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Content

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Emission allowances and environmental impact

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Abstract

The aim of the work was to analyse the mechanism of emission allowance trading within the European Union and to assess its impact on the environment. The period chosen was from 2014 to 2021. The aim was to determine whether changes in emission allowance prices affected the level of greenhouse gas emissions and to assess whether there is a linear relationship between the price of emission allowances and the level of emissions. The validity of this relationship was examined using content analysis and regression analysis. The results of the regression analysis indicated a moderately strong positive linear relationship between the variables, which indicates that if the price of emission allowances increases, the level of emissions tends to decrease and vice versa. In the monitored period, the prices of emission allowances increased, while greenhouse gas emissions tended to decrease. The lowest prices of allowances were recorded in 2014–2017 due to their surplus, while since 2019 prices have increased due to a limitation of their quantity in circulation. The analysis showed that emissions trading has a significant impact on reducing emissions and supports investment in cleaner technologies. The biggest limitation of the work was the variability of external factors, such as economic changes and political measures, that influenced the research.

Keywords: Emission allowances, emissions trading, European Union, CO2 emissions, regression analysis

Introduction

The Earth's climate is changing at a rapid pace, and each of us plays a key role in the products we buy, the electricity we use, the ways in which manufacturing units produce toxic waste, release carbon dioxide and other harmful greenhouse gases, all of which lead to global warming. It also has a serious impact on our environment and economy, affecting both future and current generations. To combat the problem of global warming, the UNFCCC includes the Kyoto Protocol, which is a universal agreement between countries and commits them to setting universally binding emission reduction targets (Tripathi, 2020).

Emissions trading within the European Union has affected European industrial companies since 2005. Companies have to choose a strategy to minimize the costs associated with emission allowances given the constantly changing conditions of the system and the volatile price of allowances, which makes this decision very difficult. Moreover, increasing pressure on society from policy makers is aimed at increasing the efficiency of the system and increasing the price of emission allowances (Zapletal, 2019).

On the contrary, Lin, BQ et al. (2020) stated that the problems of excessive CO2 emissions and global warming caused by human activities are more binding than we thought. Measures such as carbon taxes and emissions trading schemes, which include mechanisms to mitigate emissions, are being used to address these problems.

The Emissions Trading System (ETS) has long been seen as a promising tool for regulating massive carbon emissions from energy-intensive industries. However, it remains unclear whether the ETS can achieve emission mitigation without disrupting economic activity in specific sectors in emerging markets (Quan et al. 2023).

The European Union Emissions Trading System (EU ETS) was created to reduce greenhouse gas emissions. Companies that produce carbon emissions must manage the associated cash flows by buying or selling carbon allowances. In addition, future carbon prices could influence a company's decision to invest in decarbonization technology, García et al. (2020) reported.

The aim of this work is to analyse the mechanism of emission trading within the European Union and to assess its impact on the environment. The target will be set from 2014 to 2021.

In connection with the objective, the following research questions are set:

VO1: What is the real impact of emission trading on the environment in the European Union?

VO2: What are the environmental impacts of emissions trading from 2014 to 2021?

Methods and Data

Date

To answer the first research question regarding the impact of emission trading on the environment in the European Union, data from the Trading website will be used.

economics (Trading economic, 2024), European Council (European Council, 2024), Eurostat (Eurostat, 2024).

The data will be monitored and recorded in a table in MS Excel. The subject of monitoring will be the price of emission allowances for individual years, expressed in Czech crowns. The impact of CO2 on the environment will also be evaluated. The overall impact of emission allowances will be described. The obtained data will be projected into graphs. The monitored period will cover the years 2014 to 2021. Data on emission allowances will be obtained from the website Climate Facts (Climate Facts, 2024).

These data also follow up on the second research question, which focuses on assessing the environmental impacts of emissions trading from 2014 to 2021.

Methods

To answer both research questions, regression analysis will be used to analyze the actual impact of emissions trading on the environment. Regression analysis will identify potential relationships between emissions trading and various environmental indicators, such as air quality, greenhouse gas emissions, or climate change.

