of future damage and thus enforcing emission efficiency. The function of carbon tax is to raise the price of CO_2 emission. However, to identify the real tax impacts on energy demand and CO_2 emission is a serious challenge for policy-makers. As it was established by IMF (2008), the conditions of success in mitigation policy are complex.

As any mitigation policies, the carbon taxation must be flexible, robust and enforceable. According to Kim et al (2011), carbon tax has an important advantage over other mitigation measures, namely, that they create a common

price for emissions, which makes polluters more efficient in emission reduction. Efficiency of green tax can be understood as how much CO_2 emission can be reduced in energy use and production or in transportation, if a carbon tax is adopted in the mentioned industries.

In comparison to command and control, the advantages of carbon tax can be summarized in lower compliance costs, and a continuous incentive to adapt in the technology of energy use and conservation (Cooper 1998, Pizer 1997).

The main advantages of market-based carbon taxation are the followings according to Cooper (1998), Pizer (1997), Pearce (1991), Nordhaus (2007) and Kim et al. (2011):

- Creating a common price for emission taxation makes firms with lower abatement costs emit more. The carbon tax fixes the price of emissions effectively.
- The cost for CO_2 emission encourages a switch to low-emission technologies and activities, and the development of emission-reducing technologies.
- Carbon-tax systems can make use of existing tax collection mechanisms and require less intensive emission monitoring efforts.
- Carbon tax provides for greater flexibility and adjustment capability for both firms and public finances in case of changing economic conditions, allowing firms to reduce emissions more during the periods of slow demand growth, and providing opportunity for tax easing.
- The carbon tax can induce a technological change to avoid higher cost, which results in lower emission and at the same time technological shift toward better productivity or cost efficiency (Gerlagh & Lise 2005).

The disadvantages are as follows:

- The new type of tax generates administrative and transaction costs.
- Without other tax easing, the higher tax burden results a crowding out impact by government.
- Under carbon tax, the quantity of emission reductions is uncertain. Impact of tax is very dependent on non-constant price elasticity and income elasticity.
- Taxes may be politically difficult to implement (Kim et al. 2011).
- Market structure and energy consumers' heterogeneity is not treatable in a homogenous tax system (Edlin & Karaca-Mandic 2006).
- The range of applicable green tax is limited by the existing total tax burden on economy, or, from contrary view, the level of green tax determines the necessity of tax cuts in other types of tax burden (Bossier & Bréchet 1995).

The impact of carbon taxes on international competitiveness of energy intensive industries is determined to a certain extent, because additional cost factor appears in the countries devoted to mitigation, meanwhile free riders of international relations try to avoid the implementation of green taxes. However, the empirical econometric survey of Zhao (2011) concluded that empirics do not support this hypothesis. As it is established in the analysis, when only the importing countries have carbon tax, it exerts negative influence on exporters' competitiveness in energy-intensive industries. If only the exporters use carbon tax, impact on competitiveness is insignificant. When every trade partner countries harmonize the carbon taxation, the impact on competition is still not completely cancelled mutually, but there remain some net negative impact on exporting countries.

Baranzini et al. (2000) and later Zhang & Baranzini (2004) shed light on the relation of green tax introduction to fiscal reform necessity, as introduction of a new type of tax has impacts on competitiveness, distribution and environment, at least at the same time. Galinato & Yoder (2010) experience that, environmental taxes on energy are politically unpopular, especially in the USA, particularly because it is hard to accept increasing energy prices any way. That is why they suggest the implementation of a combined tax and subsidy system, because subsidies on alternative energy and fuel are financed by general budget from already existing taxes. However, these types of indirect subsidies are found to be weak in their efficiency to reduce carbon emission. The model contained a tax-subsidy mix for political boundaries. The essence of this model is that revenues from emission taxes finance the subsidies alternative energy.

3. The German Tax Reform for Ecological and Employment Objectives

The German green tax reform is not unique in Europe. It is a general Community demand to implement green taxes. Bossier and Bréchet (1995) described the first European Community initiation on harmonized green tax as follows: "As it was defined by the European Commission (EC1992), the tax considered in this study is a mixed tax. One of the basic arguments lying behind the proposal was to improve energy efficiency and to curb carbon emissions at a European level. A mixed tax meets both of these purposes since it is based both on the energy and on the carbon content of the different types of fuels (for a discussion of the use of a mixed tax (see Hoornaert 1992; Manne & Richels 1993). The tax is imposed at a level of EUR17.75/toe the first year which is roughly equivalent to a tax of USD3 per barrel of oil. The energy and carbon components represent 50% of the tax each. The energy component (EUR0.21/GJ) is levied on all fuels while the carbon component (EUR2.81 per tonne of CO_2) depends on the carbon content of each energy product."

