

## Taxes versus Targets: An Empirical Analysis of two Policy Instruments on Greenhouse Gas Mitigation in the Industry and Service Sector

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### EXTENDED ABSTRACT

A CO<sub>2</sub> tax has been levied on fossil heating and process fuels in Switzerland since 2008. The tax has been increased in five steps from an initial rate of CHF 12 to CHF 120 per ton of CO<sub>2</sub> equivalents in 2022, which makes it one of the highest CO<sub>2</sub> taxes in the world<sup>1</sup>. Large greenhouse gas-intensive plants are exempted from the CO<sub>2</sub> tax since they are required to participate in the emissions trading scheme. Medium-sized plants can be exempted from the CO<sub>2</sub> tax. In return, however, they must agree to a reduction target path with the environmental authority. The aim of this paper is to evaluate empirically the impact of the CO<sub>2</sub> tax versus the target agreements on greenhouse gas emissions mitigations in the industrial and services sector.

### Introduction / background

The analysis focuses on greenhouse gas emissions (GGE) in the industry and services sector. The share of the industrial and service sector (excluding waste incineration) of the total GGE of Switzerland is about 30%. In these two sectors, fossil fuels (e.g., heating oil, natural gas) are mainly used for heating buildings and for industrial processes as well as for other purposes. Since 2008, the CO<sub>2</sub> tax has been levied on fossil fuels. In 2008 the initial tax rate was CHF 12 per ton of greenhouse gases. In the CO<sub>2</sub> Ordinance, reduction targets are defined. Whenever these reduction targets were missed, the tax was increased according to a predefined path<sup>2</sup>. Since 2008, the tax has been increased five times. From January 1, 2022, the maximum rate of CHF 120 per ton of GGE under the existing CO<sub>2</sub> act is levied<sup>3</sup>.

Installations can be exempted from the CO<sub>2</sub> tax if they are engaged in an activity referred to in Annex 7 of the CO<sub>2</sub> Ordinance<sup>4</sup>. In return, exempted plants must commit to an individually set emissions or measures target. The emissions target is a linear reduction path based on the economically viable reduction potential. Measures targets are based on viable measures which must be implemented. It is recommended for small installations with GGEs of no more than 1,500 tons per year.

The red and blue stacked bars in Figure 1 show the evolution of GGE in the industry and services sectors (left scale). The sectoral interim target path towards a maximum of 65% of the 1990 level in 2030 is indicated. The grey columns show the CO<sub>2</sub> levy in CHF (right scale). The industrial and service sector is on a reduction path. The sectoral target of the CO<sub>2</sub> Ordinance is likely to be achieved.

<sup>1</sup> For details of the CO<sub>2</sub> levy, please refer to the website of the Federal Office for the Environment:

<https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/reduction-measures/co2-levy.html>

<sup>2</sup> CO<sub>2</sub> Ordinance Section 94, Paragraph 1, Item d

<sup>3</sup> According to a planned revision of the CO<sub>2</sub> act, the Federal Council could have increased the levy to a maximum of CHF 210 per ton of GGE if predefined interim targets were not met. However, this possibility is currently omitted due to the non-ratification of this revised CO<sub>2</sub> act by the Swiss population in June 2021.

<sup>4</sup> To be exempted at least 60 percent of the GGE of these installations must be caused by this activity and these emissions must account for more than 100 tons in one of the two preceding years.

