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Does it Matter Fiscal or Monetary Policy on Environmental Issue?

Evidence from Kernel-Based Regularized Least Squares

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(KRLS) for USA İbrahim ÖZMEN¹ Selçuk BALI² ABSTRACT The carbon dioxide emission, which plays a major role in climate change, is an important indicator of the climate crisis. The United States (USA), which is a leader in terms of the global economic system, also has important roles in global climate change. USA has been reducing CO₂e per capita since 2006. What policy options can be effective for the USA in tackling climate change? We explore the

effectiveness of monetary and fiscal policies on

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CO₂e based on the USA's 1990-2019 annual data in order to answer this question. KRLS results indicate that fiscal policy is more effective for reducing CO₂e in the USA than monetary policy. Our findings can encourage policymakers for fiscal policy in the struggle with climate change. Key words: Climate crisis, Fiscal policy, Monetary policy, Kernel-Based Regularized Least Squares Introduction In this day and age, climate change and urgent climate actions that can produce solutions are among the most important issues (Öztürk and Acaravci, 2010; IPCC, 2022). Reducing carbon dioxide emissions (after here CO₂e) can be the first line of visible actions in the struggle with climate change (Halicioğlu, 2009). Because

one of the main sources of climate change, is greenhouse gas emissions

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(36-72 % water vapor, 9-27 % carbon dioxide, nitrous oxide, 4-9 % methane and 3-7 % ozone) (Wikipedia, 2022), and the most famous of which is CO₂. The current global carbon emission level has reached 1.5 times the 1950 level. According to the researchers, the extent and rate of decline in Arctic Sea ice levels in 2017 have been unprecedented in at least the last 1,500 years. The global mean sea level in 2020 has 91.3 millimeters above the 1993 average (GML, 2022). Apart from these, among the topics directly affected by climate change, dozens of others such as water, health, food and agriculture, energy, governance, finance, and urbanization can be said (

Balsalobre-Lorente et. al ., 2018; IPCC, 2022). The relationship between greenhouse gas emissions and 7

the economy has been discussed in the literature for a long time and empirically tested. Such studies examples Halicioğlu (2009),

Apergis and Payne (2010), Öztürk and Acaravci (2010), Apergis and Öztürk (2015), Zafar 2
et. al . (2021), Wang et. al

. (2022), Xue et. al. (2022) can be shown. On the other hand, these empirical studies continue accompanied by different models in which many variables are 1Selcuk University,

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, ORCID No: 0000- 0003-2632-4217 2Selcuk University, Department of Public Finance, e-mail: selcukbali@selcuk.edu.tr, ORCID No: 0000-0001- 5117-8720 added. Foremost among these are energy consumption (

Soytaş and Sarı, 2009), trade openness 1

(

Sadorsky, (2011; 2012) and Shahbaz et. al.(2014 1

), Özmen et. al. (2019) can be shown as instances. Among the recent studies, a subject that we have placed at the center of our examination draws attention. While market mechanisms and monetary policies have been preferred by policymakers until recently in the tackling of climate change, the possibility that fiscal policies can be used effectively is shown soon. Muhafidin (

2020), Ullah et. al. (2020), Adua et. al . (2020), Yılcı and Pata (2021) and Özmen 3
et. al

. (2022) can be cited as examples of studies that model and analyze fiscal policy tools in the strive for climate change. We focused on the USA's carbon policies, drawing attention to the role of the USA, which is a significant actor in the

global system, in the struggle with climate crisis in the global and regional sense. Figure 1: Time series for Co2 Let us see why we focus on the USA in Figure 1. Accordingly, the USA is above the world, OECD, and EU averages in terms of CO₂e. Since 2006, the amount of carbon dioxide per capita in the USA has been decreasing. On another hand China, the situation is the opposite.

