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BOUNDARY SPANNING AND TEAM INNOVATIVENESS: THE ROLE OF TEAMS' TECHNOLOGY PORTFOLIOS*

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Abstract

This paper introduces teams' technology use as a contingency factor for the link between teams' boundary-spanning activities—such as regularly maintaining firm external or firm internal contacts, or memberships in multiple teams—and team innovativeness. Using novel, detailed data on the technology use of teams in a representative sample of over 3,500 German firms, we derive distinct technological portfolios at the team level, comprising comprehensive tech use portfolios with advanced artificial intelligence (AI) applications, minimalistic tech use portfolios, and focused tech use portfolios heavily reliant on specialized technologies, such as Big Data or IT security. We find that the effectiveness of team boundary spanning in increasing team innovativeness strongly depends on a team's technological portfolio. While boundary spanning is more vital for team innovativeness with either minimal or comprehensive technology use, it is less relevant for focused-tech teams. Our results emphasize the critical interplay between a team's technological portfolio and the link between boundary-spanning activities and team innovativeness. We provide insights into how teams can better align their boundary-spanning activities with their technological portfolios to support team innovativeness.

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INTRODUCTION

Innovation relies on the effective integration of diverse knowledge, skills, and perspectives. Recent evidence demonstrates that with the rise of generative artificial intelligence (GenAI), team-level innovation has become increasingly critical (Joshi, 2024; Li et al., 2024). Successful GenAI implementation in firms requires more than just top-down innovation inputs—productivity gains depend heavily on combining AI capabilities with domain-specific knowledge that resides at the operational level across various teams (Brynjolfsson et al. 2023; Tambe, *forthcoming*).[1] Management research consistently emphasizes that teams do not function in a vacuum and identifies boundary spanning—the process of interacting with external actors, resources, and knowledge—as a key driver of team performance and innovation (Cohen & Levinthal, 1990; Joshi et al., 2009, Van Knippenberg et al., 2024). These boundary-spanning activities, which provide teams with critical ideas and knowledge resources, help them improve coordination with external actors (i.e., clarifying expectations and synchronizing efforts), thereby preventing inefficiencies and conflicts (Marrone, 2010; Davison et al., 2012). In line with these benefits several studies document positive links between boundary spanning and innovativeness (Aggarwal et al., 2014; Akgün et al., 2008; Joshi et al., 2009; Marrone, 2010; Zhang & Li, 2021).

However, boundary spanning also introduces frictions. The same boundary-spanning activities that enrich a team's knowledge base can generate information asymmetries between team members and coordination costs that can undermine the benefits of boundary spanning (Backes-Gellner & Veen, 2013; Choi, 2002; Pull et al., 2015; Tortoriello & Krackhardt, 2010). Managing such costs is essential for translating heterogeneous knowledge inputs into innovative outcomes. While the literature on boundary management has already examined essential contingencies of effective boundary spanning, such as the characteristics of the boundary management carrier (i.e., the person responsible for leading the boundary-spanning activities) (Leicht-Deobald et al., 2025), or the nature of tasks that shape boundary-spanning activities (Joshi et al., 2009), the role of a team's technology use as a further potentially critical contingency has thus far been neglected. Yet a team's technology use substantially shapes how it acquires, processes, and integrates external knowledge, thereby affecting both the costs and benefits of boundary-spanning activities. Despite its theoretical and practical significance, the role of a team's technology use for the link between boundary spanning and team innovativeness remains unexplored.

Our paper examines whether and, if so, to what extent the link between teams' boundary-spanning activities and team innovativeness depends on a team's technology use. To identify the role of teams' technology use in the link between boundary-spanning and innovativeness, we implement a two-step empirical strategy. First, we measure a team's technology use by exploiting a broad spectrum of single technologies included in a representative survey of over 3,500 German firms, ranging from basic technologies such as simple collaboration tools to cutting-edge technological innovations such as AI.

At a very basic technological level, the survey covers, for example, how teams use technologies for customer or supplier interaction, human resource (HR) management, or project-based collaboration. The more advanced level includes emerging data-intensive technologies, such as Big Data, cloud computing, and IT security systems. At the cutting-edge technological frontier, the survey captures, for example, whether teams integrate AI, machine learning, or automation technologies. Overall, our data allows us to uniquely characterize a team's technology use in great detail and—through cluster analyses—to derive six unique types of teams' "technological portfolios" (i.e., distinct patterns and combinations of technology adoption within teams).

Second, we analyze how a team's technology use affects the link between boundary-spanning activities and team innovativeness. We assess boundary spanning across three core dimensions from the management literature (Ascencio et al., 2024; Marrone et al., 2010; Marrone et al., 2007; Mors, 2010): (1) firm external ties, i.e., team members' interactions with actors outside the firm, such as customers and suppliers; (2) firm internal ties, i.e., team members' connections to other actors inside the firm; and (3) multiple team memberships, which institutionalize internal ties via individuals who are part of more than one team. As our outcome variable, we measure team innovativeness using a well-established survey item from the management literature that captures whether teams continuously improve or renew their processes and methods on a 5-point Likert scale (e.g., van Knippenberg, 2017).

Our results show that the potential of boundary spanning to enhance team innovativeness is contingent on teams' technology use. We find significant positive correlations between strengthening external ties and internal ties and team innovativeness only in teams with two types of technological portfolios: minimalistic tech use portfolios with a below-average technology adoption across all technology dimensions and comprehensive tech use portfolios with consistently and strongly above-average technology adoption across all technology dimensions, including most advanced AI-driven solutions. For teams that implement either of these technology portfolios, boundary-spanning—both within and outside of the firm—significantly correlates with a higher innovativeness. In contrast, in teams with a tech portfolio that focuses on collaboration and personnel management tools, only internal boundary-spanning, i.e., intensifying internal ties and multiple team memberships, is associated with higher innovativeness. In other highly specialized teams whose technology use concentrates on a single technology domain (e.g., exclusively on Big Data or on IT-security technologies), none of the boundary spanning types correlates with innovativeness in teams. Using these results, we discuss how differences in the benefits, i.e., the need for knowledge acquisition for team innovativeness, and the costs of boundary spanning, given a teams' tech portfolio, may explain these contingent correlations.

Our paper makes two essential contributions. First, we introduce a novel, data-driven team-level classification of distinct technological portfolios that allows us to objectively describe a team's technology use in unprecedented detail. Due to data limitations, earlier studies had to focus on a single technology domain (DeStefano et al., 2023), rely on proxies for technology adoption (e.g., Behaghel et al., 2014), or measure technology adoption simply by counting the number of technologies in a firm (e.g., Battisti et al., 2023). These approaches overlook differences in technology types and unique combinations. In contrast, our approach captures how teams combine various technology types, thereby accounting for differences in the novelty of technologies.

