EFFICIENCY IN WHOLESALE ELECTRICITY MARKETS: ON THE ROLE OF EXTERNALITIES AND SUBSIDIES

Sylwia Bialek, Institute for Policy Integrity, New York University, +1 212 992 8194, smb15@nyu.edu
Burcin Unel, Institute for Policy Integrity, New York University, +1 212 992 8194, bu4@nyu.edu

Overview

Numerous national and sub-national governments are undertaking ambitious efforts to reduce emissions from the electricity sector. The focus is often on policies that advance clean energy by effectively subsidizing each MWh of pollution-free energy: clean energy mandates, technology-specific payments, and production tax credits for clean energy generation.

Subsidies are widely regarded by economists as a second-best instrument, leading to low costs-effectiveness of abatement efforts. Policymakers and market operators worry that generation subsidies, by altering incentives for entry and exit of generators, might decrease system reliability, in regions operating capacity markets, distort the capacity prices. The MOPR and CASPR capacity markets reforms undertaken in PJM and ISO-New England respectively, are a testimony to the widespread policy concern.

If there are no externalities associated with electricity generation, it is straightforward to see that subsidizing a subset of generators harms the efficiency of wholesale markets. However, when uninternalized externalities are present the welfare effects of the generation subsidies are not trivial. The existing studies on effects of generation subsidies cannot evaluate their welfare implications comprehensively as they usually either ignore the external damages from emissions (Briggs and Kleit 2013, Brown 2018a, Brown 2018b, Blumsack et al. 2018, Llobet and Padilla 2018) or use energy-only models (Reguant 2019, Abrell et al. 2019) even though many of the US regions also have capacity markets. Some studies even completely abstract away from wholesale electricity markets design (Antoniou and Strausz 2017, Eichner 2014) even though under various designs the markets can lead to allocations different than those chosen by a social planer.

We want to close the gap in understanding the interaction between generation subsidies, wholesale electricity markets, and externalities through a comprehensive evaluation of welfare effects of subsidies. Our goal is to run those evaluations in a framework that is transparent, and yields itself to generalizations, while also enabling the researcher to study a variety of policy instruments. Therefore, we develop a new analytical framework capable of reflecting the desired heterogeneity of generation and demand variability while allowing for transparent, closed-form solutions for equilibrium prices and capacity levels.

Methods

We derive an analytical, partial-equilibrium model of wholesale energy and capacity markets based on the seminal study by Joskow and Tirole 2007. We obtain formulas describing the effects of generation subsidies on equilibrium generation, prices and capacity mix in both energy and capacity markets. To the best of our knowledge, we are the first to derive the price and quantity responses in a functional form. Our main focus is on equilibrium outcomes, but our framework also provides some insights about transition periods following the introduction of a subsidy.

Next, we study how subsidies affect welfare by comparing the outcomes under generation subsidies to two benchmarks: the “status quo”, where instruments to internalize pollution damages are absent, and the “first-best” case, where polluters pay Pigouvian taxes.

Results

We first confirm that not addressing externalities in wholesale markets skews the generation mix toward polluting resources. Next, we focus on efficiency of policies that give uniform generation subsidies to multiple clean generation types, efor instance to solar, wind and biomass. We prove that if more than one type of polluting generation technology operates in the market (e.g. gas and coal), a uniform subsidy cannot produce the first-best outcomes, even when combined with an energy consumption charge. A better subsidy design would compensate resources for “avoidance” of pollution instead of paying them for “absence” of pollution. Welfare implications of a uniform subsidy rate depend

thus largely on how the relative pollution footprint of resources is distributed over the merit order. If all subsidized units replace resources with similar pollution footprint, a uniform subsidy achieves outcomes close to thosearising under optimal subsidies. If, on the other hand, some of the subsidized generators push out heavy polluters out of the markets, while others compete with relatively clean resources, the welfare contributions of the subsidy are diminished.

