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EMISSION ALLOWANCES TRADING VS. ENVIRONMENTAL TAXATION: THE CASE STUDY OF CZECH REPUBLIC

This paper focuses on the ex-post analysis of the EU ETS in Czech Republic in 2013 using the questionnaire survey and Mamdani methodology. The key part of the paper is the comparison of particular characteristics of tradable emission allowance and current environmental taxation in Czech Republic, including public budgets consequences.

Keywords: *emission tradable allowance; environmental taxation; Czech Republic.*
JEL Classification: H23, H3, Q48, Q58.

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ТОРГІВЛЯ КВОТАМИ НА ВИКИДИ ТА ЕКОЛОГІЧНІ ПОДАТКИ: ЗА ДАНИМИ ЧЕСЬКОЇ РЕСПУБЛІКИ

У статті проведено аналіз динаміки торгівлі квотами на викиди в атмосферу у Чеській Республіці у 2013 р. з використанням анкетування експертів та методології Мамдані. Проведено детальне порівняння динаміки торгівлі квотами та динаміки виплат екологічних зборів та податків у Чеській Республіці протягом 2013 року. Висновки даного порівняння стосуються, в першу чергу, необхідних змін в політиці та наслідків для бюджету Чеської Республіки.

Ключові слова: *торгівля квотами на викиди в атмосферу; екологічне оподаткування; Чеська Республіка.*
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ТОРГОВЛЯ КВОТАМИ НА ВЫБРОСЫ И ЭКОЛОГИЧЕСКИЕ НАЛОГИ: ПО ДАННЫМ ЧЕШСКОЙ РЕСПУБЛИКИ

В статье проведён анализ динамики торговли квотами на выбросы в атмосферу в Чешской Республике в 2013 г. с использованием анкетирования экспертов и методологии Мамдани. Проведено детальное сравнение динамики торговли квотами и динамики уплаты экологических сборов и налогов в Чешской Республике в течение 2013 года. Выводы данного сравнения касаются, в первую очередь, необходимых изменений в политике и последствий для бюджета Чешской Республики.

Ключевые слова: *торговля квотами на выбросы в атмосферу; экологическое налогообложение; Чешская Республика.*

Introduction. Both environmental taxation and emission allowances trading refer to the family of economic tools of negative externalities internalization for particular emissions cutting. The idea of placing a price on pollution belongs to the economist Arthur C. Pigou. The concept of environmental taxation has been developed much later; currently OECD (2006) distinguishes 2 different kinds of environmental taxation – taxes imposed directly on pollution or emissions and taxes with indirect relationship between pollution and a subject of taxation. The difference between these kinds of environmental taxes lies in consequent reaction of a particular polluter; however, the distribution of tax revenues can be also different.

The initial EU Emissions Trading System was based on Directive 2003/87/EC, which established a fundamentally decentralized system for the pilot phase of emis-

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sions trade (2005 to 2007) and the Kyoto Protocol commitment phase (2008 to 2012). Currently, based on Directive 2009/29/EC, the EU ETS has step into Phase III (2013 to 2020), the post-Kyoto commitment period. The EU ETS is actually the largest emissions market in the world; however in comparison with energy markets it is relatively small (Conrad et al., 2012). The EU ETS covers more than 11,000 power stations and manufacturing plants in the 28 EU states as well as Iceland, Liechtenstein and Norway. Aviation operators flying within and between most of these countries are also covered. In total, around 45% of the total EU emissions are limited by the EU ETS (European Commission, 2013).

The regulatory framework of the EU ETS was largely unchanged for the first two trading periods of its operation, however the beginning of the third trading period in 2013 brought changes in common rules which should strengthen the system – from 2013 the most important yield of emission allowances is auctioned. Sectorial differentiation was introduced, with (initially) far more auctioning of allowances for energy producers than energy-intensive industries. In addition, free allocations were further harmonized, to be based on common state-of-the-art technology benchmarks (Wettestad et al., 2012: 73). Policy makers give firms incentives to move towards production which is less fossil-fuel intensive (Aatola et al., 2013).