Second, we enhance the managerial understanding of whether and, if so, to what extent the link between boundary spanning and team innovativeness is contingent on a team's technology use. By doing so, we add an innovative and increasingly important contingency to the boundary spanning literature. Overall, while we find that boundary-spanning activities are positively associated with team innovativeness—consistent with prior management research—this association varies by a team's technological portfolio and is absent in some highly specialized portfolios. The balance of costs and benefits of boundary-spanning activities helps explain the heterogeneity of our results.

THEORETICAL BACKGROUND

Setting the Scene: Team Boundary Spanning

Team boundary spanning encompasses strategic team activities aimed at establishing and maintaining relationships with actors outside of the team to achieve team objectives (Ancona & Caldwell, 1992; Marrone et al., 2007). These activities enable teams to acquire new information, coordinate interdependent tasks, and manage relationships that are essential for performance and innovation (Marrone, 2010; Joshi et al., 2009).

In line with the management literature (Ascencio et al., 2024; Marrone et al., 2010; Mors, 2010), we distinguish three prevalent types of boundary-spanning activities: (1) those that span boundaries to actors outside the firm, i.e., activities that create *external ties*, (2) those that span boundaries to actors inside the firm, i.e., activities that create *internal ties*, and (3) *multiple team memberships* that create and institutionalize internal ties by design.[2] For example, external ties emerge when team members collaborate with customers or suppliers. Internal ties emerge when team members work with other employees within the same firm. Multiple team memberships emerge, for example, in large technology firms (e.g., Google or Meta) where employees may work on their core product in one team while simultaneously participating in temporary teams formed during hackathons (Asencio et al., 2024).

Boundary Spanning and Team Innovativeness: Toward a Contingency-Based Explanation

Some studies argue that team boundary spanning positively affects team innovativeness (e.g., Marrone et al., 2010; van Knippenberg et al., 2024), while others stress the challenges associated with boundary-spanning activities (Choi, 2002; Tortoriello & Krackhardt, 2010). For example, showing that boundary spanning enhances access to diverse informational resources, particularly when teams share a strong diversity mindset, van Knippenberg et al. (2024) underscore its benefits for team innovation. Yet Leicht-Deobald et al. (2025) emphasize its associated costs, arguing that boundary spanning requires significant effort and time, both of which potentially divert the team's focus from its tasks and objectives.

Given these divergent perspectives, the inconsistency in empirical results on the relationship between boundary-spanning activities and team innovativeness is unsurprising, with some studies finding a positive link (e.g., Akgün et al., 2008; Chang & Cho, 2008; Zhang & Li, 2021) and others reporting no link or even a negative one (Carbonell & Rodriguez Escudero, 2025; Gibson & Dibble, 2013). Investigating employee-level boundary-spanning behavior in Chinese manufacturing firms, Zhang and Li (2021) show that boundary spanning increases innovation performance through creative idea generation. In contrast, Carbonell and Rodriguez Escudero (2025), examining boundary spanning in new product development teams in Spain, find that it decreases team innovativeness by undermining team identification through reduced team boundedness—i.e., who is or is not part of the team.

Thus scholars have turned their attention to the role of contingency factors in the relationship between team boundary spanning and team innovation (Choi, 2002), including project task characteristics (Joshi et al., 2009; Tushman & Katz, 1980), absorptive capacity (Tsai, 2001), team communication (Hirst & Mann, 2004), or the nature of the ties spanning team boundaries (Tortoriello & Krackhardt, 2010). Aggarwal et al. (2014) argue that how technological diversity is organized within firms—whether across or within teams—has critical implications for how effectively firms combine knowledge and innovate. Despite these insights, research has yet to systematically examine how the within-team use of technologies might affect the link between boundary spanning and innovativeness. However, as the use of within-team technology likely shapes teams' ability to engage with external knowledge (i.e., guiding how they source, make sense of, and apply it), we expect within-team technology use to be a key variable influencing the potential of boundary spanning to increase team innovativeness.

A Cost-Benefit Framework linking Team Boundary Spanning and Team Innovativeness

To analyze the role of teams' technology use for the link between team boundary spanning and team innovativeness, we proceed in two steps. First, we present a cost-benefit framework explaining how team boundary spanning may affect team innovativeness. Second, we investigate how a team's technology use may alter the costs and benefits of team boundary spanning in securing high levels of team innovativeness.

To conceptualize the link between team boundary spanning and team innovativeness, we draw on Lazear's (1999) cost-benefit framework of multicultural teams, a framework that scholars have extended to other forms of team diversity—e.g., Backes-Gellner and Veen (2013) to age diversity in innovative firms and Pull et al. (2015) to functional diversity in research teams. In his model, Lazear (1999) explains why team diversity represents a double-edged sword: while diverse teams may benefit from broader knowledge variety and complementarities, in turn enhancing team outcome variables, they may also encounter increases in coordination costs, communication barriers, and conflicts, including non-task-related ones that may adversely affect team outcome variables.

Given that boundary-spanning activities introduce more perspectives and ideas and thus more diversity, we argue that boundary spanning also has the potential to either positively or negatively affect team outcome variables, such as team innovativeness. If teams intensify relationships with external partners within or outside the firm, they not only augment their knowledge and resource base but also increase their efforts to integrate these different perspectives and make heterogeneous resources compatible and actionable within their team.

Thus the theoretical link between team boundary spanning and team innovativeness remains unclear. Figure 1 presents a stylized cost-benefit framework that illustrates how the relationship between team boundary spanning and team innovativeness may be non-linear. The benefits of boundary spanning (dotted line) rise at a decreasing rate, representing diminishing marginal returns, while the costs (solid line) increase more than proportionally, reflecting increasing marginal returns. Consequently, the net benefits (dashed line) follow an inverted U-shape: innovativeness increases with boundary spanning up to a critical threshold S^*, after which the costs outweigh the benefits.

Insert Figure 1 about here

Closing the Loop: Team Technology Use as a Contingency of the Link Between Team Boundary Spanning and Team Innovativeness

A team's technology use will crucially shape how boundary spanning translates into team innovativeness along two key dimensions. First, team technology will affect the *benefits* of team boundary spanning. Teams that operate at the technological frontier and integrate a diverse range of advanced technologies likely have fundamentally different knowledge absorption and production processes than teams that largely eschew technological adoption. Aggarwal et al. (2014) emphasize that innovation often relies on the effective recombination of diverse knowledge, requiring both access to relevant knowledge and the ability to absorb and apply it. By shaping how well teams maintain external contacts and integrate external input, a team's technology use likely influences both requirements. For example, Kiener et al. (2023) argue that IT progress, e.g., software introductions, can facilitate communication and data exchange.

