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## Economic Shadows of COVID-19: Electricity Trends in Tehran

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The COVID-19 pandemic created unprecedented global health and economic challenges. Developing nations like Iran, which rely heavily on informal economic activities, faced unique hurdles in assessing and mitigating the pandemic's economic toll. Tehran, the economic hub of Iran, experienced significant disruptions, prompting a need for innovative approaches to quantify these impacts. Traditional metrics like GDP often fail to capture the nuances of economic activity in such contexts. Electricity consumption, a vital economic indicator, provides a promising alternative for real-time and sector-specific economic assessments. This study focuses on Tehran's commercial electricity consumption to estimate the pandemic's economic costs, contributing to informed policy-making and recovery planning.

The study employs a Difference-in-Differences (DID) methodology to measure the pandemic's impact on electricity consumption. Data from 14,638 commercial units in Tehran spanning 2019 (control group) and 2020 (treatment group) are analyzed. The DID model uses pre- and post-COVID-19 periods to estimate the causal effects of the pandemic on electricity usage. The model accounts for monthly and regional fixed effects to control for seasonality and unobservable heterogeneity. The DID framework ensures robust causal inferences by comparing trends in the control and treatment groups, isolating the pandemic's economic effects.

The results reveal a substantial decline in electricity consumption in the post-COVID-19 period, highlighting the pandemic's significant economic impact. Regression analyses show that the interaction term (treatment  $\times$  post) is statistically significant and negative, indicating a marked reduction in electricity usage in 2020 compared to 2019. The treatment group experienced a prolonged decrease, with consumption levels failing to recover to pre-pandemic trends until two months after the initial outbreak. This finding underscores the pandemic's enduring impact on Tehran's commercial sector.

This study demonstrates the utility of electricity consumption as a proxy for economic activity, particularly during crises. By employing a robust counterfactual framework, it provides an innovative method to quantify the economic costs of COVID-19. The research offers actionable insights for policymakers, emphasizing the need for targeted support to affected sectors and the adoption of sustainable recovery strategies. The findings also contribute to broader discussions on the intersection of energy use and economic resilience, paving the way for future studies in similar contexts.

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