Referee report

MARTIN-LUTHER-UNIVERSITÄT
HALLE-WITTENBERG

As part of the course Causal Inference

"Mideksa, T. K. (2021).

Pricing for a cooler planet: An empirical analysis of the effect of taxing carbon.

CESifo Working Paper Series 9172, CESifo"

Submitted to Prof. Dr. Christoph Wunder, Dr. Andre Diegmann, Sachintha Sarasi Fernando

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Content

1. The research questions

This study explores the causal impact of carbon emissions changes in Finland following the implementation of a carbon tax in 1990. The analysis employs panel data at the country level, spanning the period from 1970 to 2005.

2. The modeling strategy ✓

The research narrows its focus on transportation emissions, which is a judicious choice due to the sector's stability (relative to other industries with minimal international trading, ensuring a well-preserved control group), its comparable structure across countries (facilitating the construction of a valid comparison unit), and data availability. The utilization of the Synthetic Control Method (SCM) is noteworthy, as it prioritizes an interpolation-based outcome, mitigating the risks associated with extrapolation in causal analysis. More, the application of Carbon tax is fully implemented, random assignment is not feasible due to data constraints. To ensure data integrity and to circumvent contamination, the data ends in 2005, prior to the commencement of the European-wide carbon pricing scheme (ETS) in 2005

3. The hypothesis formulated and tested

SCM is employed to address causal inference questions using aggregate data, focusing on scenarios involving only one or a few treated units. In this study, Finland is the sole treated unit.

3.1. Covariates ✓

The convex hull assumption is based on predictor variables that adhere to the parallel trend assumption. These variables encompass: the percentage of Urban Population, GDP per Capita (PPP), Gasoline Consumption per Capita, and Motor Vehicles (per 1,000 people). The counterfactual estimation is anchored in actual data, albeit with potential limitations in controlling for counterfactual effects due to the absence of certain relevant control variables. The author draws from the works of Abadie and Gardeazabal (2003) and Mideksa (2013), while acknowledging reservations about the exclusion of key factors such as social and educational controls. For instance, education's impact on fuel consumption behavior and the level of Research and Development (R&D) investment in emissions reduction can significantly influence future emissions outcomes. Therefore, it is recommended to incorporate variables related to education and emissions-reduction-focused R&D into the covariate set.

Yet the inclusion of a large number of covariates may lead to reduced degrees of freedom and increased model complexity. To mitigate this, the Lasso (regularization) method (ADH, 2010) can be employed to manage complexity by identifying and discarding unnecessary variables. This step helps prevent overfitting issues in the model, allowing for the appropriate selection of predictor variables. Alternatively, a robust approach involves running the model iteratively with different configurations of control variables to assess the stability and convergence of results (Adhikari, B. & Cherry, 2023).

3.1 Including lags in covariates ✓

Nikolay Doudchenko and Guido W. Imbens (2016) highlight that lagged outcomes exhibit substantial influence. In line with this insight, the author introduced four lagged outcome variables (1975, 1980, 1985, and 1989) as additional predictors, which garnered significant weights.

3.1.1. Large pre-intervention period ✓

Drawing from Abadie et al. (2010), it is argued that a generous number of pre-intervention periods in the outcome-matching process effectively control for unobserved factors and potential effect variations. The extended pre-intervention period spanning two decades (1970-1990) adequately addresses this concern.

3.2. Donor pool ✓

The author selected a set of donor pool countries including Australia, Austria, Belgium, Canada, France, Germany, Greece, Iceland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Portugal, Spain, Switzerland, Turkey, the United Kingdom, and the United States. However, a comparison with Andersson's study (2019) on the carbon tax in Sweden prompts the exclusion of a few countries from the donor pool. Similarly, these exclusions are advisable in the context of Finland's case, such as: (1) Ireland, due to a contrasting expansionary trajectory in the 1990s, (2) Netherlands, having implemented a carbon tax specifically targeting the transportation sector, (3) Luxembourg and Austria, characterized by fuel tourism dynamics,(4) Germany, the United Kingdom, and Italy, having undergone significant fuel tax modifications.