If technologies substantially shape (a) how easily teams acquire, process, and integrate external knowledge and (b) the type of knowledge they seek, this shaping process in turn affects how effectively these teams can leverage boundary spanning to increase their innovativeness. Moreover, Lee et al. (2017) point out that a team's technological maturity affects its members' motivation and communication norms, both of which likely also affect knowledge absorption and the link between boundary spanning and innovativeness.

Second, team technology use will affect the *costs* of team boundary spanning in terms of securing high levels of team innovativeness. As Lazear's (1999) framework posits, accessing external knowledge requires coordination and integration efforts, which impose rising costs as external interactions expand. However, different technologies may alter the marginal costs of such coordination. For example, some technologies may ease information exchange and reduce frictions (e.g., communication tools), whereas others may increase the complexity of integration (e.g., systems that are incompatible or subject to strict data protection, or compliance requirements). Whether the benefits of boundary spanning outweigh the associated costs likely depends on both the types and intensity of teams' technology use and is therefore an empirical question which we analyze in the following sections.

DATA

For our analysis, we use data from the BIBB Establishment Panel on Qualification and Competence Development (BIBB Training Panel) (hereafter, BTP), which has been conducted annually since 2011 and is a representative panel survey of between 2,000 and 3,500 firms in Germany (Gerhards et al., 2023). The population of the BTP is representative of all firms in Germany with at least one employee subject to social insurance contributions. The surveys are carried out through the Computer Assisted Personal Interview (CAPI) method, in combination with telephone (CATI) or web-based (CAWI) interviewing.

The BTP focuses on (a) the incidence of apprenticeships and further vocational training (VET) and (b) the dynamics and structure of employment in the firms conducting training. The BTP also includes a set of questions eliciting structural information on the economic sector, size, and region. A unique feature of the BTP since 2017 is the measurement of technology use (either planned or current use) in the firm. This module has 13 sub-items, each measuring a dimension of technology per firm. Since 2019, the sub-items also include firm use of AI.

We use the 2023 wave of the BTP, which includes a module for measuring team-specific variables such as working arrangements, team heterogeneity (i.e., sociodemographic characteristics), boundary spanning, and team innovativeness. The survey asks interview partners (usually the CEO of SMEs, or the head of HR in larger firms) to (a) think of a concrete team within the firm that they were familiar with at the time of the interview and (b) discuss technology use in that specific team.

The BTP provides two key advantages for our research purposes. First, it offers highly detailed information on the actual technology use at the team (and firm) level, thereby eliminating the need for proxies and allowing for measuring technological adoption at a granular level. Specifically, our dataset captures 13 binary technological variables, reflecting a continuum from basic to cutting-edge technologies.

At the most basic level, there are customer-related technologies (e.g., CRM, e-commerce platforms), supplier-oriented technologies (e.g., enterprise resource planning systems, SCM), and HR technologies supporting personnel management (e.g., competency management). At a more advanced level, our dataset further details how teams implement collaborative technologies, distinguishing between those that enable novel forms of collaboration and communication among employees (e.g., gamification, rating systems) and those that support project-based and cross-company cooperation (e.g., web-based project management tools, crowdworking). Moreover, our dataset captures teams' integration of technologies enabling large-scale data storage and processing (e.g., Big Data and Cloud Computing) or IT security technologies protecting firms from cyber threats.

At the technological frontier, our dataset provides insights into how teams integrate AI and automation across different work processes. We categorize AI applications into two domains: physical processes (in which teams use for example deep learning and pattern recognition in production and maintenance) and non-physical processes (in which AI supports for example marketing and procurement processes). Moreover, our data also capture teams' adoption of technologies that connect previously separate digital and automated processes (e.g., Smart Factory and Internet of Things (IoT) solutions); customizable production technologies and additive manufacturing (e.g., 3D printing and collaborative lightweight robotics); wearable devices that enhance employee safety and efficiency (e.g., virtual reality (VR) glasses and intelligent workwear); and autonomous transport technologies (e.g., drones, self-driving transport robots, and autonomous vehicles). By covering this full spectrum of technologies, the BTP allows us to analyze teams' digital portfolios in great detail.

The second key research advantage of our dataset is its inclusion of rich team-level information, covering boundary-spanning activities, process innovativeness, and other essential team characteristics. To capture boundary-spanning activities in detail, the survey incorporates three widely established measures from the management literature: (1) external ties, (2) internal ties, and (3) multiple team memberships. External ties reflect spanning beyond firm boundaries and are measured with the item "Team members interact with customers, suppliers, and/or external contacts to ensure the team's success." Internal ties and multiple team memberships reflect boundary spanning within a firm and are measured with the item "Team members maintain contact with other employees within the firm to ensure the team's success." Multiple team memberships reflect whether individuals work simultaneously in different teams and are measured with the item "Members of this team also work in other teams." Finally, to measure our outcome variable, team innovativeness, we use the item "Team processes and practices continuously improve or renew in this team." Survey respondents rated each of these variables on a five-point Likert scale (1 = fully disagree, 5 = fully agree). For our analysis, we standardized all responses to have mean 0 and standard deviation (SD) 1.

METHOD

Exploiting our rich technology data, our study introduces teams' technology use as a novel contingency factor shaping the effectiveness of boundary spanning for team innovativeness. Our methodological approach consists of two steps. First, applying hierarchical clustering, we classify teams into distinct technology portfolios based on their technology adoption patterns. Second, to examine the effect of boundary spanning on team innovativeness, we estimate split-sample regressions for each technology portfolio with team innovativeness as outcome and our boundary spanning measures as explanatory variables.

Ward Linkage Clustering with Jaccard similarity coefficient

Given that our technology variables are binary, we apply a Ward Linkage cluster algorithm with Jaccard similarity coefficient, which is particularly well suited for analyzing dichotomous data structures. The clustering procedure, designed to maximize within-group homogeneity and between-group heterogeneity, follows a two-stage process. In the first stage, the Jaccard similarity coefficient measures pairwise similarities between teams, thereby quantifying the proportion of co-occurring technology adoptions. More specifically, the Jaccard similarity coefficient measures similarity as the ratio of shared technologies to the total number of adopted technologies across two observations and is thus defined as:

$$J(i,j) = \frac{a}{a+b+c} \qquad (1)$$

where a is the number of technologies adopted by both team i and team j, b is the number of technologies adopted by team i but not by team j, and c is the number of technologies adopted by team j but not by team i. Given that the Jaccard coefficient excludes cases where neither team adopts a given technology, the similarity calculation focuses on shared technology adoptions. Computing $1-J(i,j)$, the algorithm then transforms the similarity matrix into a distance matrix.

In the second stage, the Ward linkage algorithm groups teams into distinct clusters. This algorithm minimizes within-cluster variance at each step of the clustering process, thereby ensuring that teams within the same cluster exhibit maximally homogeneous technology adoption patterns. Overall, this hierarchical clustering approach provides a data-driven classification of teams, enabling us to analyze whether the relationship between boundary spanning and innovativeness differs across technology portfolios.

