Investing in the Twin Transition: The Impact of Green and Digital Projects on Firms' Performance

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Extended Abstract

This paper presents a comprehensive investigation into the impact of twin transition (TT)—green and digital—initiatives on firm performance in Italy over the period 2014–2023. By examining firms' participation in green and digital activities, the study provides valuable insights into how these investments correlate with economic outcomes, aligning with the European Green Deal's objectives of fostering sustainable and digital growth.

The analysis integrates two Italian-focused datasets: OpenCoesione, which provides information on green and digital investments funded by the European Regional Development Fund (ERDF), and Aida, a source of firm-level data on key performance indicators such as value added, employment, and labor productivity. The study adopts a two-stage approach. First, text analysis techniques identify the green and digital content of ERDF-funded projects by analyzing project titles and descriptions. Second, a Staggered Difference-in-Differences (DiD) econometric approach assesses these initiatives' temporal and firm-specific impacts on performance outcomes.

A key motivation of this research stems from the intertwined nature of green and digital transitions. These two dimensions are central to the European Union's strategic policies, including the Digital Compass and the Fit for 55 package, which seek to harmonize technological progress with sustainability. The European Green Deal underscores the necessity of integrating digital solutions into environmental policy, yet achieving synergy between these transitions remains a challenge. The literature suggests that while digitalization can drive efficiency and innovation, it may also increase energy consumption, necessitating careful policy design to mitigate potential trade-offs.

The twin transition represents a fundamental shift in economic and industrial structures, intertwining digital advancements with environmental sustainability to drive long-term competitiveness and resilience. However, as highlighted by recent studies, its implementation is highly uneven across regions and sectors, often reinforcing existing disparities rather than mitigating them (Faggian et al., 2024; Fatikhova et al., 2024). While ICT adoption accelerates productivity and innovation, its benefits tend to concentrate in already technology-intensive regions, leaving lagging areas struggling to integrate digital tools effectively (Fazio et al., 2024). Similarly, green investments, although crucial for achieving climate neutrality, may not yield immediate financial returns for firms, making their uptake more challenging without adequate policy incentives (Montresor & Quatraro, 2020). The European Union's cohesion policies aim to counterbalance these disparities, yet evidence suggests that without targeted measures, the twin transition could exacerbate regional imbalances rather than bridge them (Santos et al., 2023). This calls for a strategic approach that aligns financial support with tailored regional development strategies to ensure an inclusive and equitable transformation.

This study also explores regional disparities by comparing the effects of green and digital investments in northern and southern Italy. Given Italy's persistent economic divide, with southern regions often lagging in growth and innovation, this aspect is particularly relevant for assessing whether TT initiatives contribute to bridging the gap or reinforce existing inequalities. Empirical studies have highlighted the uneven distribution of innovation potential across European regions, where high-tech clusters in the North drive progress while the South struggles with structural weaknesses.

Our empirical strategy benefits from the methodological advancements in causal inference, particularly the staggered DiD framework, which accommodates variations in treatment timing. This approach allows us to isolate the effect of green and digital investments on firm performance while accounting for potential biases associated with policy implementation timing and firm characteristics. The staggered DiD methodology, following Callaway and Sant'Anna (2021), allows for the estimation of treatment effects while addressing concerns of heterogeneous treatment adoption over time. This approach mitigates biases stemming from differential adoption of TT initiatives across firms and regions, ensuring that observed effects are causally attributable to policy interventions rather than external confounding factors. Additionally, our analysis accounts for firm-level heterogeneity by incorporating control variables such as sector classification, firm size, and financial structure, which may influence firms' responsiveness to TT policies.

The first stage of the analysis involves a systematic classification of projects using text-based analysis. We employ Natural Language Processing (NLP) techniques, including text-mining and dictionary-based classification, to systematically identify green and digital investments within ERDF-funded projects. A predefined dictionary-based approach is employed, where project descriptions are parsed for keywords related to sustainability, digitalization, and twin transition. This method enables us to distinguish between projects that explicitly focus on digital transformation, green innovation, or both. To enhance classification accuracy, stemming and tokenization processes are used to account for linguistic variations. Furthermore, the reliability of this classification is verified through a manual validation step, where a sample of projects is reviewed to ensure consistency in keyword mapping.

Preliminary findings indicate that firms implementing ERDF-funded projects exhibit superior performance in terms of value added compared to the control group. However, this positive and statistically significant effect diminishes when focusing solely on digital and green projects, suggesting that the broader impact of TT investments may depend on contextual and firm-level factors. The estimated treatment effects reveal that while TT-related investments generate gains in economic performance, these benefits are more apparent in firms that engage in broader innovation activities beyond the isolated adoption of digital or green technologies. Moreover, regional heterogeneities persist, with firms in the North benefiting more than their counterparts in the South, reinforcing concerns about the uneven economic impacts of transition policies.

Sectoral analysis further reveals that the benefits of TT initiatives are more pronounced in knowledge-intensive industries and manufacturing, where firms are better positioned to leverage digitalization and sustainability investments. In contrast, traditional sectors with lower technological intensity appear less responsive to these policy interventions. This finding aligns

with prior research suggesting that digital transformation is most effective when accompanied by complementary investments in human capital and infrastructure (Montresor & Quatraro, 2020; Consoli et al., 2023). The observed disparities highlight the role of absorptive capacity in determining firms' ability to capitalize on policy-driven investments, emphasizing the need for complementary measures such as skill development programs and R&D incentives.

The findings contribute to the growing literature on the twin transition by providing empirical evidence on how digital and green investments shape firm performance in a diverse economic landscape. They also raise critical questions for policymakers regarding the design of cohesion policies that ensure an equitable distribution of technological and sustainability benefits. Future research should explore the long-term effects of TT initiatives, considering potential spillovers across regions and industries, as well as the role of complementary factors such as financial constraints and regulatory frameworks in shaping firms' adoption of green and digital technologies.

Keywords: Twin transitions; Regional Development; Firm Performance; European Green Deal

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