While the inclusion could introduce bias into the synthetic Finland, but I obtained a less goodness of fit after excluding these countries. The result suggests that these countries' data to some extent help the model capture actual trends, which we can look further. (Appendix, Figure 10 - 15)

4. Mechanism ✓

The study scrutinized gasoline and diesel consumption patterns, as well as vehicular activities and quantities. Additionally, elasticity was employed to capture emissions reductions subsequent to the carbon tax implementation. A higher elasticity signifies a more pronounced abatement effect, aligning with emission reduction goals. Conversely, lower elasticity or inelasticity implies that firms are inclined to pay the tax rather than intensify their abatement efforts, thereby impeding emission reduction objectives. However, it is important to note the potential for overestimation arising from self-selected policies. In this context, Finland's democratic policy choice could lead to spontaneous shifts in behavior, such as decreased fuel consumption and increased utilization of public transportation, rather than purchasing new vehicles.

5. Results ✓

The author arrived at a conventional conclusion, suggesting that Finnish emissions have demonstrated stability since 1990 in comparison to similar countries that lack a carbon tax.

Fluctuations in economic cycles or other unaccounted factors could potentially lead to varying degrees of impact. Notably, the uncertainty surrounding how elasticity evolves during periods of recession (such as 1990-1993) was acknowledged by the author in the conclusion. In seeking to discern the effects during the recession, a closer examination of GDP and carbon prices between the recession and the post-recession period could shed further light on the matter.

6. Confounding variables (The sensitivity checks and Robust checks)

i. The inclusion of 'end-use energy price indices ' as an additional predictor address countries in the donor pool with similar energy tax rate. ✓

ii. Countries deviating by more than 20% in absolute value from the 1994-2005 average in the tax series were excluded ✓ (Examinate the explicit carbon tax.)

iii. The back-dating test (Specific testing results were not disclosed.) ✓

iv. The unavailability of data test involved excluding the donor pool countries. ✓

v. The permutation test indicated that restricting the comparison to countries with optimal comparison units that faithfully replicate pre-1990 emissions makes the likelihood of observing emissions reductions similar to those of Finland highly improbable. However, when I excluded the countries mentioned previously, Portugal and Japan are likely larger than Finland. (Appendix, Figure 15) ✓

vi. The leaving-out predictors test entailed dropping a country with weights exceeding 15% in synthetic Finland, concurrently constructing a counterfactual emissions trajectory from the remaining countries. This method provides a lower-bound estimate of the carbon tax effect on Finland. ✓ (This approach can address the question of selecting countries for the donor pool and help us identify which countries are valuable to include in the donor pool. Yet, the results were not disclosed, compared to my result, when France was excluded, as Iceland, Australia, Canada, the United States, and Luxembourg left, the time series became unstable. Appendix, Figure 16)

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Appendix

Compare the data re-computing in R with the data in the paper.

The predictors' values in Finland, synthetic Finland, and OECD average

Table 1: CO_2 Emissions from Transport Predictor Means before 1990

Predictors	**Actual Finland**	**Synthetic Finland**	**OECD Average**
Percentage of Urban Population	71.35	71.30	73.10
GDP per Capita (PPP)	16722.56	16730.78	21793.98
Gasoline Consumption per Capita	285.80	374.64	418.94
Motor Vehicles (per 1,000 people)	291.67	314.59	421.76

Note: Gasoline Consumption is in kilograms of oil equivalent. Following Abadie et al. (2010) and Andersson (2019), we control for lagged outcome variable in 1975, 1980, 1985, and 1989 as additional predictors.

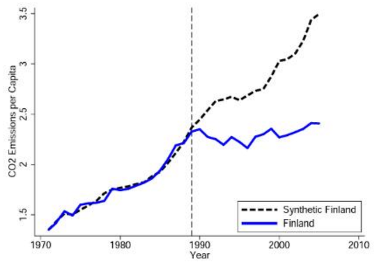
Table 1

Predictors	Actual Finland	Synthetic Finland	OECD Average
Urbanpop	71.4	71.4	71.1
GDP_per_capita	16723	16720	17204
Gasoline	286	366	390
Motor_vehicles	292	302	342
co2_1989	2.3	2.3	2.35
co2_1980	1.73	1.74	2
co2_1975	1.59	1.53	1.72
co2_1970	1.32	1.32	1.45

Table 2

From these two tables, not very different except for the "Gasoline per capita" and "Motor vehicles", it seems the recomputing data has a better fitness in synthetic Finland.

