Extended Abstract and Summary

"Promotion- or Steering-based Energy Policy: Assessing Efficiency and Distributional Impacts"*

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EXTENDED ABSTRACT

Swiss energy and climate policy has obligated itself towards sustainable development goals including a reduction of carbon dioxide (CO_2) emissions and electricity consumption. Designing politically feasible regulatory strategies to achieve these goals requires balancing economic efficiency and social equity concerns. This study assesses the economic efficiency and distributional effects of two alternative regulatory paradigms for environmental policy—which are often referred to as "Steering" ("Lenkung") and "Promotion" ("Förderung") in the Swiss policy context. The "Steering" approach represents a comprehensive market-based regulation which is based on CO_2 and electricity taxes. The "Promotion" approach represents a narrowly focused regulation which limits where-flexibility either by the enhanced use of command-and-control (CaC) instruments (emissions standards for new passenger cars and efficiency standards for electrical appliances) or the scaling down of market-based regulation to specific subsidy programs (open competitive bidding and buildings programs).

To provide a quantitative empirical assessment of both economy-wide cost-effectiveness and household-level incidence, we develop a simulation model that combines an applied general equilibrium framework with a micro-simulation analysis at the household level. Based on national income and product accounts data and survey data for a representative sample of Swiss households, the model (1) includes a detailed representation of household heterogeneity with respect to (energy and non-energy) spending and income and (2) captures the economy-wide effects of environmental regulation arising from inter-industry linkages and price-dependent cross-market effects.

We find that rigorous market-based regulation pays off at the economy-wide level: the "Steering" approach cuts down economic adjustment costs by a factor of more than five relative to the "Promotion" approach (while achieving the same environmental targets). Consumer prices for energy are not much affected under "Promotion" while they increase under "Steering". Focusing solely on price impacts as a measure for policy cost, the cost of the "Promotion" approach are thus hidden.

At the household level, we find that both policy approaches lead to a wide distribution of welfare impacts which reflects the substantial heterogeneity among households. We find that focusing on mean impacts for representative groups of households obscures substantial within-group variation of impacts which swamps the variation in mean impacts across groups. Driven by the large increases in energy prices for consumers under "Steering", impacts are, however, significantly more dispersed under the "Steering" relative to the "Promotion" approach. One third of households gain under "Steering" whereas nearly all households are worse off under "Promotion". While the mean impacts for different socio-economic groups of households (income deciles, house owners vs. renters, retired vs. working households, households living in urban, rural, and agglomeration areas) are largely identical under the "Promotion" approach, they are much more negative relative

to the “Steering” approach. Our analysis thus indicates substantial trade-offs between efficiency and equity for the two policy designs investigated here.

Households who gain under the “Steering” approach are those with relatively small expenditure shares on energy goods, high shares of income derived from (inflation-indexed) government transfers, and low income thus disproportionately benefiting from per-capita tax rebates. The household incidence under “Steering” depends importantly on how the revenues from taxing CO_2 emissions and electricity consumption are returned to households. The mean impacts across income deciles are progressive for per-capita rebating and regressive for income-neutral rebating. With a “Steering” policy, retired households experience small welfare gains, house owners are more negatively affected than renters, and rural households are relatively worse off compared to households living in urban and agglomeration areas.

Differences in cost-effectiveness between both regulatory approaches are also reflected in sector- and fuel-specific CO_2 abatement patterns: we find that the “Promotion” relative to the “Steering” approach imposes too high emissions reductions in the household sector and too little reductions in the industrial sector (non-ETS industries only). The larger reductions in the household sector are driven by the CaC measures targeting motor fuels in private transportation while cheap abatement opportunities related to thermal fuel use in the non-ETS sectors are not sufficiently incentivized.

SUMMARY

Swiss energy and climate policy has obligated itself towards sustainable development goals including a reduction in energy and electricity consumption, an increase in renewable energy sources, as well as a cutback of carbon dioxide (CO_2) emissions.[1]

Attainment of these energy and climate policy targets will require a fundamental restructuring of the current Swiss energy system with policy measures to be taken now, given the inertia and long investment cycles characterizing energy supply and demand structures. Environmental targets such as the reduction of CO_2 emissions or the expansion of renewable power generation constitute, however, only one dimension of sustainable development. Two other important dimensions reflect the desire for strong economic performance (usually termed in GDP per capita) and social justice which aims at avoiding larger income disparities among heterogeneous household groups. The three dimensions of sustainable development—environmental quality, economic performance, and equity concerns—are inherently intertwined and subject to trade-offs. Accomplishing one objective frequently means backpedaling on another.