To answer the research questions, a linear regression model will be used, which allows the prediction of the value of the dependent variable based on the values of the independent variables. The least squares method will be used to estimate the parameters of this model.

The following formula is used to calculate the parameters of a linear regression model using the least squares method:

To estimate the regression equation:

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + \cdots + b_kX_k \quad (1)$$

To estimate the regression coefficients:

$$b_1 = \frac{\Sigma_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\Sigma_{i=1}^{n}(X_i - \bar{X})^2} \quad (2)$$

$$b_0 = \bar{Y} - b_1\bar{X} \quad (3)$$

$\hat{Y}$ is the predicted environmental value,

b_0 is the estimate of the intercept (constant)

$b_1, b_2, \ldots, b_k$ are estimates of the regression coefficients

$X_1, X_2, \ldots, X_k$ are the values of emission allowances or other relevant factors,

Y is the state of the environment

$\bar{X}$ is the average of the emission allowance values,

$\bar{Y}$ is the average of the environmental state

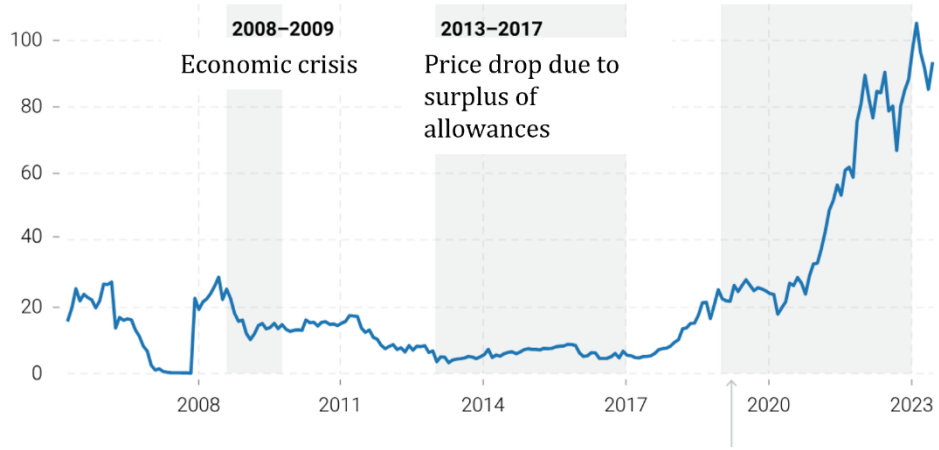
n is the number of observations

The calculation will be performed in Excel using data and data analysis and a regression analysis formula.

Results

The data shown here is from 2014–2021.

Figure 1: Development of the price of emission allowances in euros



Source: Trading economics.

Figure 1 shows the development of emission allowances from 2008 to 2023. The data was obtained from the Climate Facts website. The data was recorded in European currency. The figure shows the maximum value of emission allowances in 2023. In the years 2013-2017, the price of allowances fell due to their surplus. Since 2019, the price of emission allowances has increased due to a decrease in their quantity in circulation.