The time series



(b) CO_2 Emissions from Transportation Activities.

Figure 1

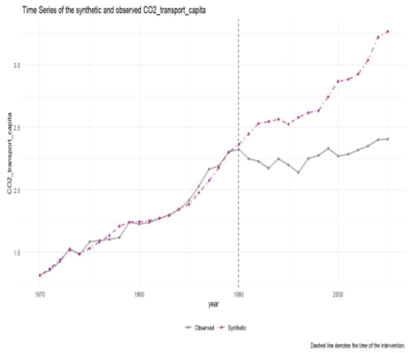


Figure 2

The difference in emissions between Finland and synthetic Finland

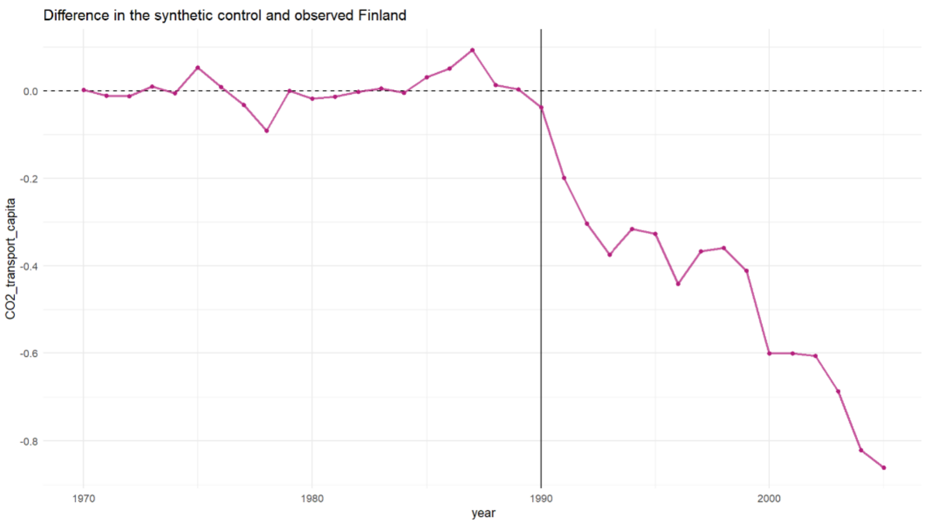


Figure 3

Before the treatment in 1990, the difference between Finland and synthetic Finland was round zero.

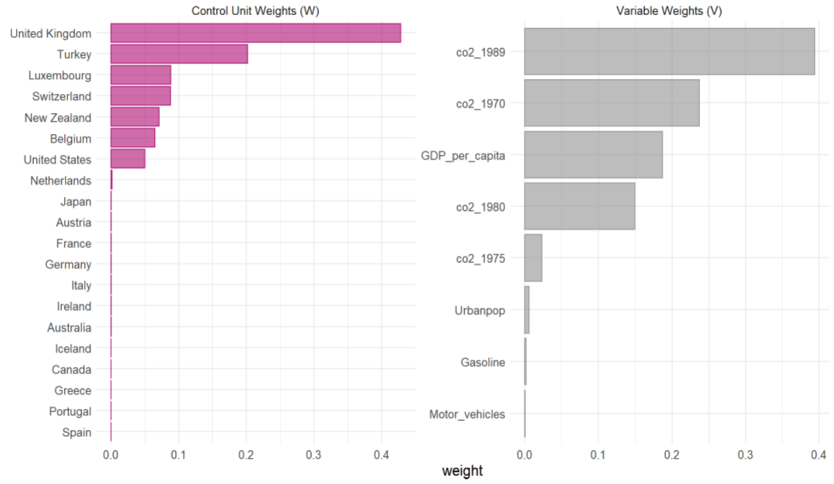
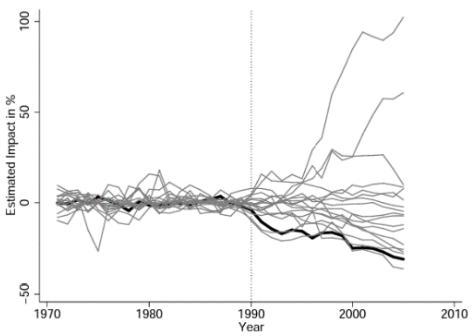


Figure 4

The United Kingdom is the main ingredient of countries of synthetic Finland, and the lag is more important when it comes close to the treatment year, but the GDP per capita plays a role as well.