Literature overview and problem statement. A number of papers and research is devoted to particular analyses and scientific studies on environmental taxation and tradable emission allowances systems. Focusing on environmental taxes, we can find various analyses simulating general environmental taxation impacts (Baranzini et al., 2000; Bach et al., 2002; Zimmermannova and Mensik, 2013), distributional impacts (Wier et al., 2005; Bork, 2006), competitiveness impacts (Ekins, 2007) or the administrative burden of environmental taxes (Pavel and Vitek, 2012). Stranlund and Chavez (2013) focus on the optimal distribution of administrative costs between polluters and government and the optimal level of emissions tax in relation to marginal pollution damage.

Since emission allowance trade has primarily started in the US, the majority of publications dealing with tradable emission allowances assess the market for SO_2 emissions under the Acid Rain Program (Benz and Truck, 2009). Regarding the EU ETS, scientists have focused mostly on modelling and forecasting the prices of CO_2 emission allowances (Benz and Truck, 2009; Li et al., 2011; Conrad et al., 2012; Garcia-Martos et al., 2013; Lecuyer and Quirion, 2013), the incidence of carbon price (Grainger and Kolstad, 2010), the EUA price drivers (Aatola et al., 2013; Lutz et al., 2013), the marginal cost of both energy intensive companies and power sector (Lund, 2007; Chernyavska and Gulli, 2008), the influence of emission allowance trading on electricity producers (Lund, 2007; Chernyavska and Gulli, 2008; Falbo et al., 2013) or its innovation impact (Rogge et al., 2011; Rentizelas et al., 2012).

Considering the characteristics of particular instruments of CO_2 pricing, their impacts, efficiency and optimization, economists have different opinions. Comparison and assessment of these economic instruments are not trivial, since they could be an important additional source of information for policy makers in particular countries.

Nordhaus (2005; 2011) focused his research mainly on carbon taxation and emission allowances efficiency comparison, advantages and disadvantages of both

economic instruments, and he strongly prefers taxation before emissions trade. In his opinion, fluctuations of the EUA price and its volatility within the EU ETS in one trading period is not good for investments planning. As a recommendation for policy makers, he has proposed pure carbon taxation in the context of current fiscal policy as the most suitable instrument for greenhouse gas emissions cut. He also suggests the consequent international harmonization of carbon taxes throughout the world as one of the instruments in international climate policy.

Speck (1999) also recommends carbon taxation, since there are many sources of emissions, which cannot be involved in emission allowances trade system and moreover which are considerably heterogeneous. He emphasizes the potential benefits of carbon taxes in the field of the so-called "double dividend", which can be considered as a typical argument of environmental taxation supporters (Bork, 2006; Ekins, 2007).

On the other hand, there are economists, who support emission allowances trade. For example, Mansur (2013) indicates that relative to taxes, tradable permits may improve welfare in a market with imperfect competition. Moreover, based on his model of strategic and competitive behaviour of wholesalers at the Mid-Atlantic electricity market, in case of regulators are opted to use a tax instead of permits, the deadweight loss from imperfect competition is greater.

However, Goulder (2013) for the purposes of research on climate change policy's interactions with the tax system included both a carbon tax and cap-and-trade system under the general label of "green tax", since these two environmental policies have the same features. Regarding the efficiency of "green taxes" and marginal costs of pollution abatement, we can have two different groups of "green taxes": 1) carbon tax (revenues recycled lump-sum) and cap-and-trade, freely allocated allowances; 2) carbon tax (revenues recycled via marginal rate cuts) and cap-and-trade, auctioned allowances (revenues recycled via marginal rate cuts).