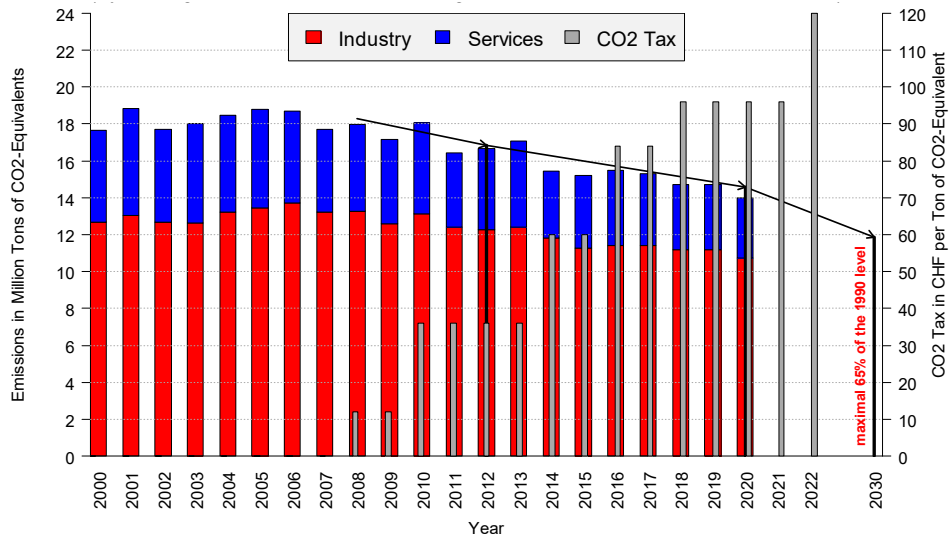


Figure 1. Evolution of Switzerland's Greenhouse Gas Emissions in the Industry & Service Sector, Left Scale: GHG Emissions in Tons (2000-2020), Right Scale: CO<sub>2</sub> Levy in CHF (2008-2020), Kyoto Targets for 2012/2020 & Sectoral Interim Target for 2030 are indicated, Data Source: Federal Office for the Environment (FOEN 2022).

## Data / methodology

The data being used is from the annual survey of the energy consumption in the industrial and service sector conducted by the Swiss Federal Office of Energy (SFOE)<sup>5</sup>. Since 1999 a representative sample of 11,000 - 13,000 plants are drawn yearly from the Swiss Business Enterprise Register containing about 360,000 entries. The chosen plants have to report their final energy consumption as well as additional variables such as the number of employees and the gross floor area. By linking the SFOE data with data originating from the Energy Agency of the Swiss Private Sector (EnAW)<sup>6</sup>, plants in the SFOE sample belonging to a company which is exempted from the CO<sub>2</sub> levy can be identified. To date, EnAW manages over 2,400 target agreements from companies being exempted from the CO<sub>2</sub> tax.

The analysis is twofold: In a first step the causal effect of the different levels of the CO<sub>2</sub> tax, paid by those plants not being exempted from the tax, is empirically analyzed. Standard firm fixed effects regression models which control for unobserved heterogeneity of time-invariant plant-specific characteristics, such as the management's attitude toward environmental aspects, are applied to identify the causal effect of the two climate policy instruments. The policy dummy variable equals one in every year where the CO<sub>2</sub> tax reaches one of the different levels<sup>7</sup>. The baseline period are the years from 1999 to 2007, before the first introduction of the CO<sub>2</sub> tax in 2008. Regressions of the form

$$y_{it} = D_k \tau + x'_{it} \eta + A'_t \gamma + \theta_i + \lambda t + \varepsilon_{it}$$

are estimated.  $y_{it}$  is the dependent variable for the GGE of plant  $i$  in period  $t$ .  $D_k$  is the policy vector indicating the different tax level periods.  $x_{it}$  is the vector of time-variant firm specific factors such as firm size, measured by the gross floor area in m<sup>2</sup> and the number of employees. These additional controls are gathered in the survey of the SFOE. They have an impact on the energy consumption and may reduce the unobserved heterogeneity. This is

<sup>5</sup> For details of the energy consumption statistics in the industry and services sectors please refer to the website of the Federal Office of Energy: <https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/sector-statistics.html>

<sup>6</sup> EnAW consults companies which agree to a binding CO<sub>2</sub> reduction commitment. These companies are reimbursed the CO<sub>2</sub> tax by the government in return: <https://enaw.ch/en>

<sup>7</sup> 2008-2009: CHF 12, 2010-2013: CHF 36, 2014-2015: CHF 60, 2016-2017: CHF 84, 2018-2021: CHF 96, 2022-20XX: CHF 120 (see grey bars in Figure 1)

especially important since the control group are the same plants in the period before the introduction of the tax.  $A_t$  is a vector of economy wide (not firm specific) indicators such as heating degree-days, oil price, economy-wide activity etc.  $t$  is a linear time trend absorbing other developments in energy efficiency technology. Results can be categorized into sector affiliation.