Permutation test

Without pruning



(a) Placebo treatment in 1990 to countries in the donor pool

Figure 5

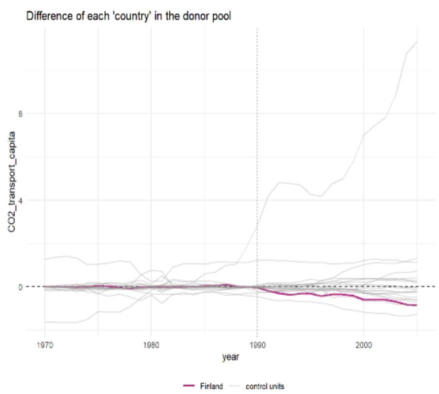
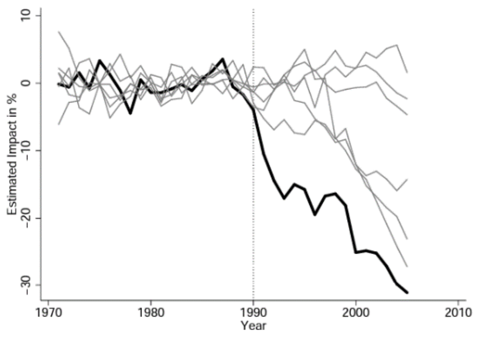


Figure 6

With pruning



(b) Placebo treatment in 1990 in countries with good pre-treatment fit

Figure 7

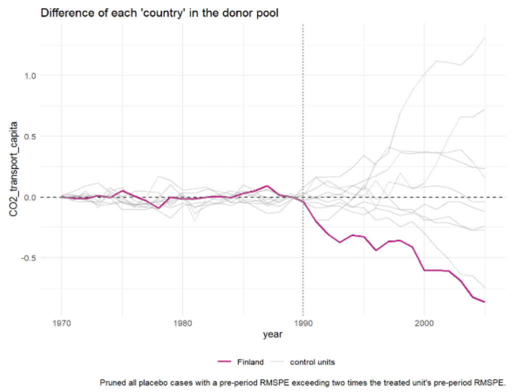


Figure 8

RMSPE

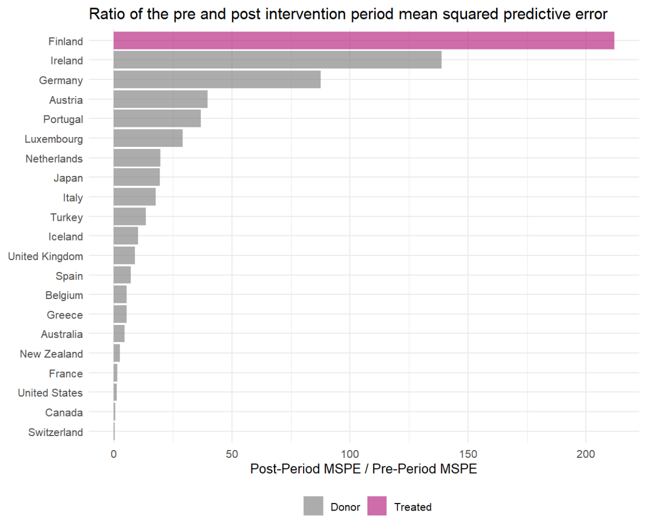


Figure 9

Excluding Ireland, Netherlands, Luxembourg, Austria, Germany, the United Kingdom, and Italy in the donor pool

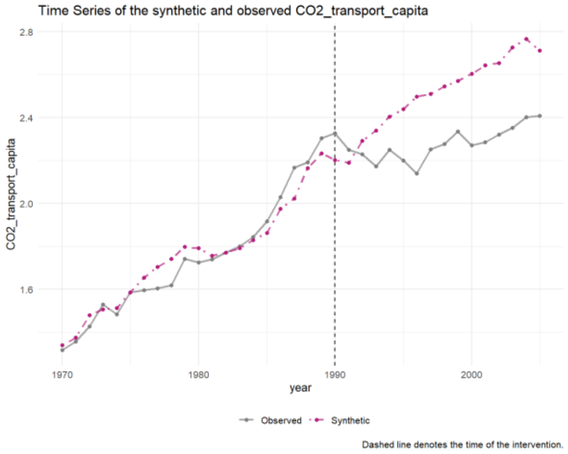


Figure 10

The pre-treatment trend seems less good fit than before excluding these countries