The main objectives of the paper. Based on Goulder's idea (2013), this paper focuses on the current European cap-and-trade system with auctioned allowances, precisely on the characteristics and behaviour of the EUAs in Czech Republic in comparison with the characteristics and behaviour of current environmental taxation in Czech Republic. The ex post analysis of the EU ETS in Czech Republic in 2013 and the consequent impacts of the EUAs on the behaviour of particular Czech companies within the EU ETS will be presented.

Data and methodology. For such purposes we have used different sources of data and information. At first, focusing on CO_2 emission allowances price and its development, the data from EEX exchange (EEX, 2014), the leading energy exchange in Europe, has been used, particularly the EU emission allowances (EUAs) spot prices in particular trading days.

Regarding environmental taxes and fees in Czech Republic, the data from current legislation has been used, including particular rates of taxes and fees.

Dealing with the behaviour of companies in Czech Republic and their decision-making (Pawliczek and Piczszur, 2013); we have used 2 sources of data. The first data set and consequent results were based on the consultations with the expert from the Association for the District Heating of Czech Republic – Association of Entrepreneurs in the Field of Heat Supply (ADH CR), responsible for emission

allowances trading. The second step of data mining and obtaining more precise information was based on the survey, which focused on the key electricity and heat producers, the members of the working group on the EU ETS and environmental taxation within ADH CR. 72% of the survey respondents on the total CO_2 emissions of Czech Republic within the EU ETS in the whole second trading period 2008–2012 provides us with sufficient information as a result of the questionnaire survey.

For the purposes of the producers behaviour analysis, fuzzy rule-based system has been used, precisely Mamdani type of rules (Cermak and Pokorny, 2001). The Mamdani fuzzy rule-based system is defined as

$$\begin{aligned} &\text{IF}(x_1 \text{ is } A_{1,1}) \text{ AND } \ldots (x \text{is} An_{,1}) \text{ THEN } (y_1 \text{is} C_1) \\ &\text{IF}(x_1 \text{ is } A_{1,1}) \text{ AND } \ldots (x \text{is} A_{n,1}) \text{ THEN } (y_2 \text{is} C_2) \\ &\ldots \\ &\text{IF}(x_1 \text{ is } A_{1,r}) \text{ AND } \ldots (x \text{is} A_{n,r}) \text{ THEN } (y_r \text{is} C_r). \end{aligned} \quad (1)$$

Based on the defined rules, the behaviour of companies in Czech Republic has been generalized and serves as a basis for the comparison of the characteristics of particular economic instruments for CO_2 emissions cut, implemented in Czech Republic.

Results. We can identify the "price" rules for electricity and heat producers in Czech Republic, based on Mamdani fuzzy rule-based system. Regarding the results of the survey, Czech producers consider the price of allowances 0–6 EUR per EUA most suitable for EUAs purchases. On the other hand, they would sale the EUAs when the market price will be 10 EUR and more per EUA. The space between 6 EUR/EUA and 10 EUR/EUA represents the uncertainty in producer's behaviour. We can describe it with help of the following Mamdani rules:

1. IF the EUA price is SMALL AND environmental taxes are almost constant THEN the producer buys the EUAs only to cover his CO_2 emissions.

2. IF the EUA price is MIDDLE AND environmental taxes are almost constant THEN the producer buys the EUAs to cover his CO_2 emissions, but starts thinking about trading with the EUAs on the exchange.

3. IF the EUA price is HIGH AND environmental taxes are almost constant THEN the producer buys the EUAs to cover his CO_2 emissions, but starts making his own predictions and calculations of the EUAs.

4. IF the EUA price is HIGHER AND environmental taxes are almost constant THEN the producer buys the EUAs to cover his CO_2 emissions, but starts trading with the EUAs on the exchange.

5. IF the EUA price is THE HIGHEST AND environmental taxes are almost constant THEN the producer buys the EUAs to cover his CO_2 emissions and trades with the EUAs on the exchange.