As Bach et al. (2002) wrote, the aim of the tax reform was to shift the structure of industrial activities and tax burden toward a composition creating less

environmental externalities. Kohlhaas (2000) described the green tax reform concept as follows: "A core concept of ecological tax reform is to levy environmental taxes (or charges) and use the subsequent revenue to reduce other existing taxes by an equivalent amount. This revenue-neutral approach ensures that the business sector and private households, taken as a whole, will not face a higher overall tax burden. Ideally, this method enables policymakers to reduce economic distortions that the tax system currently causes by reducing taxes that are considered harmful to the economy." This way, the decision makers hoped "double dividend" in environmental and productivity terms (Herdegen & Schön 2000: 9).

According to the findings by Bossier & Bréchet (1995), carbon pricing (e.g. through green tax) can be connected to employment problems, especially in developed European countries. Their recommendation toward policy makers is to pay attention on the total tax burden. Although the primary purpose of green tax is not to secure government revenues, it is eventually a budget resource. Thus the volume of carbon tax revenues can be redistributed through cuts of other duties, especially if this results in growth impacts. Europe suffers mostly by relative low employment causing high social fiscal costs. So, it seems reasonable to ease the burden on labour cost.

The simple version of tax compensation means only a redistribution of the funds in social service systems. In this case, green tax must finance the loss of revenues from the easing of social security contribution. Of course, in a complex social security reform (pension reform and health care funding reform), the tax easing anticipating the green tax can be broader. The latter approach indicated by "green tax for employment" slogan sets the carbon taxation issue in a complex economics model. The efficiency of this policy instrument will be indicated not only by carbon reduction, but also by its impact on employment, energy use efficiency, prices, wages and ultimately on global competitiveness and external balance (Bossier & Bréchet 1995).

In European relevance, two ways of so-called targeted cuts in social security contribution have proved to be practical. The targeted cuts in contribution paid either by sectors exposed to international competition or by sheltered sectors like single market services. The other way, recommended by Drèze et al. (1994), means targeted cuts in contribution paid by sectors employing low-skilled workers. The latter one can help a serious problem caused by the quickly growing value added by technological development, which excluded about 10% of the European society from the labour market (Bossier & Bréchet 1995).

There is a good practice on green tax reform combined with employment objectives in Germany. The *Gesetz zum Einstieg in die ökologische Steuerreform* (First Step toward an Ecological Tax Reform Act) took effect in 1999. Green tax was levied on primary energy consumption; in parallel with cuts on the employers labour-related cost (Bach et al. 2002). As it is described by Kohlhaas (2005),

Knigge & Görlach (2005) and Kohlhaas (2000), the ecological tax reform was started in 1999, and finalized by a later modification in 2003. This tax reform gradually raised the tax burden on petroleum and gas and introduced the electricity tax. Parallel, the wage cost was decreased in public budget revenue in a neutral way. The modification in 2003 was simply differentiation between renewable and non-renewable energy use, as the Act introduced the subsidies for renewable energy and for energy saving reconstructions of buildings.

The German green tax revenue rose up to EUR18.7 billion in 2003, but the emission reduction impact stabilized later the green revenue around EUR16 billion in the following years. This financial room created opportunity to lower the total volume of public pension insurance contribution by 1.7%. In wage cost, this made possible to lower the social insurance rate from 42.3% to 40% of gross wage (Kohlhaas 2000, Kohlhaas 2005, Knigge & Görlach 2005).

The *ex ante* estimations on impact of green tax were not too promising. The PANTA RHEI multi-industrial econometric simulation by Meyer & Ewerhart (1998) and the LEAN simulation by Welsch & Hoster (1995) showed sharply vanishing impact on reduction of carbon emission and unemployment, since different industrial sectors and income-level households reacted several way in the simulation (see also in Bach et al. 2001). The simulation of income effects by Bork (2000) showed doubtful expectations, too, as significantly the low-income households could have suffer the biggest loss in disposable income from the combined impact of cuts on social contribution and tax increase on energy use. Beuermann & Santarius (2006) describe a politically risky process of introduction and implementation what were full of uncertainty lack of information. Thus the introduction period became quite long, five years, in Germany. The political risk was that the employment effect might have been insignificant, meanwhile the new tax burden could have increased the income differences, as carbon emitting energy consumption has higher share in the consumer basket of lower income households.