Figure 2 presents the dendrogram we obtain from Ward linkage clustering with the Jaccard similarity coefficient. The hierarchical structure illustrates how teams are grouped according to their technology adoption patterns. The x-axis represents individual teams, and the y-axis denotes dissimilarity, where lower values indicate higher similarity among teams. For the dendrogram, selecting a cut-off level that balances both granularity and interpretability, we obtain six final clusters. While each cluster consists of teams with homogeneous technology adoption profiles, the clusters themselves remain highly distinct.

Insert Figure 2 about here

To characterize teams' technology portfolios, we analyze the technology composition of the teams in each of the six clusters. Figure 3 presents these compositions in a heatmap, where red fields indicate above-average technology adoption within a cluster, and blue fields signify below-average adoption. The color intensity reflects the degree of deviation from the overall mean, which is measured in percentage points (pp), allowing for a clear visualization of the dominant technologies in each cluster.

The heatmap reveals distinct technology adoption patterns across clusters, which we understand as, and call, "portfolios". Teams with Portfolio 1 adopt all technologies at below-average levels, particularly IT-security technologies (-53.2 pp), Big Data technologies (-42.4 pp), and customer-oriented technologies (-34.9 pp). In contrast, teams with Portfolio 2 stand out for their widespread adoption of all technologies, significantly exceeding the average in customer-oriented (+40.2 pp), supplier-oriented (+25.8 pp), collaboration (+37.0 pp), and project management technologies (+32.5 pp). Notably, they are the only teams to implement advanced technologies at above-average levels, e.g., AI for physical (+7.7 pp) and non-physical (+9.8 pp) processes, robotics (+6.2 pp), and autonomous transport systems (+1.5 pp).

Teams with Portfolio 3 also integrate a substantial, albeit less extensive, variety of technologies than those with Portfolio 2. They rely on technologies that support personnel management (+19.3 pp), facilitate novel forms of communication and collaboration among employees (+34.8 pp), and enable project-based and cross-company collaboration (+35.1 pp). Teams with Portfolio 4 specialize in digital technologies for customer services and supplier networking, e.g., with above-average adoption of CRM systems (+46.9 pp), SCM systems, and enterprise resource management systems (+32.6 pp).

Teams with Portfolios 5 and 6 are both narrowly specialized technology users but in different areas. Teams with Portfolio 5 have a distinct focus on IT security and Big Data and Cloud technologies. Specifically, they adopt Big Data and Cloud technologies 57.6 pp above the average and IT security technologies 22.9 pp above the average. In contrast, while teams with Portfolio 6 are heavily focused on IT security technologies and adopt them at 46.8 pp above average, they are not heavily focused on other types of technologies. Both portfolios are clearly below average for customer-oriented technologies, supplier-oriented technologies, and collaboration and project management technologies.

Overall, the technology adoption patterns reveal that the portfolios capture meaningful differences in how teams integrate technology into their workflows. We identify six distinct portfolios, which fall into three overarching categories: teams with minimalistic tech use portfolios, teams with comprehensive tech use portfolios, and teams with focused tech use portfolios with different areas of specializations. Portfolio 1 consists of minimalistic-tech teams that use technologies below the average level across all dimensions. Portfolio 2 consists of comprehensive-tech teams that adopt a wide range of digital tools and integrate these technologies intensively into their processes. The remaining four portfolios reflect different types of focused-tech teams, with each portfolio having a distinct technological emphasis: Teams of Portfolio 3 focus on HR, communication, and collaboration tools; teams with Portfolio 4 concentrate on customer services and supplier networking; teams with Portfolio 5 specialize in Big Data and Cloud technologies; and teams with Portfolio 6 are heavily focused on IT security technologies.

To more comprehensively characterize each portfolio, we analyze sectoral distributions and key team characteristics in Figure A1 and Figure A2 in the Appendix. Portfolio 1 primarily comprises teams in *construction*, *agriculture/mining/energy*, and *public services/education.* These teams typically operate at the same location and working hours, perform repetitive tasks, and share uniform task profiles—for example a construction team working on a residential project. Portfolio 2 comprises teams with an above-average representation in *manufacturing*, *trade/repair*, and *personal services*, but below-average representation in *agriculture*, *construction*, and *public services*. These teams are less likely than those with Portfolio 1 to follow fixed working schedules, perform repetitive tasks, or have identical task profiles—for example, a maintenance team in the manufacturing sector. Portfolio 3 comprises teams that work predominantly in the sectors *services/education* and *healthcare*. Similar to teams with Portfolio 2, teams with Portfolio 3 show below-average levels of task repetition, shared task profiles, and fixed workplaces—for example a human resources team in a consulting firm.

Portfolio 4 comprises teams with a pronounced representation in *trade/repair,* teams are more likely to share the same task profile, and the same location and working hours—for example, a service team specializing in automotive repair. Both Portfolios 5 and 6 predominantly comprise teams in *public services/education* and *healthcare.* Team members in both portfolios work on average more often at the same location, follow fixed working hours, and engage in repetitive tasks. However, team members with Portfolio 5 have a below-average level in consistent tasks, whereas those with Portfolio 6 have an above-average level. A typical Portfolio 5 team is a cybersecurity team for an online retail platform; a typical Portfolio 6 team, in contrast, is a cybersecurity team in municipal government (e.g., a tax office or health services).

Table A1 and A2 in the Appendix presents the summary statistics by technology portfolio. Table A1 reports both raw and standardized means of the outcome variable—team innovativeness—and the main explanatory variables: external ties, internal ties, and multiple team membership. The mean team innovativeness differs moderately across portfolios, ranging from -0.27 SD in Portfolio 1 to 0.23 SD in Portfolio 2—a gap of 0.5 SD. External ties follow a similar pattern, ranging from -0.41 SD to 0.16 SD. Internal ties vary less, from -0.16 SD to 0.07 SD. The means of multiple team memberships show the smallest difference, ranging from -0.05 SD to 0.18 SD.

Table A2 presents statistics for control variables such as team size, firm size, region, and sector affiliation. These statistics show that teams with a comprehensive tech use portfolio (Portfolio 2) and those with a focused tech use portfolio HR, communication, and collaboration tools (Portfolio 3) tend to be located in larger firms. Firm size ranges from 96 employees (Portfolio 1) to 294 employees (Portfolio 3), while team size varies only slightly, from 4.2 to 5.1 members. The share of teams located in West Germany ranges from 0.74 to 0.84.