Translated into the context of Swiss energy and climate policy the task is to design regulatory strategies that achieve the given CO_2 and electricity reduction targets while balancing economic efficiency and social equity concerns. The equity dimension is obviously normative and ideally has to be agreed upon in a broad-based societal consensus. The efficiency dimension as portrayed by the economic discipline seems to be less controversial in that policy should aim at cost-effective strategies: given environmental targets and equity metrics, the transition of the Swiss energy system should take place at minimum economy-wide adjustment cost. In this way, economic efficiency can become a maid to equity considerations and environmental targets: the less economic growth has to be sacrificed, the easier it will be for society to agree to ambitious environmental targets while keeping in line with equity principles.

Efficiency and distributional effects of alternative regulatory strategies for controlling CO_2 emissions and electricity consumption

These considerations provide the policy and intellectual background for our economic research undertaken in the present study. While economics has little to say on equity per se, the sound economic quantification of distributional effects for different agents and trade-offs between equity and efficiency objectives are a prerequisite for any rational policy debate. The quantification of trade-offs calls

[1] Within the context of its Energy Strategy 2050 (ES2050) and CO_2 legislation, Switzerland considers ambitious long-run objectives which already translate into quite stringent mid-run targets: up to 2030 total greenhouse gas emissions shall be reduced by 30% relative to 1990 levels, which implies a reduction of energy-related CO_2 emissions by 40%. Furthermore, per-capita electricity consumption in 2020 shall be curbed by 13% relative to 2000 levels.

for the use of quantitative modeling techniques to systematically and rigorously assess the interference of the many forces that interact in the economy and thereby affecting the aforementioned three dimensions of sustainable growth.

The objective of our study is to provide a rigorous impact assessment of the economic efficiency effects and distributional impacts triggered by regulatory strategies to achieve the Swiss climate and energy policy targets as laid out in the ES2050 and the CO_2 legislation.

Market-based versus command-and-control instruments

Current Swiss climate and energy market regulation is characterized by a myriad of policy measures which can be broadly attributed to two categories: market-based and command-and-control (CaC) instruments.

Market-based instruments include CO_2 emissions pricing (via CO_2 taxes or an emissions cap-and-trade program) and electricity taxes or subsidies to spur energy savings in housing (buildings program) and electricity demand reductions in the industry and service sectors (open competitive bidding). The fundamental feature of market-based instruments is that they adjust market prices with explicit tax and subsidy signals to channel production and consumption decisions towards socially desirable targets. Market-based mechanisms appeal to economists because of their superior efficiency properties: CO_2 emissions reductions or electricity savings can in principle be achieved at least-cost by letting the market identify all cost-effective measures. The yardstick for cost-effectiveness is to exploit "where-flexibility" at an economy-wide level implying that CO_2 emissions reductions should take place where they are cheapest.[2] Importantly, a uniform price on CO_2 emissions achieves such a situation without further information needs on behalf of the regulatory authorities. It thus *a priori* qualifies as a market-based cost-effective regulatory instrument. The same reasoning applies to the taxation of electricity in case that electricity demand reductions are an explicit desirable (socially agreed) goal. Taxing the "bad" can be reversed to subsidizing the "good" such that taxes and subsidies can be viewed in principle as similar (but not equal) twins in efficient market-based regulation.

Command-and-control (CaC) instruments includes instruments such as explicit bans or standards. While CaC regulation can be justified in situations where market-based consumer and producer (choices) sovereignty is not desirable[3], they are more generally viewed with scepticism by economists regarding efficiency implications. The reason is that by typically prescribing discrete economic actions, CaC measures suppress or limit economic flexibility to achieve given targets at least cost. Examples of CaC measures in the Swiss energy and climate policy context include emissions standards for new passenger vehicles and efficiency standards for electrical appliances. Standards effectively work as blending constraints

[2]In technical terms, this comes down to a situation in which the cost of reducing the next (marginal) ton of CO_2 is equalized across all emission sources.

[3]For example, with respect to the use of harmful pesticides.

that dictate a certain relationship between input (say vehicle fuel use) and output (say kilometers traveled). At the sectoral level, they implicitly correspond to taxing energy services produces with technologies that do not fulfill the standard and subsidizing energy services produced with technologies that meet the standard. The subsidy component undermines efficiency as the output channel for energy savings is not fully exploited due to distorting the price for energy services. At the economy-wide level, standards, being narrowly focused on a specific sector, limit "where-flexibility" to achieve broader-based targets such as CO_2 emission reduction. As a result, a fuel standard on cars may come along with a multiple of the cost to reduce the next ton of carbon than reducing this ton of carbon elsewhere.