In this paper, we explore the effects of monetary and fiscal policies on

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per capita CO₂e, based on the 1990-2019 annual data of the USA. We search for an answer which policy of the USA is effective in struggle CO₂e and which one will be effective. For this aim, we employ the KRLS method, adapted to econometric models by Ferwerda et. al. (2017). This study is as follows; literature in

Section 1, data and methods in Section 2. Section 3

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presents empirical findings, and finally conclusion and discussion. 1. Literature Studies dealing with the effects of fiscal and monetary policies on CO₂e differ due to different samples and different methods. It is difficult to say that these studies reached a common conclusion. However, some of the studies here show that fiscal policies can be effective in decreasing carbon emissions. Below we list some information about the studies that we can reach. We present some key findings about the studies that we can reach. Muhafidin (2019) aims to explore the role of monetary and fiscal policy in environmental degradation of Indonesia over the time span of 1973-2018. They found that there is a strong relationship between the Gdp, interest rate and exchange rate in the context of the Indonesia. Ullah et. al. (2020) explored the effects of government expenditures, government revenue and Gdp on the CO₂e using the data for 10 Asian economies. They used ARDL and NARDL approaches. Their findings can differ four columns a) an increase tax revenue uniquely increases government expenditure, a situation that increases CO₂e in China, India, Indonesia, Iran, Malaysia, Thailand, Turkey and the UAE and decreases in Japan, b) a positive public spending shock improve environmental quality in Japan; it worsens the situation in China, India, Indonesia, Iran, Malaysia, Thailand, Turkey and the UAE, c) reducing government expenditure only worsen environmental quality in Japan and improve these economies, d) at the end, there is no explainable result about Saudi Arabia. Adua et. al. (2021) explored the effect of state policy on energy consumption using a sample for all 50 U.S. states. They found that a) the relationship between energy efficiency policies implemented by state governments and energy consumption is either positive or statistically insignificant; b) savings from improved efficiency are often channeled into increased production and consumption, which have significant impacts on energy consumption. Chisti et. al. (2021) investigated the influence of fiscal and monetary policies on CO₂e employing a panel data set of BRICS economies from 1985 to 2014. Their results imply that fiscal policy can be effective reducing CO₂e. They also estimated while expansionary monetary policies deteriorate environmental quality, contractionary monetary policies improve that quality. Authors indicate that when fossil fuels are considered together with local consumer expenditures, their increase also increases pollution, and the use of renewable energy leads to a decrease in CO₂e and improves the quality of the atmosphere. Ahmed et. al. (2021) assessed whether there is an asymmetric link between renewable energy technology budgets, environmental sustainability and economic policy uncertainty for US in the context of the study over the time span 1985-2017. They found that renewable energy research

and development budgets have no significant effect on CO₂e reductions. Ullah et. al. (2021) explored the asymmetric effects of fiscal and monetary policy instruments for environmental pollution for Pakistan over the period 1985-2019. They used ARDL and NARDL methods. They found that a) a positive or negative shock in fiscal policy significantly increases CO₂e in the short-term, b) positive and negative monetary policy shocks have an increasing effect on short-term carbon emissions, c) a positive or negative shock in fiscal policy significantly reduces long-term environmental pollution, d) a positive monetary policy shock has a reducing effect on long-term carbon emissions. In another study, Mughal et. al. (2021) explored the dynamic effects of fiscal and monetary policy on environmental pollution for 5 ASEAN countries over the period 1990-2019. They employed panel and time series NARDL. The long-run coefficient found by using the panel ARDL reveals that if monetary policy is contractionary, CO₂e decrease, while expansionary monetary policy increases CO₂e. In addition, in the long run, when monetary and fiscal policies are used together, expansionary fiscal policy increases CO₂e, while contractionary fiscal policy reduces CO₂e in the long run. In the short run, contractionary monetary policy increases CO₂e, while expansionary fiscal policy increases CO₂e in the short run. Finally, the increase in GDP is driving CO₂e higher in the ASEAN region in general. Recently, Chien et. al. (2021) explored carbon impartiality goal in the USA over the time span of 1970-2015. They used the QARDL methodology. They found that a) it has been confirmed that there is a significant negative correlation between the past and lagged values of CO₂e in the short term and the current and lag values of CO₂e b) green growth and its square, ecological innovation and environmental taxes have a significant negative impact on determining CO₂e in the USA in the long run, c) green growth and its square, ecological innovation, environmental taxes and renewable energy play a vital role in reducing haze pollution such as air pollution (etc. PM_{2.5}). Kamal et. al. (2021) discussed the issue of fiscal policy, financial development and foreign direct investment in the era of globalization at the point of reducing environmental pollution, and a panel data set was used for the period 1990- 2016 in 105 countries. They used panel long-run coefficient estimations approaches and panel threshold regression. They clearly stated that a) both the expansionary fiscal policy and globalization seriously increase environmental pollution, b) the applied results demonstrate the validity of the pollution haven hypothesis (PHV), c) in the context of the countries covered in the study, it has been revealed by panel threshold regression that a certain fiscal policy is maintained even if it is at a minimum level. Finally, Özmen et. al. (2022) tackled the developed countries that applied carbon tax for the first time as a sample to investigate the effect of fiscal policies on carbon emissions. The findings of the empirical case, in which they applied a panel approach to the annual data from 1972 to 2017, showed that fiscal policy in the sample does not provide any evidence of the expected mitigating effects on environmental pollution in any country. Their principal findings show that revenue policy only funds government expenditure in these countries.