Regarding the explanation of these rules, SMALL represents 0–6 EUR/t CO_2, MIDDLE represents 7 EUR/t CO_2, HIGH represents 8 EUR/t CO_2, HIGHER represents 9 EUR/t CO_2 and THE HIGHEST represents 10 EUR/t CO_2. Figure 1 graphically presents the behaviour of Czech producer in the sector of combustion processes in 2013.

Focusing on the real EUA market price development in the year 2013, Figure 2 shows the development of the EUA auction price in the 3rd trading period (11/2012–7/2014).

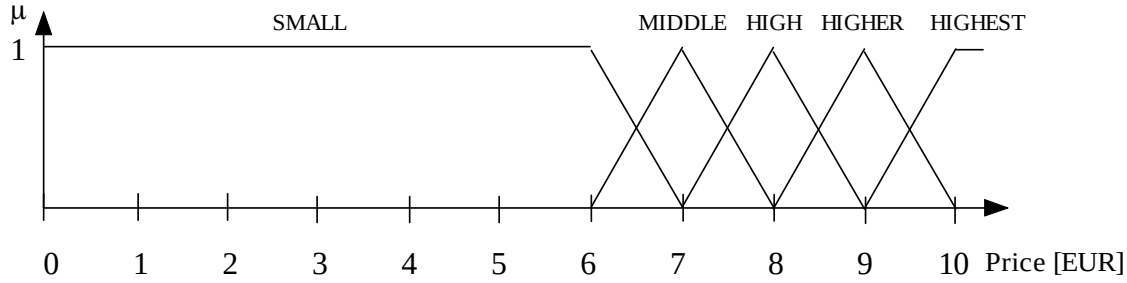

Figure 1. **Shapes of Membership Functions for Given Input Variable Price,** *authors'*

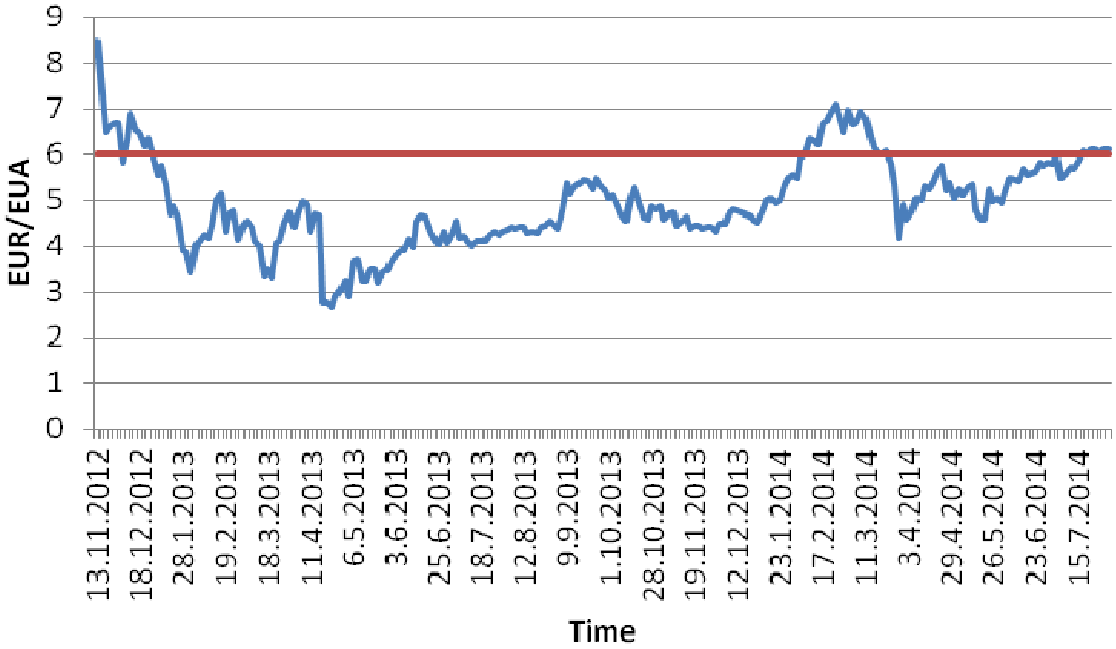

Figure 2. **EUA Auction Price at the Primary Market in the 3rd Trading Period,** *authors' construction* (EEX, 2014)