While the analysis of alternative regulatory approaches in the academic literature is mostly focused on efficiency aspects, it is important to understand that in policy practice efficiency it is often not the dominating criterion. The political feasibility of regulation depends importantly on the distribution of costs and benefits (rents) associated with the choice of specific instruments. While being a cost-effective market-based instrument, a CO_2 tax may be difficult to implement since the society may perceive a tax as an explicit financial burden with the rents (tax revenues) accruing to the government. Subsidies may be easier to push for since at first glance they come as a carrot rather than a stick. However, in a broader perspective, the informed citizen should acknowledge that a subsidy has to be financed as well. Standards may be preferred to taxes by firms because they implicitly work as a combination of input taxes and output subsidies with the rents of regulation being recycled internally to the firm or industry rather than passed to the government. For a comprehensive and economic incidence assessment of regulation it is necessary to go beyond the accounting of tax and subsidy transfers. The fundamental question is how households—owning firms and providing labor services to the economy while consuming energy and non-energy goods—are affected by alternative regulatory strategies. This requires tracking down how commodity prices and factor prices are affected by regulation and analyzing how these price changes affect heterogeneous households groups that spend their income in different ways (preferences) and that earn their income in different ways (sources of income).

Impact assessment with an integrated modeling framework

To accommodate such a quantitative assessment of the efficiency and distributional impacts of alternative strategies for Swiss climate and energy policy, we have developed a numerical framework which combines a computable general equilibrium (CGE) model with micro-simulation analysis at the household level. The advantage of this combination is that we can analyze implications for economy-wide cost-effectiveness of policy reforms while providing at the same time a very detailed perspective on household incidence. The integrated modelling framework does not only feature a rich representation of household heterogeneity but accounts for important inter-sectoral linkages and price-dependent market feedbacks across the whole economy.

Summary of main results

We use our quantitative framework to provide insights into the efficiency-equity trade-offs of alternative Swiss policy designs targeted to reduce CO_2 emissions and curb electricity demand. Our simulations focus around two broader policy packages—referred to as "steering" and "promotion". The "steering" package represents a more comprehensive market-based regulation based on taxes on CO_2 and electricity consumption only. The "promotion" package represents a more narrowly focused regulation which limits "where-flexibility" either by the enhanced use of command-and-control (CaC) instruments (emissions standards for new passenger cars and efficiency standards for electrical appliances) or the scaling down of market-based regulation to very specific subsidy programs (open competitive bidding and buildings programs). Our main findings are as follows.

First, the compliance cost of achieving agreed policy objectives (CO_2 and electricity) can vary substantially depending on how much the efficiency properties of market-based instruments are exploited. Our simulation results clearly indicate that more rigorous market-based orientation of Swiss climate and energy policy pays off at the economy-wide level. We find that the "steering" policy package cuts down the economic adjustment cost by a factor of more than five as compared to more rigid "promotion" package (for reducing CO_2 emissions by 40% by 2030 relative to 1990 levels and lowering electricity consumption by 3% by 2030 relative to 2005 levels).[4]

Second, devising cost-effective regulation requires considering both instrument choice *and* instrument design. While the choice between market and non-market based instruments clearly matters, the specific design of a policy instrument (e.g., with regard to its scope) can be highly important, too. We find that the "promotion" package—relying largely on narrowly (i.e., sector-specific) designed market-based instrument (buildings program)—entails large excess cost of regulation when compared to a broad-based CO_2 tax. The reason is that focusing on specific segments of the economy instead of providing economy-wide scarcity signals can severely undermine the scope for cost savings from comprehensive "where-flexibility".

Third, the difference in cost-effectiveness across both policy package are also reflected in the sector- and fuel-specific CO_2 abatement patterns. Relative to the cost-effective "steering" package, we find that the "promotion" imposes too

[4]For the "steering" package, annual costs amount to 0.23% of consumption—corresponding to total absolute costs of 0.99 billion CHF per year or a welfare cost of 292 CHF per year for the average Swiss household (measured in CHF for the year 2008). For the "promotion" package, annual costs are equal to 1.19% of consumption—corresponding to 5.52 billion CHF per year or 1548 CHF per year for the average household). The excess cost of regulation based on the "promotion" package is also reflected by higher average costs per avoided ton of CO_2 (1195 CHF and 225 CHF under the "promotion" and "steering" package, respectively).

high emissions reductions in the household sector and too little reductions in the industrial sector (non-ETS industries only). The larger reductions in the household sector are driven by the CaC measures targeting motor fuels in private transportation while cheap abatement opportunities related to thermal fuel use in the non-ETS sectors are not sufficiently incentivized.

