Time lags between policy implementation and market diffusion: An empirical framework for low-carbon technological change in Austria

Conference track: Methodological advances to study transitions, including modelling

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Transforming the transport and energy sector of Western industrialised countries towards low carbon emissions calls for swift action. Relying on slow self-regulatory processes alone not only incurs substantial social and ecological costs but also limits the room for manoeuvre in the coming years. Facing these critical time constraints, decision-makers need to know which policies are effective and, more importantly, how fast these policies unfold on a society/regime level. The present paper estimates impact lags in policy implementation describing the timespan between policy actions, such as the passing of laws or regulations, and their actual impact on the market diffusion of low carbon technologies. We analyse the dynamic interactions between two parallel processes over time: the policy vector, describing how technology-specific policies are issued by EU, national and provincial authorities; and the technology vector, describing how a certain technology penetrates the market.

We investigate the market diffusion of electric and hybrid vehicles, heat pumps in residential buildings, and photovoltaics panels for private roofs for the case of Austria in yearly intervals during the last decade. The evolution of the policy vector is reconstructed along a historical time line drawing on document analysis and expert interviews. Multiple processes and actors are joined to narratives that identify crucial milestones in Austrian policy deployment. Where applicable, indicators of policy stringency such as fuel tax rates or feed-in tariffs are compiled as quantitative time series. The technology vector is established from longitudinal market statistics (e.g., market shares, installed capacity). Diffusion curves with various shapes and parameters are fitted to the observed market data. Change point analysis identifies the statistically most likely points in time when the first-order derivative of the technology vector changed, i.e. when the speed of market penetration accelerated or decelerated. These turning points are then connected to preceding events in the policy vector.

Exemplary results are presented to illustrate our methodological rationale. Preliminary findings show a pull-forward effect of targeted polices for electric vehicles and heat pumps in the province of Vorarlberg. Heavily subsidising the acquisition of innovative technologies incurred an almost immediate increase in market adoption. However, as soon as the subsidy was discontinued or small pilot regions had spent their investment volume, the diffusion curve fell back to the trend prevalent in other provinces.

The presented framework aims to quantify the time it takes for policy steps to become effective for low carbon transformation. However, temporal sequence alone does not suffice to derive full

causality between policy and technology vectors: real-world policies may be developed in an adaptive and reflexive manner instead of dedicated milestones; technology vectors underlie socio-economic trends that may obscure the occurrence of change points; technologies evolve from niche to mature products following consumer acceptance. Thus, we propose to use insights from temporal delay as learnings for the timely design of transition pathways for Austria's transformation into a low carbon society.

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