Predictors	Actual Finland	Synthetic Finland	OECD Average
Urbanpop	71.4	88.9	72.3
GDP_per_capita	16723	16981	17211
Gasoline	286	348	422
Motor_vehicles	292	367	347
co2_1989	2.3	2.23	2.37
co2_1980	1.73	1.79	2.12
co2_1975	1.59	1.59	1.89
co2_1970	1.32	1.34	1.61

Table 3

When excluding these countries, synthetic Finland does not perform nicely on Urbanpop, but others' variables are fine to fit.

Figure 11

It has a larger difference before the intervention.

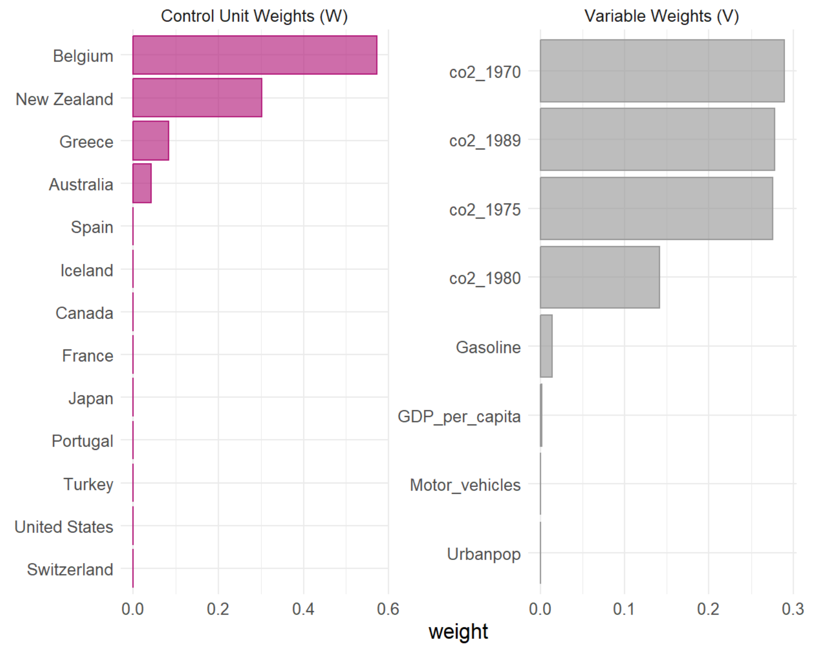


Figure 12

Belgium replaces the United Kingdom as a main ingredient, and the lags were assigned more weights than the other covariates.

