HOW DO ROADMAPS AND THEIR FRAMING IMPACT REGULATORY DECISIONS TOWARDS ENVIRONMENTAL TARGETS?

Busra Gencer, HEC Lausanne – University of Lausanne, +41 21 692 3665, Busra.Gencer@unil.ch
Ann van Ackere, HEC Lausanne – University of Lausanne, +41 21 692 3454, Ann.VanAckere@unil.ch

Overview

For a reliable and sustainable energy future, most countries have defined renewable energy targets, many of which focus on the electricity sector. To achieve these long-term targets, policymakers often determine intermediary objectives, i.e., a sequence of sub-goals on the way towards the final objective, defined as roadmaps. These roadmaps depend on the market characteristics and take different forms in terms of time scale, metrics and obligations (IRENA, 2015).

In this work, we study the influence of roadmaps on regulatory decisions and market performance using laboratory experiments. The recruited subjects take on the role of a regulator in a simple electricity market and decide on the amount and type ("green" or "thermal") of subsidized capacity. We manipulate the presence (presenting a roadmap or not), the level of detail (time granularity), the framing (reducing pollution or increasing green generation) and the complexity of the roadmaps (expressed as only green generation, only pollution or both).

We find that all of our roadmap manipulations have an impact on subsidy decisions for green capacity, while thermal subsidy decisions are not influenced by the granularity and the framing of roadmaps. Our results also indicate that the differences in subsidy decisions do not always translate into differences in market performance.

Our work confirms, in the complex setting of a simplified electricity regulation exercise, that people's choices are prone to be influenced by the formulation and labeling of the options. Therefore, choosing roadmaps appropriately can facilitate the evolution of markets towards an environmental target. Moreover, roadmap choices should also take into consideration the market performance criteria and their relative importance.

Methods

We conduct laboratory experiments, using a simulation model created in Vensim® software and a user interface based on the Forio® Online Simulation Platform. During the experiments, participants are presented with a simple electricity market for which they act as regulator. In this market, there are two generation technologies, thermal and green, and demand is constant. We assume a merit order dispatch. In the model, there are endogenous thermal investors who decide based on thermal profitability, while green generation capacity requires subsidies. The participants' aim is to increase the share of green generation from 3% to 50% over 40 years, while avoiding blackouts, by deciding on how many MWs of thermal and green generation capacity to subsidize each year.

Each session lasts about 60 minutes; the first 20 minutes are dedicated to the settlement in the lab, signing of the consent form and the video presentation where the basic principles of electricity markets and the rules of simulation are introduced. This is followed by a 20 minute training period during which participants familiarize themselves with the market dynamics and the interface. Finally, participants have 20 minutes for the last round, on which their payment is based.

A between-subject[1] approach is adopted for the study. We manipulate (i) presence, (ii) framing, (iii) time granularity and (iv) complexity of the roadmaps to test their effect on environmental targets with five treatment groups. The roadmap names and their definition are summarized in Table 1. In the first treatment (F), the participants are presented with only the final target (50% of renewable generation). Treatments G1 and G5 represent roadmaps for the green share of generation target, respectively for each year and every five years. The treatment P1 has mathematically the same objectives as G1, but is framed as decreasing pollution rather than as increasing the green share of generation. In treatment G1P1, P1 is coupled with G1.

[1] In a between-subject design, each participant experiences only one experimental condition.

Table 1: Treatment groups and definitions

Name	Definition
F	No roadmap
G1	Annual roadmap for green share of generation
G5	Five-yearly roadmap for green share of generation
P1	Annual roadmap for pollution
G1P1	Annual roadmap for green share of generation and pollution

Table 2 summarizes the relevant treatment comparisons. The effect of the presence of a roadmap can be tested by comparing F with either G1 or G5. The comparison of G1 and G5 tests the effect of the number of milestones. The framing can be tested by comparing G1 and P1. G1P1 is the combination of treatments G1 and P1, therefore, the effect of two roadmaps can be tested by comparing G1P1 to either G1 or P1.

Table 2: Treatment comparisons

<table>
<tr><th></th><th>F</th><th>G1</th><th>G5</th><th>P1</th><th>G1P1</th></tr>
<tr><td>F</td><td></td><td colspan="2">Presence of a roadmap</td><td></td><td></td></tr>
<tr><td>G1</td><td></td><td></td><td>Number of milestones</td><td>Roadmap formulation</td><td rowspan="2">Two roadmaps</td></tr>
<tr><td>P1</td><td></td><td></td><td></td><td></td></tr>
</table>

Results

The experiments were conducted with a total of 207 participants. One participant with a software related problem is excluded from the analysis. First, we test whether the probability of reaching the final target differs across treatments; we do not find any significant difference.

Next we eliminate participants who had a blackout (10 participants) and who failed to achieve the final target (18 participants). Therefore, we conduct the analyses with a total of 178 participants, with at least 31 participants in each group.

For each comparison, participants' green and thermal subsidy decisions are tested. Then, in case of significantly different subsidy decisions, final goal achievement and market performance criteria are evaluated. To test the subsidy decisions and market performance criteria, we use a Generalized Additive Model (GAM) which assumes a nonparametric relation between the predictor and output variables (Hastie & Tibshirani, 1986). This choice is appropriate since we focus on the paths over the course of 40 years.

We find that all of our manipulations have a significant effect on green subsidy decisions. Thermal subsidy decisions are only influenced by the presence (presenting a roadmap or not) and the complexity (two mathematically identical roadmaps vs. one roadmap) of roadmaps.

Finally, we examine whether the differences in subsidy decisions translate into differences in market performance criteria, pollution, blackout risk and price, which capture respectively sustainability, reliability and affordability. We find that the paths of market performance criteria are not influenced by the presence of a roadmap or roadmap framing. The time granularity has an effect on the paths of pollution and blackout risk. Presenting two mathematically identical roadmaps rather than one influences only the path of pollution.

Conclusions

In this work, we study the impact of roadmap manipulations on regulatory decisions and market performance. In an experimental setting, we show that subsidy decisions for renewables are influenced by presenting a roadmap, its framing, the level of detail of a roadmap and the complexity of roadmaps, while thermal subsidy decisions are only influenced by the presence and complexity of roadmaps.

This study provides support that regulatory decisions can be influenced by the roadmap choice. The findings further suggest that differences in subsidy decisions do not necessarily translate into differences in market performance.

References

Hastie, T., & Tibshirani, R. (1986). Generalized Additive Models. *Statistical Science*, *1*(3), 297–218.

IRENA. (2015). *Renewable Energy Target Setting*. *Irena*.