



The Effect of R&D Expenditure on CO₂ Emissions in Austria

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ABSTRACT

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The developed financial sector can significantly provide financial services to developing economies by the motive as well as best opportunity of using new advanced technology. Financial development would increase R&D investment as to speed up growth, thereby influencing the environmental quality. The objective of this research is to determine the effect of R&D expenditure on CO₂ emissions in Austria in 1996-2006. We presented a quantitative study using simple linear regression to analyze the data and we found that R&D expenditure has significant effect to CO₂ emissions in Austria in 1996-2006. The fact that R&D influence on CO₂ emissions can be positive, negative and insignificant must be taken into account when designing environmental policies and various programs, strategies and initiatives to encourage and fund R&D activities, in the context of environmental protection, government efforts should be focused on the promotion and support of R&D programs directly aimed at reducing CO₂ emissions.

Introduction

Over recent decades the sustainability of economic growth has become a critical objective for most of the economies and achieving these goals need the stability or reducing the emissions of Green House Gas (GHG) ([Fernández Fernández et al., 2018](#)). An environmental perspective shows us that economic growth based on consumption of fossil fuels is closely related to environmental degradation, and the economic theory considers the accumulation of R&D to be essential for economic growth ([Fernández Fernández et al., 2018](#))

Environmental scientists highlight that use of energy consumption producing CO₂ emissions, which have one of the main reasons for forming greenhouse gas (GHG); resulting in climate change and global warming and consequently, around the world, there is more consciousness of the eco-friendliness and consequences of economic growth, therefore, countries shifted their attention from economic growth to the environmentally friendly economic growth ([Raghutla & Chittedi, 2020](#)).

Energy supplies needed for more productions, and the energy consumption use in emerging nations was 16% higher than the advanced nations in 2010, whereas emerging nations was estimated to consume 88% more energy than advanced nations by 2040 ([Paramati et al., 2016](#)). Energy consumption and economic growth alone cannot explain carbon (CO₂) emissions ([Ozturk & Acaravci, 2013](#); [Zhang, 2011](#)). Many researches show that macroeconomic variables have a relationship with other things. For example macroeconomic variables have cointegration with the Dow Jones Industrial Average Index toward Indeks Harga Saham Gabungan in Indonesia ([Sukmawati & Haryono, 2021](#)), the Nepalese investors do not think that there is no relation between the economic condition of the nation and the stock market trend ([Vaidya, 2021](#)), and macroeconomic variables associate with non-performing loans ([Khairi et al., 2021](#)). The developed financial sector can significantly provide financial services to developing economies by the motive as well as best opportunity of using new advanced technology; it may help them to maintain clean environment with help of environmentally friendly production, thus providing with a higher level of the global environmental quality and further it will boost sustainable development of economies ([Frankel & Rose, 2002](#)). Financial development would increase R&D investment as to speed up growth, thereby influencing the environmental quality ([Frankel & Romer, 1999](#)). This research aims to determine the effect of R&D expenditure on CO₂ emissions in Austria, because the population is 8.8 million according to data on April 1, 2018, therefore we suspect that CO₂ emissions are still at a safe level.

Literature Review

Financial development has a significant positive impact on carbon (CO₂) emissions in the case of India ([Boutabba, 2014](#)). In Latin America, financial development has a significant positive impact on CO₂ emissions ([Blanco et al., 2013](#)). Financial development significantly decreases CO₂ emissions in the case of Indonesia ([Shahbaz et al., 2013](#)). Other research reported a bidirectional causality relationship between FDI net inflows and carbon emissions for a panel of developing economies ([Hassaballa, 2014](#)).

A research estimates suggest that the relationship between R&D and CO₂ emissions is time-varying, the estimated time varying coefficient function of R&D was negative for three quarters of the period studied, but was positive for a 35-year period (1955–1990) during the second half of the twentieth century and the non-parametric local linear estimates show that the common trend functions gradually increased for the first 110 years (1870–1980), but then flattened out and showed a slight decrease for the next three decades ([Awaworyi Churchill et al., 2019](#)). The results of the model of the research support the hypothesis that spending on research and development contributes positively to the reduction of CO₂ emissions for developed countries, with regarding the regions, the corrective effect in the European Unión (15) compared to the figures in the United States is highlighted, and with regard to energy consumption, the results show that this variable is linked to the

growth of CO₂ emissions so that increases in energy consumption translate into an increase in emissions, which the European Union (15) is where the effect of this variable is lower, followed by the United States where energy consumption is more polluting, and finally the results obtained for China are quite different, due to its economic and environmental performance ([Fernández Fernández et al., 2018](#)).

