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For a successful energy transition

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Energy transition: the cost of acceptability

To get rid of fossil fuels, the energy transition involves two crucial steps: decarbonising electricity production and electrifying industry, transport and building uses. The most direct and natural way to get rid of coal and gas in electricity generation is to make them more and more expensive, with a carbon price that increases over time to reflect our shrinking carbon budget (Rogelj et al., 2018). There is a wide consensus among economists to support carbon pricing, through a carbon tax or a cap-and-trade, as the best if not the only climate policy. However, an overview of the direct pricing of carbon emissions around the globe makes clear that there is a substantial gap between the suggested and the observed price of carbon (OECD, 2021), even though carbon pricing is getting more and more adopted (World Bank, 2022).

Would carbon pricing be popular among economists only? In several countries, the prospect of an increasing carbon tax has received strong political opposition, as exemplified by the famous Gilets Jaunes protest in France in 2018. Since then, the carbon tax has remained stuck at its 2018 level, and a resumption of its increase is completely absent from the public debate. In the United States, carbon pricing at the federal level seems out of reach, even though a few states (California, Oregon, Massachusetts) have implemented cap-and-trade schemes. The Inflation Reduction Act of August 2022 consists of a subsidy package of 391 billions of US dollars over ten years for energy and climate, among which 41% are production and investment tax credits for clean electricity[1]. The European Union has also amply subsidized carbon-free energy in the past decades, and in 2020 renewable energy subsidies have reached 80 billions euros, which is roughly twice as much as US annual subsidies. However, these subsidies come along with some carbon pricing through the Emissions Trading Scheme, targeting large energy-intensive companies. Though the carbon price on the EU-ETS has been very low in the past, it is no longer the case, and the European ambition is clearly increasing (see the Fit for 55 policy package).

1 Local-content requirements are linked to these subsidies, which make the Inflation Reduction Act not only a climate policy but also an industrial policy, potentially protectionist. But this is another story.

But fear of a European Gilets jaunes protest is clearly present: the current proposal (as for April 2023) is to implement in 2027 a second cap-and-trade scheme that will cover transport, building use and small businesses, and to cap the carbon price on this market at 45€/tCO2, a level close to the current French carbon tax, at least until 2030. Hence, mitigation policies do not rely exclusively or even mainly on pricing carbon emissions. They typically include subsidies, which do not face the same political opposition.

We build in our most recent research paper (Schubert et al, 2023)[1] a stylized model of the energy transition taking accounts of these facts. Initially, energy consumption comes mostly from fossil sources. Making them progressively more expensive through carbon pricing would encourage investment in carbon-free electricity generation capacity (renewable or nuclear energy) to replace them. But as long as the demand for energy is greater than the carbon-free electricity supply, the residual demand is met by fossil fuels, and it is, according to the principle of marginal cost pricing, the price of the latter that sets the price of electricity. The price of electricity therefore increases with the carbon price throughout the transition. When the energy transition is achieved however, the price of electricity begins to fall, because carbon-free sources are very capital-intensive but have very low variable production costs. If the rise in the price of electricity during the transition is deemed socially unacceptable, society can very well choose a different route to achieve the transition: waive the carbon price or set it at a low level, and subsidize the carbon-free electricity production capacity (for instance through Feed-in Premiums) or the investment in this capacity (for instance through investment tax credits). In the latter case, the transition takes place without the price of electricity increasing and therefore without consumption decreasing.

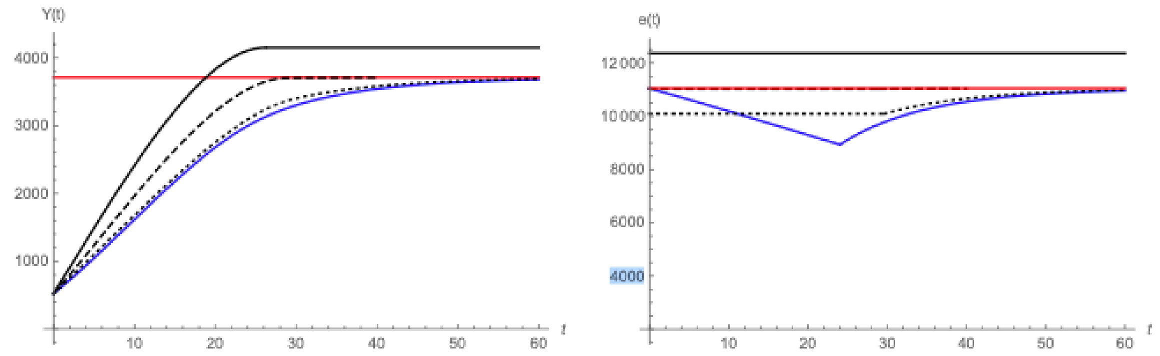
We study the consequences of choosing the second route. We consider that the regulator is unable to implement the optimal climate policy which would consist in a carbon tax increasing over time, but is only able to charge a constant carbon tax, insufficiently high to ensure that the carbon budget is respected. Climate policy then suffers from a *carbon pricing gap*, that has to be filled with subsidies to carbon-free electricity production capacities. Additional taxes (here lump-sum taxes on households) have to be levied to finance the subsidies, which puts a strain on public finances that is all the greater when the effective carbon tax is low. We show that, to ensure a non-decreasing energy consumption during the transition while fighting against the excessive use of fossil fuels without increasing their price, the economy must invest too much and too quickly in carbon-free electricity production capacities, and that the energy transition is delayed. Forgoing a rising carbon price in favor of subsidies to carbon-free electricity generation does allow the decarbonisation objective to be achieved, but later, at a cost to public finance, and at the cost of a welfare loss.