Insert Figure 3 about here

Split-Sample Regression

The data-driven derivation of distinct technology portfolios allows us to examine whether the link between boundary spanning and team innovativeness differs across teams with different technology use. We estimate the relationship of boundary spanning on team innovativeness with split-sample regressions for each technology portfolio, using the following equation:

$$y_i = \beta_0 + \beta_1 E_i + \beta_2 I_i + \beta_3 M_i + \beta_4 X_i + \varepsilon_i \quad (2)$$

where y_i, E_i, I_i, and M_i are continuous variables. y_i denotes our outcome team innovativeness; E_i captures team *i*'s investment in external ties; I_i captures the team *i*'s investment in internal ties; and M_i measures the extent to which team members of team *i* work across multiple teams. X_i is a vector of control variables, including the sector of the firm the team belongs to, firm size, firm location (i.e., West Germany versus East Germany) and the position of the manager who responded to the survey.

RESULTS

Main Results

Our analyses show that the association between boundary-spanning activities and team innovativeness varies substantially depending on a team's technological portfolio. Table 1 presents the results of the ordinary least squares (OLS) split-sample regressions, which examine the relationship between boundary-spanning activities and team innovativeness across technological Portfolios 1 through 6. We measure our outcome variable (team innovativeness) and our explanatory variables (external ties, internal ties, and multiple team memberships) in SD units. In all split sample regressions, we control for industry sector, firm size, the position of the interview partner in the firm, and whether the firm location is in West Germany.

Portfolio 1 (minimalistic tech use portfolio), comprising teams with consistently below-average technology adoption, exhibits positive and significant coefficients for external ties ($\beta = 0.095$, $p < 0.05$) and internal ties ($\beta = 0.105$, $p < 0.05$). These associations suggest that boundary spanning—within or beyond the firm—enables teams with a minimalistic tech use to leverage the technological infrastructure of external partners and thereby compensate for their limited innovation capacity. However, the coefficient for multiple team memberships remains insignificant.

The results for Portfolio 2 (comprehensive tech use portfolio), comprising teams with consistently above-average technology adoption, largely mirror those in Portfolio 1. Again, the coefficients for external ties ($\beta = 0.078$, $p < 0.05$) and internal ties ($\beta = 0.088$, $p < 0.05$) correlate positively with team innovativeness, whereas the coefficient for multiple team memberships reveals no significant relationship with team innovativeness. Thus, for teams with a comprehensive tech use portfolio, recombining knowledge from external and internal ties may enable them to sustain their competitive advantage and push the technological frontier even further. The absence of a significant association of multiple team memberships and innovativeness in teams with either minimalistic or comprehensive tech use may stem from two factors. First, external and internal ties may already be sufficient for knowledge transfer, rendering formal multiple team memberships redundant. Second, multiple team memberships may exist only nominally, rather than being actively used, a factor that could be particularly relevant in minimalistic tech use teams, where the lack of technological infrastructure likely limits the feasibility of overlapping membership—with members unable to collaborate and communicate effectively.

In Portfolio 3 (focused tech use portfolio HR, communication, and collaboration tools), comprising teams that focus on technologies for collaboration and personnel management, the coefficient for internal ties remains significant ($\beta = 0.149$, $p < 0.01$), demonstrating that fostering internal contacts and resource exchange correlates with an increase in team innovativeness. The coefficient for multiple team memberships, our second measure for internal boundary spanning, is also positive and significant ($\beta = 0.102$, $p < 0.05$). In contrast, the coefficient for external ties is not significantly associated with innovativeness ($\beta = -0.045$, n.s.). One possible explanation for only internal boundary spanning strategies, not external ones, correlating with innovativeness in teams with Portfolio 3, is their specialization in technologies that directly support firm-internal processes, such as personnel management systems or collaboration tools. Relying on these technologies, these teams can likely minimize the coordination costs of internal boundary-spanning activities, ultimately fostering innovativeness.

In the split-sample regression for teams with Portfolio 4 (focused tech use portfolio customer services and supplier networking), focusing on customer-and supplier-related technologies, only the coefficient for internal ties correlates positively with team innovativeness ($\beta = 0.108$, $p < 0.05$). Teams with this portfolio are strongly overrepresented in the trade and repair sector, where external interactions with customers and suppliers are often highly routinized. As a result, additional engagement in external ties may offer limited scope for additional innovativeness, if the marginal benefits of additional inputs in such routinized environments are low and exceeded by the costs of building new relationships or investing more in existing ones. By contrast, increasing internal ties with other units within the firm—such as logistics, IT, or sales—may enable teams to refine workflows and implement customer-oriented process innovations more effectively and comes with low costs.

Regressions for teams with Portfolios 5 (focused tech use portfolio Big Data and Cloud technologies) and 6 (focused tech use portfolio IT security technologies) yield no significant coefficients for any boundary-spanning measure. One explanation for the lack of association could be intensified security and compliance regulations. Teams that focus on IT security technologies (Portfolio 5) or Big Data and Cloud technologies (Portfolio 6) often operate under strict data protection, security, or regulatory constraints. These restrictions may substantially raise coordination costs, thereby diminishing the benefits of boundary spanning for team innovativeness.

Overall, these results show that the relationship between boundary-spanning activities and innovativeness is contingent on teams' technological portfolios. Increasing internal ties almost consistently emerges as an important predictor of team innovativeness, with significant effects in Portfolios 1 through 4. In contrast, investing in external ties or multiple team memberships, correlates with team innovativeness only in Portfolios 1 to 3.

Our results support our theoretical argument that a team's technology portfolio shapes the costs and benefits of boundary-spanning activities, thereby determining whether these activities translate into greater innovativeness. In both minimalistic and comprehensive tech use teams, where boundary spanning in form of increasing external and internal ties is positively associated with innovativeness, the benefits of acquiring external knowledge appear to outweigh the costs of integration. Specifically, in minimalistic tech use teams (i.e., Portfolio 1), knowledge transfer from more advanced environments likely provides substantial benefits, while standardized tasks keep integration costs low. In comprehensive tech use teams (i.e., Portfolio 2), boundary spanning likely helps maintain a position at the innovation frontier, and mature internal infrastructures, along with strong absorptive capacities, reduce coordination costs. Thus for both minimalistic-tech and comprehensive-tech teams, boundary spanning can foster greater innovativeness.

In contrast, in focused-tech teams, where the associated costs of boundary spanning may outweigh the benefits, boundary spanning does not consistently translate into higher innovativeness. For focused tech use portfolio HR, communication, and collaboration tools (i.e., Portfolio 3), only internal boundary spanning shows a positive link to innovativeness. Given that these teams rely heavily on internal collaboration and project management tools, they likely face lower costs of internal knowledge transfer. However, as the higher coordination costs of maintaining external relationships likely offset potential benefits, external boundary spanning appears ineffective. In teams with focused tech use portfolio Big Data and Cloud technologies (i.e., Portfolio 5) or with focused tech use portfolio IT security technologies (i.e., Portfolio 6), boundary spanning shows no positive association with innovativeness. In these teams, substantial coordination challenges—such as regulatory constraints and infrastructure incompatibilities—likely outweigh the potential benefits of engaging with external environments.