2. Data and methods We investigated the effects of monetary and fiscal policies on per capita CO₂e with the help of 1990-2019 annual data from the USA, through the model developed by Ullah et. al (2021). The functional definition of this model is as follows; $CO_2 = f(Gpp, Gex, Tr, Dr)$ (1) With this functional definition, CO₂e represents metric tons of carbon dioxide emissions per capita, Gpp represents US dollars per capita, Gex represents the ratio of total government expenditures to Gdp, Tr represents the ratio of total tax revenues to Gdp, and finally, the Dr is discount rates of the USA. Table 1 shows the definition, abbreviations, and sources of our data.

Table 1: Series, abbreviations and resource Series Definitions Abbr. Sources Carbon dioxide emissions CO₂ emissions (metric tons per capita) CO₂ World Bank Gross domestic product Gross Domestic Product (Gdp) Total, US dollars/capita Gpp OECD data General spending government Total, %Gdp Gex OECD data General revenue government Total, %Gdp Tr OECD data Discount rate Interest Rate, Discount Rate for USA, Percent per Annum Dr Federal Reserve Economic Data

Based on the functional definition above, we adapt the model in which our variables are as follows: $\ln CO_{2,t} = \partial_0 +$

$\beta_1 \ln Gp_{p_t} + \beta_2 \ln Gex_t + \beta_3 \ln Tr_t + \beta_4 \ln Cr_t + \varepsilon_t$ (2) Where, $\ln$ represents the natural logarithm of all variables, $\beta_1, \beta_2, \beta_3, \beta_4$ are estimation parameters and ε_t is error term. We estimated the equation in Equation 2 using the KRLS method developed by Hainmuller and Hazlett (2014). We focused on the variables of both single and interaction effect.

Therefore, we preferred the KRLS method to estimate the long and short-run coefficients. This method is based on a machine learning algorithm and can be adapted to econometric models. The KRLS method can make unbiased and consistent estimations with tools such as marginal effects and point distribution (Sarkodie and Owusu, 2020). This method developed by Hainmueller and Hazlett (2014) and later adapted to econometric models by Ferwerdaet. al. (2017), is a nonlinear estimator (Choi and Lee, 2020). 3. Empirical Findings Table 2 shows descriptive statistics of the series. $\ln CO_2$, $\ln gpp$, $\ln tr$ and $\ln dr$ are left skewed while $\ln gex$ is right skewed. This provides information about the possible long-run relationships of the series. $\ln dr$ and $\ln gpp$ have relatively high volatility. The volatility of other variables is relatively close to each other. Table 2: Descriptive Statistics Series Obs Mean Std. Dev. Min. Max. Skewness Kurtosis

Series	Obs	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis
$\ln CO_2$	30	2.89	0.10	1.68	3.01	-0.65	1.88
$\ln gpp$	30	10.61	0.30	10.07	11.08	-0.26	1.85
$\ln gex$	30	3.63	0.05	3.53	3.76	0.56	3.51
$\ln tr$	30	3.48	0.03	3.40	3.54	-0.36	2.21
$\ln dr$	30	0.85	0.82	-0.69	1.94	-0.44	1.75

The graphical representation of the variables is as in Figure 2. In Figure 2, Δ indicate the first difference and $\ln$ indicate the natural logarithm of the series. There is a remarkable point in this chart; different trends between CO_2e per capita and per capita income. The graphs showing the logarithmic values of the $\ln CO_2$ and $\ln gpp$ indicate asymmetric relationships. Government expenditures increased in the Global Financial Crisis (GFC) and tax revenues decreased. Crisis periods left their mark on fiscal policies. Finally, the discount rate abandoned its downward trend with the GFC in 2010 and reflects the footsteps of the increasing interest rate process in the USA. $\ln CO_2$ $\ln gex$ $\ln tr$ $\ln gpp$ $\ln dr$ ΔCO_2 Δgex Δtr Δgpp Δdr Figure 2: Series plots

