

Unlocking the Green Transition: Open Innovation as an Econometric Framework for Efficient European Eco-Innovation

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Abstract

Eco-innovation is a central pillar for driving environmental sustainability and economic competitiveness under the European Green Deal. However, traditional closed innovation approaches frequently fail under the weight of high capital expenditure, systemic complexity, and the multidisciplinary knowledge demands required for clean technology breakthroughs. Integrating the Knowledge-Based View (KBV) and the Natural-Resource-Based View (NRBV), this paper formulates a panel econometrics framework to model European Eco-Innovation Efficiency (EIE) across EU Member States. We propose a theoretical two-stage stochastic frontier specification that incorporates inbound knowledge flows, collaborative network depth, and institutional regulatory stringency to isolate the mechanics of eco-innovation performance. Our structural model yields a key theoretical finding: Open Innovation operates non-linearly on Eco-Innovation Efficiency, where institutional regulatory stringency acts as a crucial moderating catalyst. While open inbound collaboration accelerates knowledge recombination, its efficacy is bound by search friction and coordination costs. Strict environmental policy stringency shifts the efficiency frontier upward by standardizing cross-organizational goals, mitigating opportunistic behavior, and directing collaborative networks toward high-impact, compliance-oriented green technologies. These findings demonstrate that open innovation ecosystems, when coupled with targeted regulatory drivers, provide the necessary structural framework to eliminate systemic inefficiency and optimize clean technology deployment across the European Union.

Keywords: Open Innovation, Eco-Innovation Efficiency, Panel Data Econometrics, Absorptive Capacity, Knowledge Spillovers, European Union