

Spatial Proximity and Technological Relatedness in the Twin Transition Interfirm Agreements

Emanuela Marrocu, Raffaele Paci, Luca Serafini

Department of Economics and Business & CRENoS, University of Cagliari, Italy

1. Motivation and Research Questions

The twin transition — the simultaneous shift towards digitalisation and environmental sustainability — represents one of the most profound structural transformations of the contemporary economy. Firms navigating this dual challenge face substantial risks, capital requirements, and the need to access complementary competencies that seldom reside within a single organisation. Interfirm agreements (IAs) — such as joint ventures (JVs) and strategic alliances (SAs) — are therefore increasingly recognised as a key organisational vehicle for pooling capabilities, sharing costs, and coordinating investments in green and digital domains.

While a growing body of literature investigates firm-level innovation strategies in the context of the twin transition, comparatively little attention has been paid to the role of IAs as collaborative forms enabling firms to confront these challenges jointly. This paper aims to fill that gap by providing a long-run, systematic analysis of how IAs have evolved in connection with the twin transition, with a particular focus on Italy. The study is guided by three interrelated research questions: (i) How have IAs evolved over time in connection with green and digital transformations, globally and in Italy? (ii) Which industries and firms are most actively engaged in transition-related IAs, and what is their geographical distribution? (iii) How is the occurrence of such collaborations driven by spatial proximity and technological relatedness among participants?

2. Data

The empirical analysis relies on a novel and comprehensive dataset drawn from SDC Platinum (LSEG), covering all announced JVs and SAs worldwide over the period 2000–2025. The dataset includes detailed information on deal names, synopses, dates, status, and the characteristics of participating firms — notably their names, nationality, sector (at the four-digit SIC level), and institutional status. In total, the dataset contains approximately 164,000 announced agreements, of which strategic alliances account for roughly 73% and joint ventures for the remaining 27%.

To identify IAs linked to the twin transition, we employ a keyword-based text analysis of deal names and synopses, classifying agreements into three non-exclusive categories: green (linked to environmental sustainability, renewable energy, clean technologies), digital (linked to digitalisation, ICT, artificial intelligence, data infrastructure), and their intersection (agreements addressing both dimensions simultaneously). This approach enables a consistent, reproducible identification of transition-related IAs across sectors and over the full time span.

For the econometric analysis of IAs' determinants, attention is restricted to agreements involving at least one participant headquartered in Italy. All agreements with more than two participants are decomposed into dyads, retaining only pairs that include at least one Italian firm. Participant cities — if missing in the original source — were recovered using a large

language model, leveraging firm names and available contextual information. Coordinates were obtained via geocoding in OpenStreetMap, and Italian participants were assigned to NUTS-2 regions via a spatial join with official Eurostat shapefiles. This process yields approximately 3,200 dyads involving at least one Italian participant, spread across a wide range of sectors and partner countries.

3. Descriptive Evidence

A first set of results concerns the global distribution of IAs over time and across nations. The United States, China, and the major EU economies — including Italy — emerge as the most active participants in terms of the number of agreements and share of transition-related deals. The temporal evolution reveals a clear upward trend in both green and digital IAs since the mid-2000s, with an acceleration particularly after 2015, coinciding with the Paris Agreement and the intensification of EU digital policy. The share of IAs simultaneously classified as both green and digital has also grown, suggesting an increasing convergence of the two dimensions of the transition.

With respect to Italy, the descriptive analysis reveals that the vast majority of Italian-involved dyads feature an international partner: roughly 83% pair an Italian firm with a foreign counterpart, while the remaining 17% are domestic (both partners are located in Italy). Within domestic dyads, approximately 30% involve firms located in the same NUTS-2 region, suggesting that spatial proximity continues to play a role in partner selection even within national borders. Average distances for domestic dyads are around 260 km, with considerable heterogeneity reflecting Italy's geographic extension and the concentration of economic activity in the North.

Looking at the sectoral composition, manufacturing — and in particular energy-related and high-tech manufacturing — accounts for the largest share of both green and digital IAs in Italy, consistent with the broader European pattern. Services, including ICT, finance, and professional activities, are a growing component of digital IAs. Large, publicly listed companies tend to appear most frequently as agreement participants, often involving partners from a broad range of countries, while smaller and private firms are more likely to engage in domestic or regionally concentrated partnerships.

4. Econometric Framework and Expected Results

The econometric analysis models the probability that any two firms — at least one of which is Italian — establish a collaborative agreement as a function of multidimensional proximity and network characteristics. Given the rarity of actual agreements relative to all possible firm dyads, we follow the rare-events logit framework of King and Zeng (2001), applying a prior correction via the Bayesian method as in Usai et al. (2017).

Two main dimensions of proximity are operationalised. Geographical proximity is measured as the inverse of the geodesic distance between partners' cities, complemented by co-location dummies at the country and NUTS-2 region level. Technological relatedness is captured through a set of mutually exclusive dummies that reflect the degree of sectoral relatedness at increasing levels of SIC disaggregation (from one-digit divisions to four-digit industries).

We also include a full set of controls for the individual characteristics of the participants: Firm's characteristics: status (listed, private); organization (independent, subsidiary), ownership nationality (Italian, foreign); industrial sector (division of the standard industrial classification); geographic location (Italy: Northwest, Northeast, Center, South, Islands; EU country; rest of the world)

We expect all proximity dimensions to exert a positive and significant effect on the probability of observing an IA, with technological proximity likely to carry the highest impact. A key novelty of the present analysis is the interaction of proximity effects with the digital and green classification: we investigate whether transition-related agreements exhibit a distinctive proximity structure compared to the full sample — for instance, whether green IAs are more geographically concentrated or whether digital IAs are more strongly driven by technological relatedness across distant sectors. This decomposition by agreement type provides direct policy-relevant insight into the spatial and sectoral logic underpinning the twin transition.

5. Contribution and Policy Implications

This paper makes several contributions to the literature. First, it provides the most comprehensive longitudinal mapping of IAs in the context of the twin transition to date, covering a 25-year window across all economic activities. Second, it combines text-based classification of agreements with descriptive and econometric analysis, offering a richer characterisation of collaborative behaviour than prior work. Third, by focusing on Italy, it offers direct comparability with an established benchmark while advancing the analysis in scope, time coverage, and thematic focus.

From a policy standpoint, the findings shed light on whether transition-related collaborations are geographically concentrated or widely distributed, which sectors and regions are leading the formation of green and digital alliances, and whether proximity dimensions operate differently for different types of transition agreements. These insights are directly relevant to the design of industrial and cohesion policies aimed at fostering coordinated innovation in complex and uncertain environments, particularly in a country like Italy characterised by strong regional disparities and a significant share of small and medium-sized enterprises.

Keywords: twin transition, interfirm agreements, joint ventures, strategic alliances, proximity, networks, Italy

JEL Codes: F23, L14, O33, R12