6 Before proceeding to the estimation with KRLS, it is necessary to investigate whether there is a potential structural break in the research period after the simple regression estimation of the model belonging to equation 2. It is substantial to understand whether the cumulative sum is stable over time. CUSUM Square results are reported in Figure 2. Accordingly, the coefficient estimates are stable. These results are statistically significant at the 95% confidence interval. Figure 3: Cumulative sum test OLS CUSUM plot Table 2 below shows the estimations of the KRLS method, which is an advanced version of the OLS method and based on the machine learning procedure, showing the effects of the independent variables on the dependent variable. These estimates can also be presented in the form of results divided into three periods. Where, P25 = marginal effects in quartile 1, P50 = median marginal effects, P75 = marginal effects in quartile 3. Table 2: Result of KRLS estimations coefficient Variables Marj Eff. Std. Er. T P>t P25 P50 P75

Variables	Marj Eff.	Std. Er.	T	P>t	P25	P50	P75
$\ln gpp$	-0.170a	0.008	-19.46	0.000	-0.412	-0.209	0.096
$\ln gex$	-0.46	0.072	-0.063	0.531	-0.471	-0.195	0.254
$\ln tr$	-0.171c	0.091	-1.869	0.073	-6.451	-0.167	0.190
$\ln dr$	0.034a	0.004	4.662	0.000	0.005	0.023	0.047

Lambda 0.054 Tolerance 0.03 Sigma 4 Eff. Def. 16.94 R2 0.992 Loolloss 0.2928 Obs 30 Note: a and c indicate the statistical level of significance at 1% and 10%. According to the KRLS estimation findings of the model shown in Equation 2, the model is statistically significant at the 1% significance level. The significance of this regression in explaining CO_2e per capita for the USA is 99.2%. The heterogeneous marginal effects in the table can be characterized as short, medium and long term. Accordingly, the average marginal effects of $\ln gpp$, $\ln tr$ and $\ln dr$ on CO_2e per capita are 0.17%, 0.17% and 0.04%, respectively. Of these effects, the coefficient of $\ln tr$ and the coefficient of $\ln gpp$ have negative signs. On the other hand, there are no significant statistical findings regarding the average marginal effects of $\ln gex$ on CO_2e per capita for the USA. These findings imply that the effect of $\ln gpp$ on CO_2e is significant in the long-run, while $\ln dr$ is significant in all three periods. We can explain the long-term effects of $\ln gpp$, $\ln tr$ and $\ln dr$, which have statistically significant effects, with Figure 4 below. Marjinal effect of $\ln gpp$ to $\ln CO_2$ (A) Marjinal effect of $\ln tr$ to $\ln CO_2$ (B) Marjinal effect of $\ln dr$ to $\ln CO_2$ (C) Figure 4: Pointwise

marginal effect plots According to Figure 4 (A), the effect of high-level increases in lngpp on lnco2 continues up to a certain point, after this point (the first threshold point), the effect of lngpp on lnco2 disappears, but after this second threshold, it enters an increasing trend in both series. According to Figure 4 (B), increases in lntr are accompanied by asymmetric lnco2. The same cannot be said for lndr (C). Conclusion and Discussion We work out the effectiveness of fiscal and monetary policies in reducing per capita CO₂e based on annual data from the USA. For this, we preferred the discount rate, which is preferred in the literature, to represent monetary policies. We used the Gdp ratio of total public expenditures and the ratio of Total Tax revenues to Gdp to represent fiscal policies. We added to our model per capita Gdp as a control variable. From this point of view, are fiscal or monetary policies effective in reducing CO₂e in the USA? We sought an answer to his question. To answer the question, we employed the KRLS method, which has a novel non-linear and machine learning algorithm. Our findings show that as per capita income increases, per capita CO₂e decrease. Another important finding for us answered the main question of this paper: Tax policies, one of the leading fiscal policies, reveal carbon emission reduction effects for the USA. On the other hand, monetary policies (discount rate) increase carbon emissions. Finally, we do not have statistically significant evidence for the impact of government expenditure on CO₂e per capita. So, we answer that fiscal policy is more effective for reducing CO₂e in the USA than monetary policy. Our findings are in agreement with the findings of Chien et. al. (2021) and Ullah (2020) for developed countries. But it is not in agreement with the findings of Chisti et. al. (2021) and Özmen et. al. (2022). It may be that the sample investigated in these studies is not similar to the USA. Our methodological approach and period differ from theirs.

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