Insert Table 1 about here

DISCUSSION

This paper argues and presents evidence for the essential role of teams' technological portfolios in the relationship between boundary spanning and team innovativeness. Our results show that the effectiveness of boundary-spanning strategies is highly contingent on the technological context in which teams operate. Specifically, teams at the extremes of technological adoption—those with either minimalistic tech portfolios or comprehensive tech portfolios—derive the greatest innovativeness benefits from boundary spanning. In these teams, external and internal ties enhance access to new knowledge, facilitating the recombination of ideas and technological inputs. In contrast, boundary spanning has no significant correlation with innovativeness in teams that concentrate their investments exclusively in the technology domain IT security or Big Data, where the costs of external engagement may outweigh the benefits resulting from coordination challenges and requirements for specialized expertise.

Theoretical Implications

Our study offers three main theoretical implications. First, we contribute to the literature on team boundary spanning. Introducing a previously overlooked contingency—teams' technology portfolios—our study responds to calls for deeper insights into how to form effective team structures (Hoffman & Stanton, 2024) and into *contingencies* of boundary spanning behavior (de Vries et al., 2014; Joshi et al., 2009). Although earlier studies have pointed to the importance of environmental context (e.g., stable versus uncertain environments) in shaping the value of boundary spanning (Ramarajan et al., 2011; Schwab et al., 1985), more recent research has largely focused on characteristics of the boundary itself or on individual-level antecedents—such as identification with the team, leadership support, or boundary spanners' embeddedness in formal networks (e.g., Carbonell & Rodriguez Escudero, 2025; Huang et al., 2016; Marrone et al., 2022). These recent studies often conceptualize boundary spanning as a primarily interpersonal or relational phenomenon. We add to this literature and conceptualize boundary spanning as a *technology-sensitive process*, whose value is shaped by the team's absorptive and coordinative capacities embedded in its technological infrastructure. Our results challenge the notion that boundary spanning is universally beneficial. We show that boundary spanning yields contingent, rather than automatic, returns that vary systematically across distinct technology portfolios.

Second, we extend cost-benefit frameworks of team diversity to heterogeneity introduced by boundary-spanning activities. Lazear's (1999) foundational cost-benefit model of multicultural teams describes how diverse teams create value when the complementarities of disjoint knowledge exceed the costs of coordination. While this logic has since been applied to other critical dimensions of team diversity, including age (Backes-Gellner & Veen, 2013) and functional background (Pull et al., 2015), we add boundary spanning and argue that it generates a similar cost-benefit structure: it adds valuable, non-redundant external knowledge, but also introduces coordination challenges resulting from increased heterogeneity. Our results suggest that the team's technology portfolio alters this cost-benefit trade-off by shaping both the marginal value of new knowledge and the team's capacity to integrate it effectively. While past studies have emphasized the functional benefits of boundary spanning for access to external knowledge (e.g., Cross & Cummings, 2004; Rosenkopf & Nerkar, 2001), fewer have examined the costs of these ties—especially when the recipient team's absorptive or coordination capacity is constrained. By framing boundary spanning within a cost-benefit logic similar to that applied to team diversity, our study helps explain null or negative effects reported in some empirical studies (e.g., Ramarajan et al., 2011).

Third, deriving a portfolio-based conceptualization of digitalization at the team level, we contribute to the literature on technology adoption. This literature strand often measures technology adoption and digitalization at the firm level with binary indicators (e.g., whether a team uses AI) or additive counts of implemented technologies (e.g., Battisti et al., 2023; Huang et al., 2016). While informative, these approaches neglect the structural complexity of how teams combine technologies. Our study introduces a portfolio-based lens, enabling researchers to capture not just the quantity but the *composition and breadth* of technologies adopted. Moreover, examining digitalization at the team level—an increasingly important locus of innovation activity that remains underexplored in this literature, we shift the analytical focus to a more granular level (Hoffman & Stanton, 2024). This conceptualization aligns with recent calls to move from "if" and "how much" questions in the technological change literature to understanding how specific configurations of digital technologies shape coordination, knowledge integration, and team outcomes (Raisch & Krakowski, 2021; Shao et al., 2024).

Managerial Implications

Our results suggest that managers should not apply boundary-spanning strategies uniformly across teams. Instead, they should carefully align any decision to invest in boundary-spanning activities with their teams' technological portfolios. While minimalistic tech use teams can benefit from leveraging external contacts to access missing infrastructures, comprehensive-tech teams can use boundary spanning to amplify their innovation potential. In contrast, specialized teams operating in tightly regulated or complex domains may experience limited returns and higher coordination costs from such efforts. By tailoring boundary-spanning approaches to the team's technological portfolio, managers can increase the efficiency of their innovation efforts.

Limitations and Future Research

While our study offers valuable insights, several limitations warrant discussion. First, despite including rich cross-sectional information at the firm level, our data capture team-level information only for a single wave. Therefore, we cannot draw causal inferences from our results. Although our theoretical reasoning and empirical patterns align, future research should exploit longitudinal data or use experimental designs to provide causal evidence. Second, our technology variables reflect technology use at a single point in time. As digital technologies, especially AI, evolve rapidly, longitudinal data would help capture dynamic adjustments in boundary-spanning behavior. Third, our measure of team process innovativeness relies on self-reported assessments, which may not fully reflect realized innovation outcomes. Future research could validate or supplement these measures with additional innovation performance indicators. Fourth, while our study draws on a representative sample of German firms, institutional settings and technological environments vary across countries. Replicating this analysis in other contexts would help assess the generalizability of our results.

NOTES

[1] Recent field experiments show that productive AI use emerges when subject matter experts collaborate to solve concrete problems, improve processes, and identify opportunities for AI integration (Dell'Acqua et al., 2025; Li et al., 2024). AI-augmented teams significantly outperform human-only teams only when AI capabilities are effectively integrated with existing team knowledge and processes, which underscores that innovation occurs primarily at the team level, where the combination of human expertise and AI capabilities creates synergies.

[2] Whereas multiple team memberships always generate internal ties by embedding teams in broader firm networks, internal ties can also develop through informal collaboration or shared processes, even if no team member holds multiple team memberships. Given that such memberships actively link teams and accelerate knowledge diffusion, they represent an essential form of internal boundary spanning within firms.