Forth, consumer prices for energy are not much affected under "promotion" package whereas prices increase under the "steering" package. Instruments in the "promotion" package either explicitly subsidize energy-saving capital (in the case of open competitive bidding and buildings programs)—thereby averting consumer price increases obtained when taxing "dirty" energy inputs directly with "steering" measures—or they enforce the use of higher quality equipment to reduce energy demand without raising the price for the energy commodity itself (in the case of standards for vehicles and electrical appliances). As we find that prices for capital and labor (relative to consumer prices) are also only modestly affected under the "promotion" package, the compliance cost of the "promotion" package largely materializes through the need to finance the subsidy instruments (open competitive bidding and buildings programs). The important insight is thus that the efficiency cost of the "promotion" package remain "hidden" to the extent that the costs for providing the budget for the subsidy programs are not directly observed by households.

Fifth, the efficiency metric underlying macro-economic cost-effectiveness analysis is normative as it builds on a utilitarian social welfare function being agnostic on the distribution of cost across heterogeneous households. In policy practice (from a political economy view) the cost incidence of regulation is, however, central to the feasibility of policy implementation. Our finding that household-level impacts are largely scattered around the mean cost estimate under both policy packages strongly substantiates this point. Similarly, focusing on mean impacts for specific socio-economic groups (e.g., income deciles) obscures substantial within-group variation of impacts that swamps the variation in mean impacts across groups. The dispersion in household-level impacts reflects the heterogeneity of consumers in terms of preferences (expenditure patterns) and endowments (income sources).

Sixth, our analysis indicates substantial trade-offs between the efficiency and equity dimension of policy designs. While the "steering" package is more cost-effective (from an aggregated, economy-wide perspective), it leads to a much larger dispersion of household-level impacts. This hinges on the result that changes in factor and output prices are considerably smaller under the "promotion" package, in turn translating into less dispersed household-level welfare impacts given the heterogeneity of consumers' preferences and endowments.

Seventh, about one third of the households under the "steering" package gain whereas nearly all households are worse off under the "promotion" package. Households that gain under the "steering" package tend to be those with relatively small expenditure shares on energy, high shares of income derived from government transfers (indexed to inflation across scenarios), and low total income thus benefiting more from per-capita rebates of (CO_2 and electricity) tax revenues.

Eighth, the cost incidence for the “steering” package depends importantly on how the tax revenues are recycled to households. The incidence in terms of mean impacts by (annual) income deciles is progressive if revenues are recycled on a per-capital basis. It is, however, regressive if revenues are handed back to households in proportion to income. The latter is driven by the fact that low-income households have higher energy expenditure shares while the former is driven by the progressive nature of per-capita rebates.

Ninth, assuming that the costs for the subsidy programs (open competitive bidding and buildings programs) are financed by a tax such that government revenue remains constant, the mean impacts are identical across income deciles under the “promotion” package. This is driven by the design of the tax which is levied proportional to the net income of households. While alternative assumptions about the distribution of re-financing costs across households would obviously yield different incidence outcomes, the main insight here is that the variation in impacts stemming from heterogeneous preferences and endowments is muted as factor and output prices are not much affected.

Tenth, the cost incidence across the socio-economic groups considered in our analysis (house owners vs. renter, retired vs. working households, households living in urban vs. rural vs. agglomeration areas) is more dispersed under the “steering” package. Mean impacts for these groups under the “promotion” package are largely similar (echoing the result stated above that price impacts are larger under the “steering” package). For the “steering” package and focusing on mean impacts, we find that house owners are more affected than renters (as the latter have smaller energy expenditure shares), retired households slightly gain (due to relatively low energy expenditure shares and large transfer income), and that adverse impacts for rural households are bigger than for households living in agglomeration or urban areas (because rural households have higher expenditure shares on motor fuels due to higher private transport requirements and higher expenditure shares on thermal fuels for heating consistent with a higher population of home owners in rural compared to urban areas).

Contents and organization of detailed study report

The detailed report for this study is available for download (click here)[5] and provides comprehensive detail on the following aspects:

1) a review of the relevant background literature;

2) a documentation of the empirical, quantitative method framework used for the analysis (including a description of the simulation model, data, and

[5]The link address is: https://www.ethz.ch/content/dam/ethz/special-interest/mtec/cer-eth/economics-energy-economics-dam/documents/people/srausch/NFP71_ProSTEP_Report_LONG.pdf

computational strategy);

3) a descriptive analysis of the household survey data;

4) a short primer providing a conceptual discussion of the efficiency and distributional effects of alternative regulatory instruments;

5) a description of the regulatory measures which are central to Swiss climate and energy policy and are investigated here;

6) a description of the scenarios & assumptions underlying the ex-ante policy analysis;

7) a presentation and discussion of the main results;

8) a summary reporting on additional sensitivity analyses to check for the robustness of results;

9) supplementary material containing (1) a complete algebraic description of the simulation model and (2) a description of the model-based representation of energy savings in buildings and industrial sectors.