

Uncertainty Barrier in Energy Transition Dynamics

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Abstract

This paper studies a structural shift in the energy transition—from persistent carbon price uncertainty to the idiosyncratic but predictable variability of renewables. We develop a dynamic equilibrium model in which this shift is endogenous, producing a mechanism that generates gradualism in a distinctive, non-monotonic form: renewable capital and uncertainty exposure are initially dynamic complements, but eventually become substitutes. This feature overturns standard policy predictions, including: higher carbon taxes can reduce prices and their dispersion; greater intermittency can lead to more predictable market outcomes; and carbon-based technologies may themselves become intermittent in use. We provide a quantitative assessment of common policy proposals targeting price stability, accelerated investment, and high-renewable systems with large intermittency.

Keywords: renewable energy, investment, real options, competitive equilibrium, electricity

JEL Classification: D81; D41; L1; Q42.