In a second step plants belonging to firms which are exempted from paying the CO<sub>2</sub> tax are empirically analyzed. These plants, in turn, are committed to a binding target agreement. In this natural experiment, the chosen policy variable is again the different levels of the CO<sub>2</sub> tax. As firms self-select themselves into target agreement programs, differences-in-differences estimators are applied to best avoid self-selection issues. Plants exposed to the CO<sub>2</sub> levy are compared to plants which committed to a CO<sub>2</sub> reduction target. The null-hypothesis, which states that the impact on greenhouse gas emissions mitigations does not differ between the two groups, is being tested. The resulting empirical evidence might provide findings that allow to distinguish the impact of the CO<sub>2</sub> tax opposed to that of the target agreements.

## Literature

Despite the fact that this topic is relevant for the evaluation of Switzerland's CO<sub>2</sub> and climate strategy, the literature on this issue is still limited. Existing literature refers to the CO<sub>2</sub> tax alone, without considering in-depth empirically companies being exempted from the CO<sub>2</sub> tax<sup>8</sup>. Alternatively, it focuses on more behavioral aspects<sup>9</sup>. Jakob *et al.* (2016) investigate the impact of the CO<sub>2</sub> levy on emissions-related decisions of the companies. Their study distinguishes between companies paying the CO<sub>2</sub> tax and exempted companies. Based on extensive survey results, they conclude that companies with high CO<sub>2</sub> emissions have reacted earlier than other companies. The study of Ecoplan *et al.* (2015) empirically estimates the CO<sub>2</sub> mitigation effect in 2015 ranging from 4.3 to 7.1 %. Empirically, my analysis can be compared to the paper of Martin *et al.* (2014). They found out that the UK climate change levy caused plants, paying the full rate, to reduce CO<sub>2</sub> emissions by between 8.4% and 22.6% more, compared to those plants that paid the reduced rate.

## Conclusion & discussions

This study contributes to the existing literature by adding a micro-data-driven ex-post estimation of the impact of the CO<sub>2</sub> tax in comparison to target agreements in the industry and service sector. The paper fills a gap in the existing literature by applying more recent data where the CO<sub>2</sub> tax has been risen several times. The possibility of identifying plants under a target agreement, instead of paying the CO<sub>2</sub> tax, can help governments in adjusting existing climate policy instruments. Furthermore, the question whether the 2030 Paris targets can be reached in these sectors might be addressed as well.

## Bibliography

- Ecoplan, EPFL and FHNW (2015). 'Wirkungsabschätzung CO<sub>2</sub>-Abgabe: Synthese'. Bern: Study on behalf of the Federal Office for the Environment.
- Jakob, M., Y. Roszkopf, I. Kendall, R. Looser, F. Remo, U. Reiter, C. Nathani and O. Hoff (2016). 'Wirkungsabschätzung CO<sub>2</sub>-Abgabe auf Brennstoffe. Direktbefragungen zur Abschätzung der Wirkung der CO<sub>2</sub>-Abgabe auf Unternehmensstufe'. Bern: Study on behalf of the Federal Office for the Environment.
- Martin, R., L. B. De Preux and U. J. Wagner (2014). 'The impact of a carbon tax on manufacturing: Evidence from microdata', *Journal of Public Economics*, **117**, 1-14.

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<sup>8</sup> See references of the FOEN:

<https://www.bafu.admin.ch/bafu/de/home/themen/klima/fachinformationen/verminderungsmassnahmen/co2-abgabe.html>

<sup>9</sup> See EnAW: <https://enaw.ch/wp-content/uploads/2018/02/Anreize-CO2-Regulierungen.pdf>