The estimates of long-run regression models of the study, that analyze the impact of research and development (R&D) expenditures on CO₂ emissions in 16 Organisation for Economic Co-operation and Development (OECD) countries for the period between 1981 and 2014, show that the expected average effect of R&D expenditures on CO₂ emissions is negative. Growth of R&D investments by 1% reduces CO₂ emissions by 0.09%-0.15% on average, but estimated country-specific regressions indicate that the long run effect of R&D expenditures on CO₂ emissions can be both positive and negative, and they vary from -0.79% in Denmark to 0.52% in Belgium, in other words, in most cases, viewed from a long-term perspective, higher R&D expenditures reduce CO₂ emissions, but this does not apply to about 40% of countries ([Petrović & Lobanov, 2020](#)). The impact of energy research innovations on CO₂ emissions in France in the period from 1955 to 2016 and the results they obtained indicated negative effects ([Shahbaz et al., 2018](#)). The impact of environmental innovations on CO₂ emissions in 30 Chinese provinces over the period between 2000 and 2013 tested and the results have demonstrated that majority of environmental innovation variables in China effectively reduce CO₂ emissions ([Zhang et al., 2017](#)).

The effect of technological changes on CO₂ emissions in 95 countries in the period between 1996 and 2007 explored and after separating the scale from intensity effects, the obtained results suggested the negative impact of technological progress on CO₂ emissions ([Li & Wang, 2017](#)). The effect of green research and development investment on CO₂ emission and financial performance for Japanese manufacturing firms in the period between 2001 and 2010 analyzed and the results indicate negative impact of green research and development investment on CO₂ emissions ([Lee & Min, 2015](#)). The empirical testing of impact of public energy R&D investments on carbon emissions per GDP for 13 developed economies in the period from 1980 to 2004 have carried out and reveals that public energy R&D investments do not have a significant impact on CO₂ intensity ([Garrone & Grilli, 2010](#)).

Method

We presented a quantitative study ([Bajpai, 2018](#)), which is a case study in Austria in 1996-2006. The research data is obtained from the World Bank website. Purposive sampling was used in this study by using the available data criteria. This study uses simple linear regression data analysis ([Bajpai, 2018](#)), caused by the use of one independent variable each, R&D expenditure and the dependent CO₂ emissions. The regression equation is as follows:

$$Y = \alpha + \beta X + e$$

Explanation:

Y = CO₂ emissions

α = constant

β = regression coefficient

X = R&D expenditure

e = error

Result and Discussion

The results of the data analysis of this study indicate that there is an influence R&D expenditure on CO₂ emissions in Austria in 1996-2006. The regression equation as follows:

$$Y = 5.721 - 0.420 X$$

Y is CO₂ emissions and X is R&D expenditure. The equation above shows that each unit addition of R&D expenditure will cause decrease in CO₂ emissions of 0.420 units.

The results of the analysis are presented in table 1 and table 2 below:

Table 1
R square result

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.514 ^a	.264	.226	.4336175019929

a. Predictors: (Constant), r_d

Table 2
Linear regression result

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.721	1.282		4.461	.000
	r_d	-.420	.161	-.514	-2.614	.017

a. Dependent Variable: co2

The 0.017 significance figure shows that there is a significant effect of R&D expenditure on CO₂ emissions. The R square figure of 0.264 indicates that the R&D expenditure variable explains the CO₂ emissions variable by 26.4% and the remaining 73.6% is explained by other variables. The results of this study are in line with previous studies ([Awaworyi Churchill et al., 2019](#); [Fernández Fernández et al., 2018](#); [Garrone & Grilli, 2010](#); [Lee & Min, 2015](#); [Petrović & Lobanov, 2020](#); [Shahbaz et al., 2018](#)).

The fact that R&D influence on CO₂ emissions can be positive, negative and insignificant must be taken into account when designing environmental policies and various programs, strategies and initiatives to encourage and fund R&D activities, in the context of environmental protection, government efforts should be strictly focused on the promotion and support of R&D programs directly aimed at reducing CO₂ emissions and increasing the use thereof ([Petrović & Lobanov, 2020](#)). For example the German Federal Ministry of Education and Research is financially focused on R&D projects and innovations in the field of CO₂ utilization ([Mennicken et al., 2016](#)). Emerging market economies, especially, need to focus on the financial sector development since financial development has a considerable impact; however, in the perspective of sustainable development, the study suggests that both policymakers and governments initiate long-run financial development policies, and should significantly initiate future development plans and targets for the emerging group to reduce their risk and significantly increase their total share of the finance in the global market, and finally economies in the initial stages can build confidence among the international groups by creating a trade-friendly environment and encouraging foreigners to directly participate in the emerging economies ([Raghutla & Chittedi, 2020](#)).

Conclusion

The result of the research shows that there is a significant effect of R&D expenditure on CO₂ emissions. This study has limitations in independent variable. Future studies should use different independent variable that associate with CO₂ emissions, such us GDP and the number of vehicles in the country.

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