We can see that the EUA auction price in 2013 fluctuated in the interval between 6.18 EUR/EUA (7.1.2013) and 2.75 EUR/EUA (18.4.2013), where only 2 auction days had the auction price higher than 6 EUR/EUA. Comparing Figure 2 with Figure 1, it is obvious that electricity and heat producers evaluated the EUA price as small and therefore participated at the market only in the role of buyers – usually bought the EUAs only to cover all of their CO_2 emissions.

Comparison of characteristics of environmental taxes and EUAs. Regarding the current environmental taxation in Czech Republic, we can find energy taxes imposed on electricity, solid fuels and natural gas; however, this group of taxes represents indirect environmental taxation, not imposed directly on emissions. Based on the Database on instruments used for environmental policy, administrated by OECD (2014), some environmental fees in Czech Republic can be considered as direct environmental taxes, mainly the fees imposed on emissions in the air protection area.

Focusing on budgetary determination of revenues from environmental taxation and the EUA auctions, all additional revenues obtained from the auctions (the EUA auctions on behalf of Czech Republic) are the income of the State Budget of Czech Republic. However, at least 50% of all revenues should serve as an additional source

of financing for the projects focused on greenhouse gas emissions decreasing, introduction of innovations in industry sector, energy efficiency improving, energy intensity decreasing, science and research support and other project specified in current legislation of Czech Republic. Table 1 shows the overview of distribution of this kind of auctions revenues.

Table 1. **Distribution of 50% of Total Auctions Revenues,** *%*

Period	State Environmental Fund	Ministry of Industry and Trade
2013	100	0
2014–2015	65	35
2016–2020	60	40

Source: Current legislation; authors' summary.

Dealing with an average auction price at the market in the year 2013, we can compare this auction price with air protection fee's rates in Czech Republic (imposed on SO_2, NOx, VOC and PM emissions) and the CO_2 tax proposal[3]. Figure 3 shows the comparison of all tax rates, charges and pollutant's prices in 2013. However, energy taxes are missing, since their rates are not directly imposed on pollution.

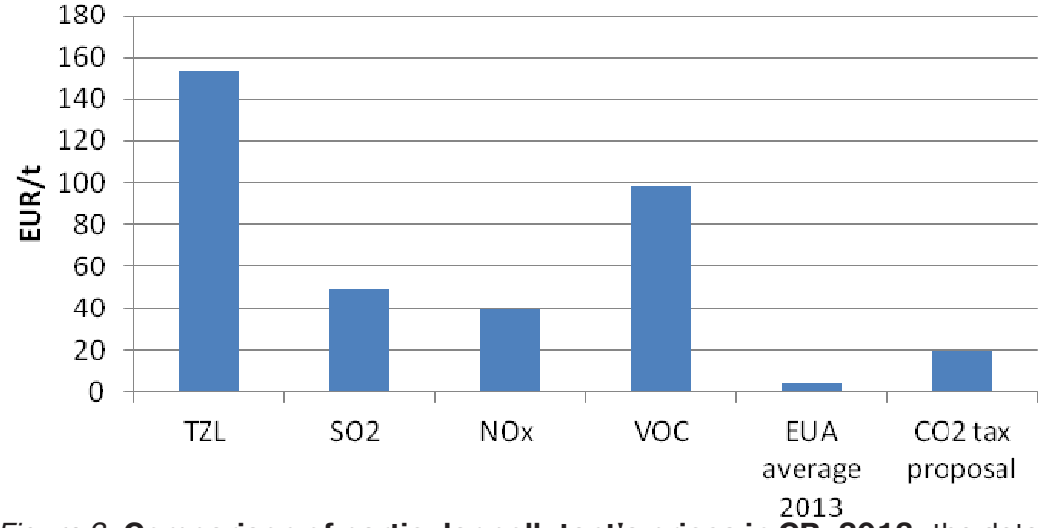

Figure 3. **Comparison of particular pollutant's prices in CR, 2013,** the data, summarized *by the authors from the current Czech Republic legislation and the EEX, 2014*