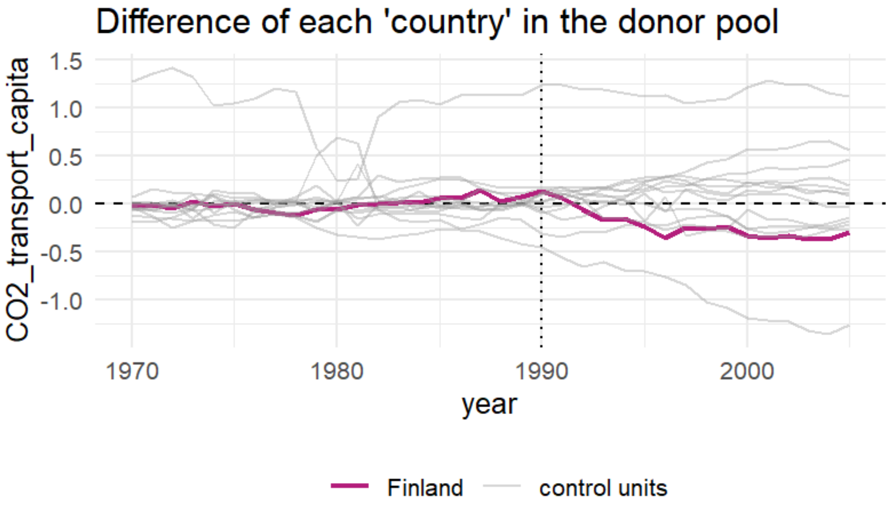
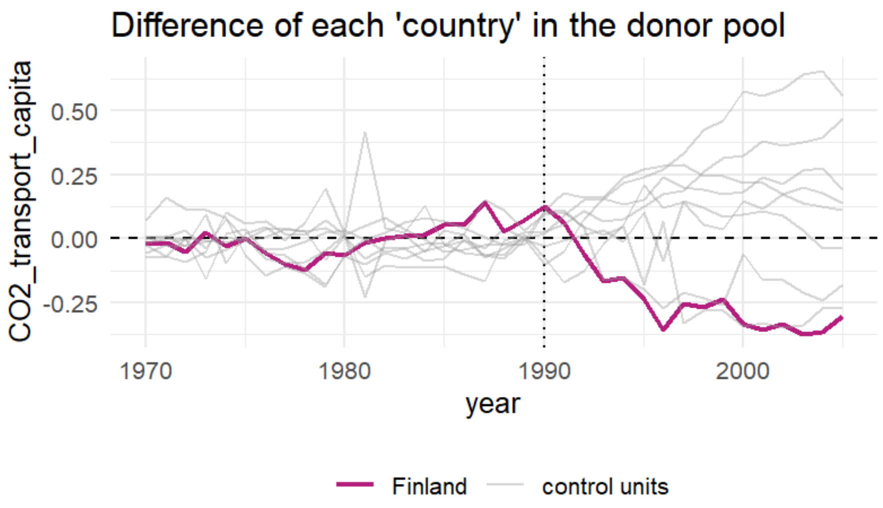


Figure 13



with a pre-period RMSPE exceeding two times the treated unit's pre-period RMSPE.

Figure 14

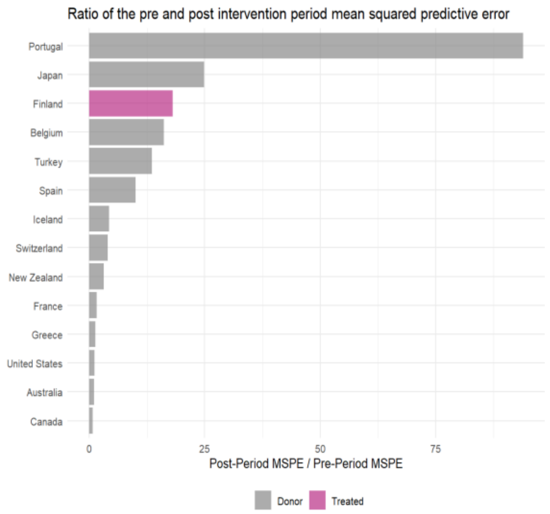


Figure 15

Portugal and Japan has higher Post / Pre-period MSPE than Finland, which means the important information contain the countries which were excluded. Including contaminated data could lead to a bias in the estimation, but we can look at how the result change in the sensitivity check to capture the important countries, and look further if the countries are reasonable to include meanwhile without bias estimation.

The leaving-out predictors test

I excluded the countries with weight over 15% subsequently, without replacement, after excluding France, the goodness of fit turned out unstable.

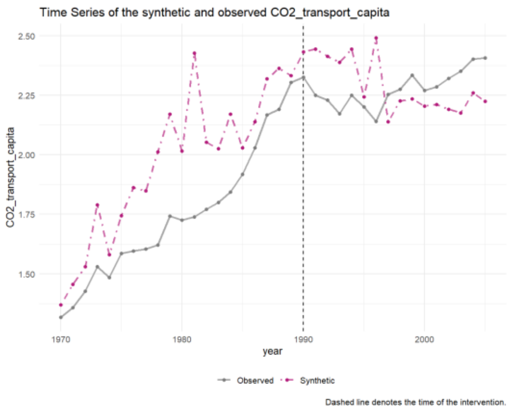


Figure 16

Statement of authorship

▪ "I hereby declare that this work has been composed by myself, unless otherwise acknowledged in the text. All points – literally or analogous – taken from published and unpublished sources are identified as such.

▪ This work has not been submitted in identical or similar form as an examination paper.

▪ I am aware that the failure to acknowledge all used sources amounts to plagiarism and will result in failing this paper (zero points).

With my signature I certify that I fully understand the paragraph above."

09, 08, 2023

Signature Place, Date