In order to gain insights on the magnitude of the carbon pricing gap, the cost for public finance and the welfare cost associated to various choices of the constant carbon tax, we (roughly) calibrate the model to the case of the European energy transition and provide illustrative simulations.

1 The introduction of this policy brief draws heavily on the introduction of the working paper.

Figure 1 illustrates the optimal trajectory, as well as three sub-optimal trajectories corresponding to three levels of the constant carbon tax, large, small and very small. *Table 1* displays in the same cases the *welfare cost of acceptability*, defined as the welfare loss with the sub-optimal climate policy compared to the optimal policy, measured by the equivalent constant additional electricity consumption that should be given to households to make them indifferent. It also displays the cost of the sub-optimal policy in terms of public budget balance, defined as the present value of additional lump sum taxes or transfers that are levied on households in percentage of the present value of electricity consumption, over the transition.

Figure 1:
Optimal policy (blue, long run steady state in red) versus sub-optimal policy with constant carbon tax and subsidies to decarbonized electricity production capacity, for a large tax (black, dashed), a small tax (black, dotted) and a very small tax (black, plain).



Decarbonized production capacity (GW) — Electricity consumption (TWh)

Table 1:
Optimal and sub-optimal policies

	carbon tax	carbon pricing gap	T_0	T	$w(\%)$	$b(\%)$
Optimal policy	$100\ e^{\rho t}$			26		
Sub-optimal policy, large carbon tax	140	$96e^{\rho t} - 140$	12	30	0.3	-0.4
Sub-optimal policy, small carbon tax	100	$121e^{\rho t} - 100$		29	1.6	-32
Sub-optimal policy, very small carbon tax	60	$156e^{\rho t} - 60$		26	7.7	-90

Notes: The optimal carbon tax is initially of 100€/tCO_2; then it increases exponentially at the constant rate $\rho = 3\%$ per year
The carbon pricing gap is initially negative in the case of a sub-optimal large carbon tax of 140€/tCO_2 $(96 - 140 = -44)$; then it increases at the discount rate, and becomes positive after $T_0 = 12$ years
T is the date at which the energy transition is achieved
w and b are respectively the welfare cost and the cost for public finances.

With a large constant carbon tax there is a first phase where subsidies are not necessary because the carbon pricing gap is negative. The resulting accumulation of carbon-free capacities is slightly faster than what it is at the optimum. The climate policy is almost neutral in terms of public finance and the welfare loss is moderate.

With a small constant carbon tax, subsidies have to be very large to fill the carbon pricing gap. This policy fosters a fast accumulation of carbon-free capacities. Incidentally, electricity consumption is at each date higher than optimal, and electricity price lower. The policy based on very large subsidies to carbon-free energy sources is very costly in terms of welfare loss and for public finance. Fossil phase out is delayed.

With a very small constant carbon tax, the over-accumulation of carbon-free capacities necessary to phase-out fossils is so large that the electricity production capacity exceeds its optimal long run value at the date of fossil phase-out, and has to remain at this very high level to prevent the come-back of fossils in electricity generation. Indeed, fossil fuels are cheap, and the only way to avoid their come-back is to provide subsidies to carbon-free capacities forever. This policy is hugely costly in terms of public finance, and in terms of welfare as well, but allows households to benefit from low electricity prices and a high electricity consumption.

Clearly, the situation where the regulator puts in place a large constant carbon tax is better. But it is difficult to believe that if he cannot commit to the optimal carbon tax for political economy reasons, he would be able to put in place a higher carbon tax early on. Hence, the cases closer to the public concern seem to be the ones of a small or very small carbon tax. They entail strong distortions in terms of investment, implying large inefficiencies and huge costs. If climate policy were to rely on subsidizing carbon-free sources to complement a small constant carbon tax, we find that meeting the climate target is feasible, but at a huge cost. The subsidies have to be very large, in order to foster green investment at a fast pace, resulting in important investment costs, weighing on households' budget. Overall, larger investment costs and deformed consumption paths together reduce welfare. The key problem is that subsidies to carbon-free technologies do not tackle directly the issue of limiting fossil resource use early on. They can crowd out fossils from the market, but the second best policy implies some strong and costly distortions such as boosting energy consumption, during the early phase when it should be falling.

References

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