Table 1: Volume of emission allowance prices

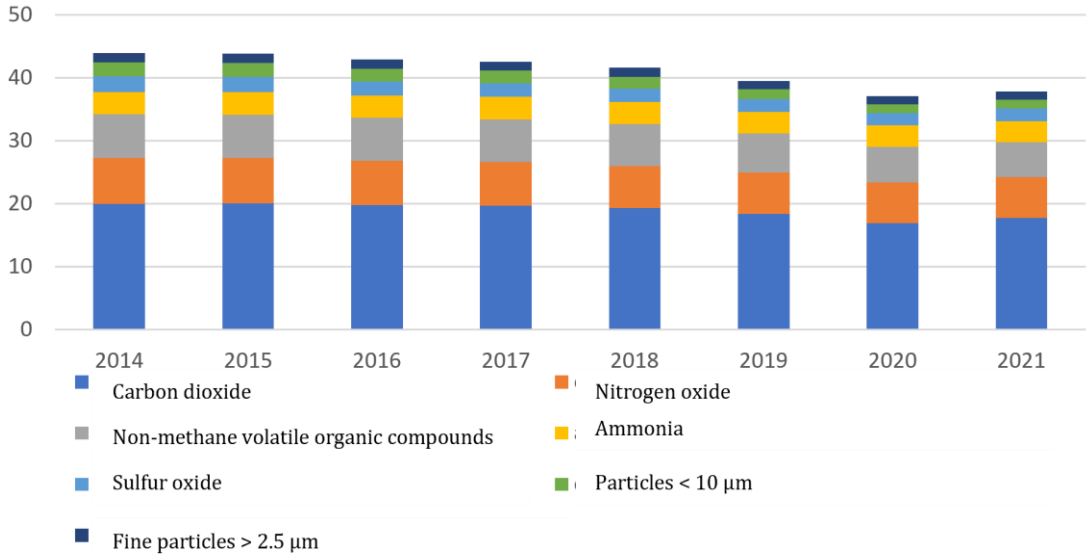
Year	Volume in billion CZK
2014	2.08
2015	1.97
2016	1.8
2017	1.7
2018	1.6
2019	1.7
2020	1.6
2021	1.9

Source: Own processing.

Table 1 shows the volume of emission allowances in the European Union in individual years from 2014 to 2021. The data is recorded in billions of Czech crowns. It can be seen from the table that the lowest volume was in 2018 and the highest in 2014. The volume is also decreasing because not as many allowances are issued for fees anymore, some are

even valid without fees.

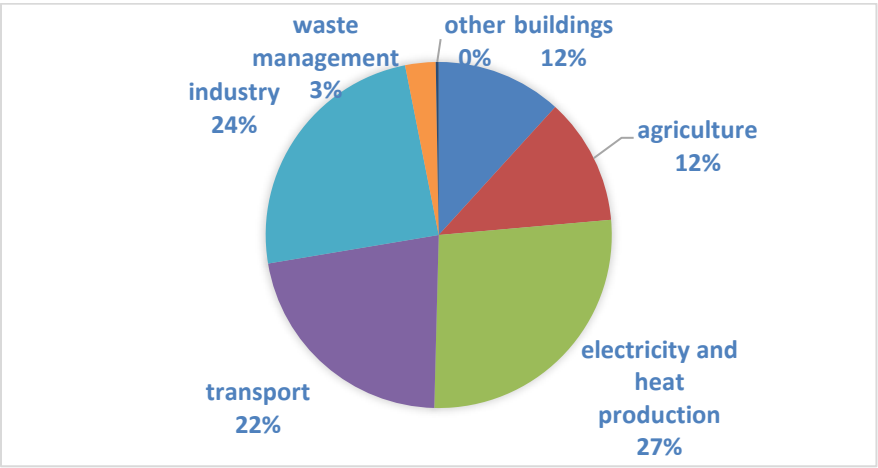
Figure 2: Air pollutant emissions from 2014-2021



Source: Own processing (Eurostat).

Figure 2 shows emissions of air pollutants from 2014-2021. Data on individual types of emissions are obtained from the Climate Facts website. From the chart, we can identify 7 individual substances that occur in the European Union. As can be seen from the chart, over the past few years, it can be observed that individual emissions are decreasing, except for a small jump in 2021.

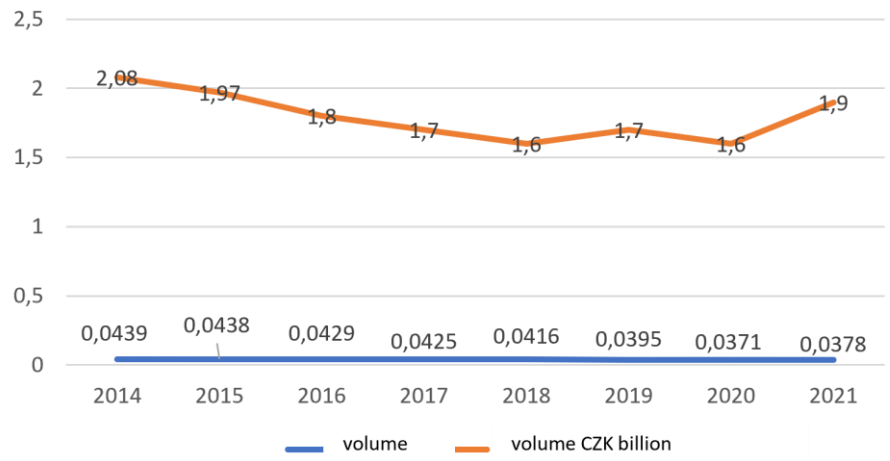
Figure 3: Greenhouse gas emissions in the EU by sector