The average EUA auction price in 2013 (4.4 EUR per ton of CO_2) is much lower than all of the fees imposed on other pollutants in air protection, relative to the tonne of particular pollutant; moreover it is lower than CO_2 tax proposed in the revision of Directive 2003/96/EC (20 EUR per ton of CO_2). However, we should focus also on the revenues obtained from the EUA auctions, air protection fees and general energy taxation, based on the current Directive 2003/96/EC. Figure 4 shows the comparison of all revenues from environmental taxes and charges in the air and climate protection area and the EUA auction's revenues in Czech Republic in 2013.

It is obvious, that contrary to the lowest "price" per ton of pollution, the revenues from the EUA auctions in 2013 were much higher than the revenues obtained from all

[3] Revision of 2003/96/EC Directive.

of the air protection fees; furthermore, exceeded revenues obtained from particular energy taxes – natural gas tax, solid fuel tax and electricity tax. We can say that the auctioned EUAs were an important source of public budgets revenues in Czech Republic in the year 2013.

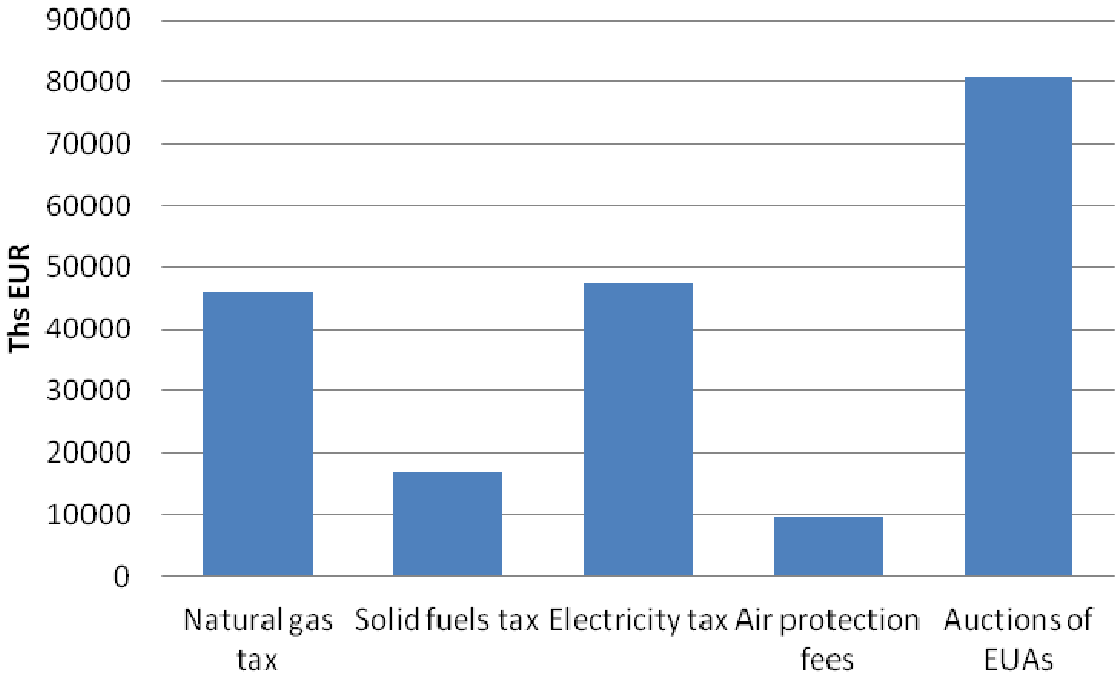

Figure 4. **Environmental taxes and EUA auction's revenues in CR, 2013,** *the data, summarized by the authors from* (EEX, 2014; MoF, 2014)