Importantly, even a uniform subsidy can improve the efficiency of the electricity markets if pollution is not internalized. We argue that by showing that with subsidies financed from the general budget, there always exist an efficiency-enhancing subsidy rate. For subsidies financed through additional charges on energy consumption, there exist market configurations where any subsidy rate detracts from market efficiency. However, those configurations are rare and do not represent the situation in current wholesale markets.

We also show that generation subsidies are irrelevant for long-term competitive equilibrium capacity prices when two conditions are met: 1) the introduction of a generation subsidy for non-polluting resources does not change the peaking generator type and 2) the peaking generator is of polluting type. This finding is relevant in the context of policy discussions about the potential for generation subsidies to affect wholesale capacity prices.

Using the analytical modelling results, we investigate the welfare implications of recent capacity market reforms in PJM and ISO-New England. These reforms, motivated by concerns of generation subsidies leading to price suppression and uneconomic entry of resources, require subsidized resources to bid in the capacity market at their administratively determined "unsubsidized" cost (i.e. "minimum bid requirements"). We argue that, because capacity market price suppression holds true only under very limited circumstances, policies that indiscriminately mitigate any subsidy, without taking its welfare effect into account, harm the economic efficiency of wholesale electricity markets.

Conclusions

Policymakers have widely embraced subsidies for non-polluting generation as a policy tool: As of 2020, twenty-nine states have a Renewable Portfolio Standard providing additional revenues to eligible generators. New York and Illinois pay some of their nuclear generators Zero-Emission Credits and five further states are considering similar payments. At the federal level, the Renewable Electricity Production Tax Credit provides a per-MWh subsidy to renewable generation technologies.

As subsidies are increasing in numbers and magnitude, it is important to remember that generation subsidies are a second-best instrument incapable of producing first-best outcomes. Nevertheless, with the greenhouse gas emissions leading to climate change and the lacking political will to implement pollution pricing, we claim that subsidies are still a valuable tool in policymakers' toolbox as they increase welfare compared to the status quo. Our results show that existing generation subsidies do not affect capacity prices and do not lead to the feared loss of resource adequacy. Consequently, the capacity market reforms in PJM and ISO-New England with their goal of mitigating the impacts of generation subsidies on capacity markets create distortions and detract from welfare.

References

Abrell, J., S. Rausch, and C. Streitberger (2019). The economics of renewable energy support. *Journal of Public Economic*s 176, 94–117.

Antoniou, F. and R. Strausz (2017). Feed-in subsidies, taxation, and inefficient entry.*Environ Resource Econ* 67, 925–940.

Blumsack, S., C. Lo Prete, U. V. Shanbhag, and M. Webster (2018). Analysis of state policy interactionswith electricity markets in the context of uneconomic existing resources: A critical assessment of the literature. Working Paper.

Briggs, R. and A. Kleit (2013). Resource adequacy reliability and the impacts of capacity subsidies incompetitive electricity markets. *Energy Economics* 40, 297–305.

Brown, D. P. (2018a). Capacity payment mechanisms and investment incentives in restructured electricitymarkets. *Energy Economics* 74, 131–142.

Brown, D. P. (2018b). The effect of subsidized entry on capacity auctions and the long run resource adequacy of electricity markets. *Energy Economics* 70, 205–232.

Eichner, T. and M. Runkel (2014). Subsidizing renewable energy under capital mobility. *Journal of Public Economics* 117, 50–59.

Joskow, P. and J. Tirole (2007). Reliability and Competitive Electricity Markets. *RAND Journal of Economics* 38, 60–84.

Llobet, G. and J. Padilla (2018). Conventional Power Plants in Liberalized Electricity Markets with Renewable Entry. *Energy Journal* 39, 69–91.

Reguant, M. (2019). The Efficiency and Sectoral Distributional Impacts of Large-Scale Renewable Energy Policies. *Journal of the Association of Environmental and Resource Economists* 6, 129–168.