Source: Own processing (Climate Facts).

Figure 3 shows greenhouse gas emissions in the European Union by sector. It shows 7 sectors, which show in percentage terms how harmful each sector is to Europe. The most polluting sector is electricity and heat production, followed by industry, which is also quite harmful to the environment.

Figure 4: Comparison of emissions and emission allowances



Source: Own processing.

Figure 4 shows the volume of emission allowances in Czech crowns and the volume of emissions in the air. This is all focused on the European Union. The period from 2014-2021 is shown here. From the graph we can see that the volume of individual emissions is not as high as the volume in crowns.

Table 2: Regression analysis calculation

Regression statistics	
Multiple R	0.49625
Reliability value R	0.246264
Set reliability value R	0.120642
Average value error	0.165102
Observation	8

Source: Own processing.

Table 2 contains the results of the regression analysis. The analysis was created in Excel. The data used were the volume of emission allowances and the volume of emission allowance prices in billions of crowns. This regression analysis provides information about the relationship between two variables. The multiple R, which measures the strength and direction of the linear relationship between the variables, was calculated to be 0.496, indicating a moderately strong positive linear relationship. The reliability value of R reaches 0.246, which represents the square of the correlation between the observed and predicted values, while the set reliability value of R is 0.120, which means that 12% of the variability of the explained variable can be explained by the modeled factors.

Table 3 Further calculation of regression analysis

ANOVA								
	Difference	SS	World Cup	F	Significance of F			
Regression	1	0.053436	0.053436	1.960351	0.211006			
Residue	6	0.163551	0.027259					
Total	7	0.216988						
	Coefficients	Average value	t Stat	P-value	Lower 95%	Upper	Lower	Upper

		error				95%	95.0%	95.0%
Limit	0.449161	0.962107	0.466851	0.657077	-1.90503	2.803353	-1.90503	2.803353
File X 1	32.68524	23.34451	1.400125	0.211006	-24.4367	89.80721	-24.4367	89.80721

Source: Own processing.

This part of the table contains the results of the analysis of variance (ANOVA) and the coefficients of the regression analysis. The variance is evaluated for the difference between the regression and the residuals, the total difference, and their significance. The regression shows that the model has explanatory power, but is not statistically significant ($F = 1.960$, $p = 0.211$). The regression coefficients describe the relationship between the independent variable (X) and the dependent variable (Y). The t-values, together with their significance (p-value), indicate the statistical significance of the relationship between X and Y. In this case, none of the coefficients are statistically significant.

Discussion

Based on the results obtained, we can answer the research questions:

VO1: What is the real impact of emission trading on the environment in the European Union?

Based on the research, it can be assessed that the trading of emission allowances in the European Union has a significant impact on the environment. The analysis of the data shows that the price of emission allowances tends to influence the emission level, through the mechanism of market forces. The falling prices of allowances in the years 2013-2017 led to a surplus of allowances and a subsequent drop in the price, which was associated with higher emissions. On the contrary, since 2019, when the number of allowances in circulation was limited and the prices of allowances began to increase, emissions have started to decrease.

The data also suggests that the volume of emission allowances in circulation is linked to the volume of emissions, and that reducing the volume of allowances can lead to a reduction in emissions. The graphs and tables show that while emissions are decreasing, the volume of allowances to regulate them is decreasing, which can still reduce emissions if properly implemented and managed.

