

## Executive Summary

# Deregulation and Investment in Generation Capacity: Evidence from Nuclear Power Uprates in the United States

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Economic theories have long argued that market deregulation and competition change firm investment incentives, leading to potentially significant gains in social welfare. Under traditional rate of return regulation, firms have strong incentives to engage in excessive capital investment if the allowed return rate exceeds the cost of capital; meanwhile regulated firms have less motivation to invest in efficiency and technological innovation. With economic deregulation, firms are not only discouraged from excessively investing in capital, but also incentivized to pursue profitable investment opportunities because they are no longer limited to a “capped” rate of return.

This paper provides the first comprehensive study on the impacts of deregulation on investment in power uprates by owners of U.S. nuclear power reactors. Nuclear power uprates enable a nuclear reactor to operate beyond its originally licensed thermal power limit, thus increasing its electricity generation capacity. Since nuclear reactors have a significant fuel cost advantage over coal and gas fired plants, power uprates allow plant owners to gain the most from their nuclear units.

We study power uprate applications submitted by investor-owned reactors to the U.S. Nuclear Regulatory Commission (NRC) between 1991 and 2012. We employ a Difference-in-Differences

(DID) strategy and investigate the change in power uprates by eventually-deregulated reactors after versus before deregulation, using always-regulated reactors as the control group.

First, we find that deregulation incentivized reactor owners to invest in power uprates. On average the owner of a deregulated reactor is more than twice likely to invest in power uprates than that of a regulated reactor. Second, we find that even for such generally profitable power uprate investments, owners of deregulated reactors make careful decisions that are consistent with the technological characteristics of their plants. After deregulation, the two types of nuclear reactors, Boiling Water Reactors (BWRs) versus Pressurized Water Reactors (PWRs), differ in which types of power uprates to pursue. Owners of deregulated BWRs are more likely to choose Extended Power Uprates (EPUs) that could increase the reactor thermal power by up to 20 percent. In contrast, owners of deregulated PWRs, for which EPUs are more technically challenging, risky and expensive due to imbedded technical constraints, tend to choose Stretch Power Uprates (SPUs) or Measurement Uncertain Recaptures (MURs) that typically add 2 to 7 percent of the original thermal power.

Our study suggests that deregulation and competition provide incentives above those of regulated markets for firms to invest in generation capacity if such investments are profitable and the rate of return is higher than the allowed return under regulation. The study provides a unique perspective on the impacts of deregulation in electricity markets on firm incentives and efficiency in capital investment. The literature has so far focused on the effects of increased uncertainty in restructured markets on investment, showing that power generators in restructured markets delay or are less likely in investing in new generation capacity and capital intensive pollution abatement equipment. Our study focuses on investment in nuclear generating capacity for which profitability uncertainty seems to be of less concern because of the baseload nature of nuclear power. This allows us to identify incentives for investment by owners of deregulated reactors, shielding the impacts of uncertainty on such decisions.

Our paper also proposes a novel indicator for deregulation. We determine the regulatory status of a nuclear reactor base on whether it is removed from the regulatory rate-base of the utility owning it (according to the financial statements of the utility). We consider our proposed deregulation indicator to be more accurate in determining whether a plant is deregulated than currently used indicators that are either based on the state level enactment of electricity restructuring or on the divestiture of the plant.