The characters of CO_2 emission allowances and environmental taxes are more similar mainly in the 3rd trading period (2013–2020), since the general rules have changed and the important yield of emission allowances is auctioned. Table 2 summarizes particular characteristics of the auctioned EUAs, energy taxes and emission fees in 2013 in Czech Republic and focuses on their comparison.

Table 2. **The characteristics of the EUA, energy tax and emission fee in 2013**

	EUA auctions	Energy taxes	Emission fees
Pollution price, tax rate	Floating, based on market development	Fixed, based on 2003/96/EC	Fixed, based on national legislation
Market trading	Market price < 6 EUR/EUA – almost only purchasing Market price > 10 EUR/EUA – also sale	No	No
The major role of companies	EUA price payer	Tax payer	Fee payer
Budgetary determination of revenues	General state budget, State Environmental Fund	General state budget	State Environmental Fund
Emissions	CO2 and ekv.	Indirect relationship – mix of emissions	SO2, NOx, VOC, PM
Payer	Companies	Companies, households	Companies
Primary price impact	Energy product's prices	Energy products' prices	Energy products' prices

Source: Current legislation; authors'.

It is obvious that there was one significant difference between auctioned EUAs and environmental taxes and fees in Czech Republic in the year 2013 – it was pollution price or in case of indirect taxes the tax rate. While in the case of environmental taxes and fees in Czech Republic the tax rate was fixed, in case of the auctioned EUAs the "tax rate" was floating.

Regarding other characteristics, trading on the exchange, we can say, that the low EUAs price in 2013 represented weak motivation for electricity and heat producers in Czech Republic to trade on exchange. Generally, companies were almost entirely buyers on the exchange, they were willing to sale only if the EUA price was higher than 10 EUR.

Focusing on other characteristics of environmental taxes, fees and auctioned emission allowances, it is obvious, that their characteristics in Czech Republic in the year 2013 were similar, precisely the major role of companies (producers), budgetary determination of revenues, payers and primary price impact.

However, focusing on addressing emissions, there was a difference, of course, since Czech Republic had no direct carbon taxes in 2013. Regarding technical data connected with air pollution and climate policy in the Republic, you can see the study by (Madr et al., 2014).

Conclusions and directions for further studies. This paper is focused the an ex post analysis of the EU ETS characteristics in Czech Republic in 2013 and their comparison with the environmental taxation. The research is based on the analysis of electricity and heat producer's behaviour. The comparison and assessment of emission trading and environmental taxation is not trivial, since it can be important additional source of information for policy makers in the EU.

Regarding the behaviour of Czech companies within the EU ETS in 2013, it is obvious, that most of them evaluated the EUA price as small and therefore at the market they were only in the role of the buyer, usually buying the EUAs only to cover their CO_2 emissions. Moreover, the budgetary determination of revenues obtained from the EUA auctions in 2013 was the same as in the case of environmental taxes and fees in Czech Republic. Therefore, the characteristics of CO_2 emission allowances and environmental taxation in the Republic were more similar in 2013 than in the previous trading periods. Focusing on the characteristics of an auctioned emission allowance and environmental taxes and fees, it is obvious that the EUA behaved as an additional carbon tax or fee – in case that a company exceeded the level of emission limit represented by free emission allowances. The most significant difference can be visible in the "floating tax rate".

The problem of particular economic instruments impacts in the air and climate protection area is very interesting. Since the presented analysis refers only with economic characteristics of environmental taxation and emission trading, the following research should be focused on the relationship between particular economic instruments and pollution development in Czech Republic.

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