The reduction of emission speeded up exponentially from the start-up year 1999 (see Kohlhaas 2005: 13, Tabelle 3-1). The -2.39% change of CO_2 emission in 2003 meant 20 million tons less carbon air pollution. In parallel, employment grew by approximately 250 thousand people until 2003 which already meant an employment ratio of +0.75%. However, the impact of reform on GDP growth was measured to be insignificant, close to zero. Among the sectors of national economy, the private sector felt lower social security cost and higher energy and fuel prices, the government balance was not affected, the investments were diverted toward energy saving technologies, which resulted high fluctuation among industries. Thus, the industrial level impacts proved to be very various (see Kohlhaas 2005: 13, Tabelle 3-2). The current account impact is negative, the higher cost of import energy ruined the export competitiveness of German industries; thus, export sank and import grew. Especially the transportation and

the construction sector suffered from the highest increase of cost as they have been the most energy intensive sectors, at the same time the agriculture suffered the biggest contraction by higher energy price for being more price elastic than former industries (Kohlhaas 2005, Knigge & Görlach 2005).

It is a serious dilemma for policy makers, that new taxes cause competitive disadvantage for national companies. Barker et al. (2007) assumes, that unilateral environmental tax reforms leads to imperfection in the single market of the European Union if participation is particular. It is called carbon leakage, when the efforts made by unilaterally green reforming countries are ruined by the non-reforming countries in two ways. First, the sustained emission level of non-reforming countries ruins the mitigation of reforming ones. Second, the reforming countries suffer from unilateral degradation in their competitiveness since their additional tax. However, very similarly to the weakness of green paradox, Barker et al. (2007: 6291) found very few proof for carbon linkage: "Only in a highly competitive, export-driven market does the small industry price increase lead to a decrease in output, namely the UK and German basic metals industries. The absence of strong evidence for carbon leakage is most likely due to the fact that the ETR [environmental tax reform] energy taxes are relatively small and so they do not have a large enough effect on unit costs to justify the cost of relocation." That might be explained by the generally weak impact of green taxes on economy and emission.

Kohlhaas (2005) created *ex post* and *ex ante* model to estimate the effect of German green tax reform on GDP and employment. The German green employment shows effective characteristics, as during the global recession the German unemployment could have decreased from 10% to 7%, in period of 2008–2011 (see Eurostat statistics).

Conclusion

A carbon tax could be one of the most effective policies to mitigate carbon emissions. The implementation of green tax is expected to price the externalities cost-effectively, thus, really enforce the mitigation of the private sector. However, there are some limits of the policy making by taxation. The carbon tax impact is not absolutely certain if price and income elasticity cannot be empirically forecasted. The flat tax rate can have various impacts on industries or different size of companies having various productivity or profitability.

The ideal fiscal policy affected by climate change would be a green stimulus combining spending and green tax, meanwhile keeping the scale and balance of the budget, but restructuring the fiscal preferences, thus, cutting the wage related cost of employment and improving the international competitiveness of the national economy.

A multilateral ecological tax reform seemed to be more effective than a unilateral one, however, the assumption that the impact on competitiveness would be smaller if more countries participated or took equivalent measures was not proved by empirical studies. Anyway, after the proposal of the German government, the EU accepted tax rate minimum limits for ecological taxes like environmental protection product fee, environmental charges, and energy taxes on electricity, natural gas and coal (see Directive 2003/96/EEC). However, a EU-wide counter tax easing was not harmonized for higher employment.

In the case of complex environmental tax reform, the extent of increase and cuts on tax rates will be cautious and prudent since the impact of green tax on medium or long term emission reduction will result a fall in tax revenues, too.

The German experience on green tax shows small impact on emission, welfare and competitiveness. Because substitution opportunities on carbon-related fuel and energy are income dependent, households with lower income take relatively more burden. This means that the theoretically flat carbon tax actually works as a regressive tax.

The empirical studies measure low efficiency and low elasticity in the case of green tax implementation, which can be explained with a broad range of exemptions in energy use and rigid, inelastic demand in gasoline consumption.

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