It can therefore be confirmed that emissions trading in the European Union has a positive impact on the environment, through the regulation of emissions and the encouragement of investment in cleaner technologies.

Dimos et al. (2020) examined the effects of capping on the price of allowances and the power of the financial sector in ETS trading. Their analysis provided useful insights into the mechanisms that influence the price of emission allowances and financial market dynamics within the ETS.

VO2: What are the environmental impacts of emissions trading from 2014 to 2021?

According to the analysis carried out as part of this study, the environmental impacts of emissions trading in the European Union from 2014 to 2021 were examined.

During the monitored period, the price of emission allowances showed a significant change. There were periods when prices decreased due to a surplus of allowances, and, conversely, periods when prices increased due to a decrease in the number of allowances in circulation. The maximum value of emission allowance prices was recorded in 2023.

The volume of emission allowances in the EU also showed changes. The lowest volume was recorded in 2018 and the highest in 2014. The trend shows a decreasing volume of allowances due to a smaller number of newly issued allowances and the cancellation of some valid ones. Emissions of air pollutants over the monitored period showed a slight decrease, with the exception of a small increase in 2021. The regression analysis performed as part of the work provided information on the relationship between the volume of emission allowances and their prices. It turned out that there is a moderately strong positive linear relationship between these two variables.

It can be said that trading in emission allowances in the EU has complex impacts on the environment, whether through pricing mechanisms, the volume of allowances or the emissions of air pollutants.

Fernandez et al. (2018), their study assessed the effectiveness of the EU-ETS in reducing greenhouse gas emissions and provided key insights for further optimization and implementation of economic mechanisms in the field of emissions regulation.

Conclusion

The aim of this work was to analyse the mechanism of emission allowance trading within the European Union and to assess its impact on the environment. The target was set from 2014 to 2021. Based on the analysis carried out, it can be stated that the objective of the work was met.

This study conducted extensive research aimed at analyzing the mechanism of emission allowance trading within the European Union and assessing its impact on the environment in the period from 2014 to 2021. Based on the knowledge and analysis obtained, the work will examine possible strategies for improving and optimizing this instrument with regard to environmental protection and sustainable development.

Content analysis and regression analysis were used in this work. These analyses were used for both research questions. Content analysis and regression analysis methods were used to identify the relationships between emission trading and the environment.

The first part of the thesis provides an overview of the development of emission allowance prices over the years. Figure 2 shows that since 2019, the price of emission allowances has increased, which was caused by a decrease in their quantity in circulation.

The volume of emission allowances within the European Union was also monitored in individual years. Table 1 shows that the volume of allowances decreased, which was mainly caused by a decrease in the issuance of new allowances and invalid allowances.

The following section analyses emissions of air pollutants in the period 2014-2021. Figure

2 shows that emissions of these substances have gradually decreased, with the exception of 2021, when there was a moderate increase.

Another analysis focused on greenhouse gas emissions in the European Union by sector. Figure 3 shows that industry and electricity and heat production account for the largest share of emissions.

Subsequently, a comparison was made between the volume of emission allowances and the volume of emissions. Figure 4 shows that the volume of emission allowances in Czech crowns is much higher than the volume of emissions, which may be the result of various factors, including the reduction of emissions within the EU.

Finally, a regression analysis was performed to identify the relationship between emission allowance trading and environmental indicators. The results of the regression analysis (Table 2) show that there is some connection between emission allowance trading and the state of the environment, but this connection is not completely significant.

Overall, it can be said that the work achieved its goal and provided a comprehensive view of the impact of emission allowance trading on the environment in the European Union.

The recommendation for further research is to continue monitoring the emissions trading mechanism after 2021 and to analyse its long-term environmental impacts. It would also be appropriate to increase the frequency of data collection in order to capture a wider range of factors influencing the emissions trading market. A higher frequency of data collection could lead to more accurate and detailed conclusions. The results of this work can be used, for example, to predict the future development of the emissions trading market and its impact on the environmental policy of the European Union.

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