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Figure 1

Stylized relationship between the costs and benefits of boundary spanning and team innovativeness

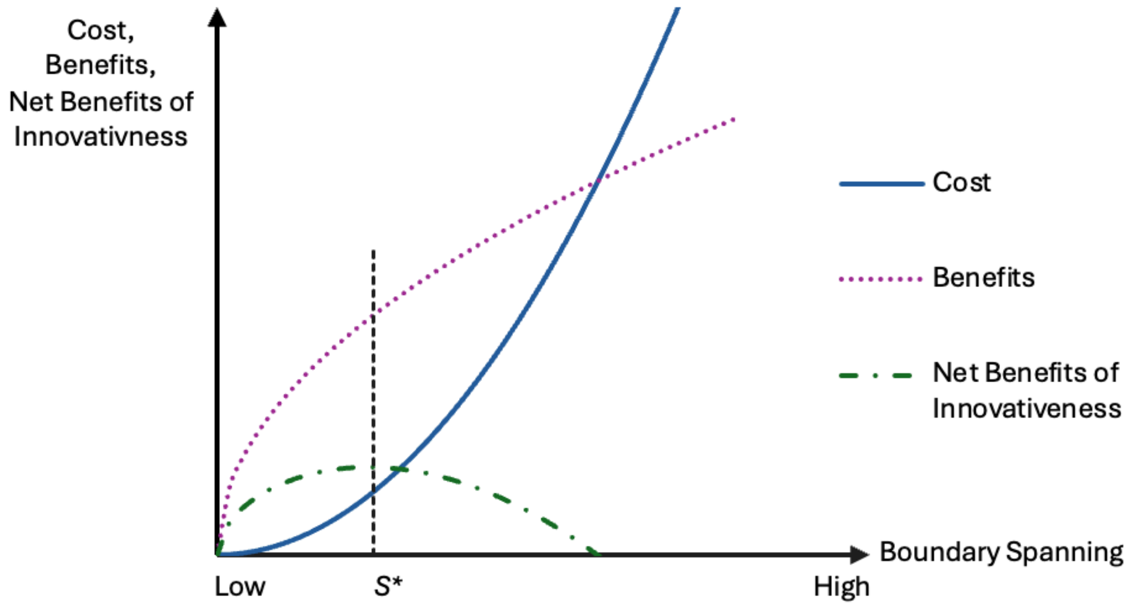


Figure 2

Ward Linkage Clustering with Jaccard Similarity Coefficient - Dendrogram

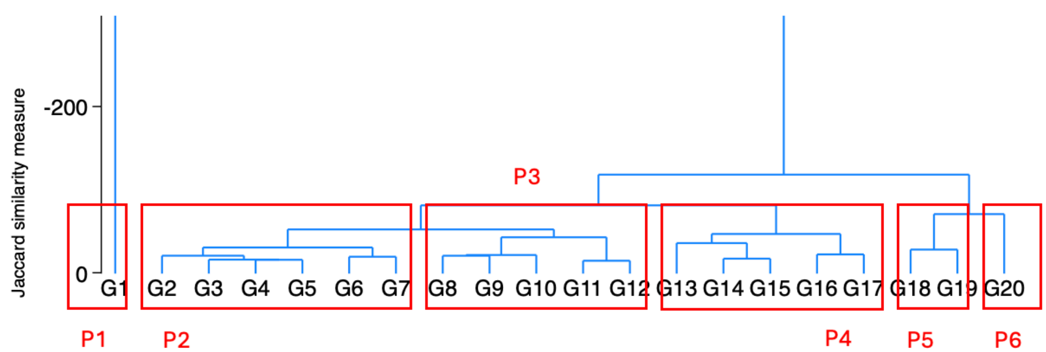


Table 1

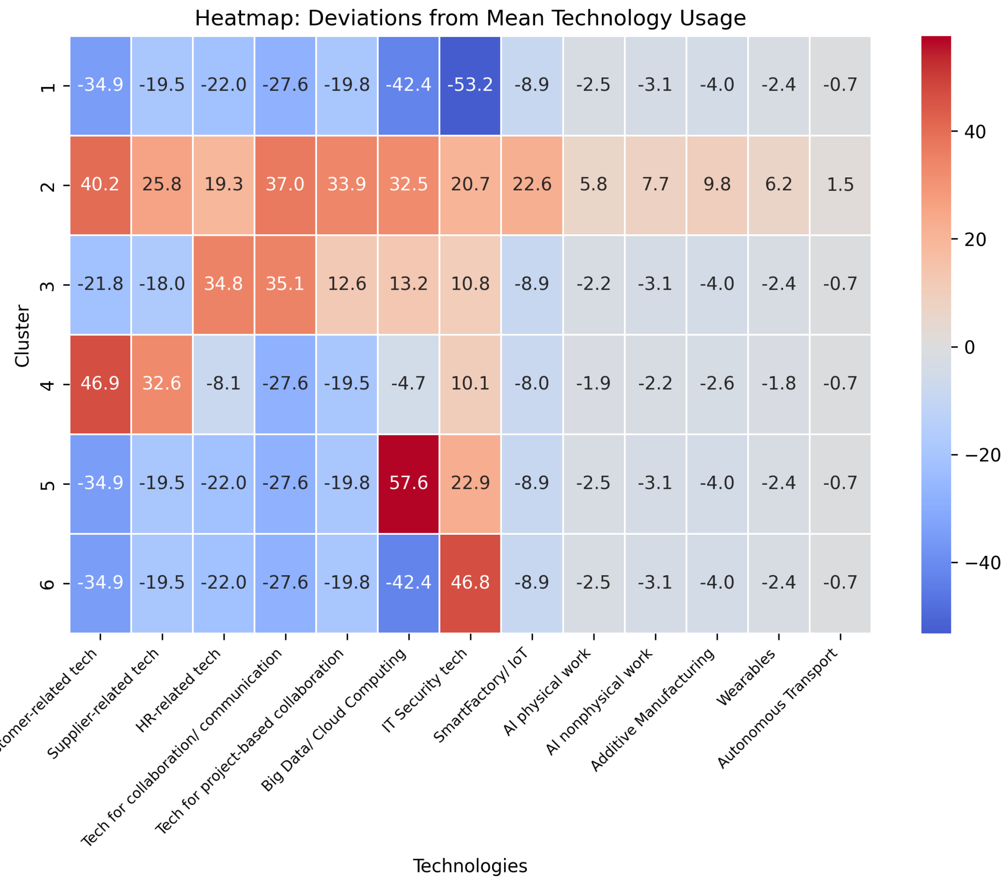
Split Sample Regressions — External Ties, Internal Ties, Multiple Team Memberships & Team Innovation

	Portfolio 1 ***Minimalistic Tech Use Portfolio***	**Portfolio 2** ***Comprehensive Tech Use Portfolio***	**Portfolio 3** ***Focused Tech Use Portfolio HR, Communication & Collaboration Tools***	**Portfolio 4** ***Focused Tech Use Portfolio Customer Services & Supplier Networking***	**Portfolio 5** ***Focused Tech Use Portfolio Big Data & Cloud Technologies***	**Portfolio 6** ***Focused Tech Use Portfolio IT-Security Technologies***
	Team Innovativeness	Team Innovativeness	Team Innovativeness	Team Innovativeness	Team Innovativeness	Team Innovativeness
External Ties	0.081* (0.047)	0.083** (0.036)	-0.043 (0.052)	0.003 (0.060)	-0.042 (0.091)	0.004 (0.109)
Internal Ties	0.100** (0.046)	0.097*** (0.036)	0.147*** (0.055)	0.114** (0.053)	0.045 (0.089)	0.066 (0.082)
Multiple Teams	-0.054 (0.052)	0.044 (0.032)	0.120** (0.051)	0.024 (0.053)	-0.048 (0.091)	0.075 (0.098)
1.Agriculture / Mining / Energy (ref. group)						
2.Manufacturing	0.318 (0.213)	-0.113 (0.157)	-0.060 (0.222)	-0.023 (0.252)	-0.163 (0.357)	0.685 (0.534)
3.Construction	0.122 (0.241)	-0.093 (0.212)	0.380 (0.349)	0.016 (0.323)	0.682 (0.550)	0.815 (0.611)
4.Trade / Repair	0.208 (0.261)	-0.119 (0.168)	0.061 (0.273)	-0.137 (0.252)	-0.043 (0.461)	1.313* (0.666)
5.Business Services	0.251 (0.243)	-0.094 (0.168)	0.154 (0.230)	0.033 (0.285)	0.017 (0.401)	0.469 (0.547)
6.Personal Services	0.121 (0.232)	0.060 (0.167)	-0.096 (0.245)	-0.050 (0.265)	-0.239 (0.438)	0.661 (0.595)
7.Healthcare Services	0.236 (0.236)	0.039 (0.191)	0.334 (0.245)	0.525* (0.286)	-0.221 (0.420)	0.365 (0.539)
8.Public Services / Education	0.396* (0.224)	0.063 (0.177)	0.111 (0.227)	-0.221 (0.277)	-0.207 (0.379)	0.516 (0.518)
Firm Size	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.001* (0.001)	0.001 (0.001)
West Germany	-0.078 (0.116)	-0.102 (0.083)	0.022 (0.122)	0.203 (0.126)	0.180 (0.248)	0.165 (0.222)
R-square	0.0738	0.0509	0.0728	0.0916	0.112	0.114
Obs	438	755	382	323	149	115

Notes. Standard errors in parentheses. Dependent variables: Team innovation in SD units. Independent variables: Boundary spanning (External ties, Internal ties, Multiple team memberships). Controls: Sector, firm size, manager position, firm location West Germany. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 3

Ward Linkage Clustering with Jaccard Similarity Coefficient – Six Team Technology Portfolios



APPENDIX

Table A1 Summary Statistics

	Portfolio 1 ***Minimalistic Tech Use Portfolio***	**Portfolio 2** ***Comprehensive Tech Use Portfolio***	**Portfolio 3** ***Focused Tech Use Portfolio HR, Communication & Collaboration Tools***	**Portfolio 4** ***Focused Tech Use Portfolio Customer Services & Supplier Networking***	**Portfolio 5** ***Focused Tech Use Portfolio Big Data & Cloud Technologies***	**Portfolio 6** ***Focused Tech Use Portfolio IT-Security Technologies***	**Min**	**Max**
Innovativeness	3.288 (1.103)	3.809 (0.907)	3.705 (0.973)	3.486 (0.973)	3.591 (1.027)	3.513 (0.949)	1	5
Innovativeness (SD)	-0.274 (1.056)	0.225 (0.868)	0.125 (0.931)	-0.084 (0.931)	0.016 (0.983)	-0.058 (0.908)	-2.46	1.37
External Ties	3.436 (1.444)	4.144 (1.133)	3.880 (1.194)	4.158 (1.141)	3.792 (1.291)	3.939 (1.157)	1	5
External Ties (SD)	-0.406 (1.152)	0.159 (0.904)	-0.005 (0.952)	0.170 (0.910)	-0.122 (1.030)	-0.005 (0.923)	-2.35	0.84
Internal Ties	4.354 (1.017)	4.551 (0.783)	4.541 (0.771)	4.446 (0.905)	4.497 (0.819)	4.496 (0.977)	1	5
Internal Ties (SD)	-0.160 (1.174)	0.068 (0.904)	0.056 (0.890)	-0.054 (1.045)	0.005 (0.945)	0.004 (1.127)	-4.03	0.56
Multiple Teams	2.646 (1.619)	3.024 (1.602)	2.634 (1.584)	2.734 (1.637)	2.255 (1.560)	2.383 (1.537)	1	5
Multiple Teams (SD)	-0.053 (1.006)	0.181 (0.996)	-0.061 (0.984)	0.001 (1.017)	-0.296 (0.969)	-0.217 (0.955)	-1.08	1.41
Obs	438	755	382	323	149	115		

APPENDIX

Table A2 Summary Statistics — Control Variables

	Portfolio 1 Minimalistic Tech Use Portfolio	**Portfolio 2** ***Comprehensive Tech Use Portfolio***	**Portfolio 3** ***Focused Tech Use Portfolio HR, Communication & Collaboration Tools***	**Portfolio 4** ***Focused Tech Use Portfolio Customer Services & Supplier Networking***	**Portfolio 5** ***Focused Tech Use Portfolio Big Data & Cloud Technologies***	**Portfolio 6** ***Focused Tech Use Portfolio IT-Security Technologies***
Team Size	4.235 (2.184) [2;20]	5.095 (3.820) [2;75]	4.861 (3.254) [2;35]	4.858 (3.377) [2;42]	4.584 (2.408) [2;24]	4.643 (2.066) [2;14]
Firm Size	96.301 (181.393) [4;1950]	235.074 (622.940) [4;8434]	294.415 (597.058) [6;5512]	113.180 (179.023) [3;2200]	103.785 (141.245) [4;823]	132.148 (172.706) [5;990]
West Germany	0.740 (0.439) [0;1]	0.819 (0.386) [0;1]	0.802 (0.399) [0;1]	0.774 (0.419) [0;1]	0.839 (0.369) [0;1]	0.765 (0.369) [0;1]
Agriculture / Mining / Energy	0.075 (0.035) [0;1]	0.048 (0.213) [0;1]	0.063 (0.243) [0;1]	0.053 (0.224) [0;1]	0.067 (0.251) [0;1]	0.035 (0.184) [0;1]
Manufacturing	0.231 (0.422) [0;1]	0.289 (0.453) [0;1]	0.227 (0.420) [0;1]	0.229 (0.421) [0;1]	0.282 (0.451) [0;1]	0.235 (0.426) [0;1]
Construction	0.103 (0.304) [0;1]	0.042 (0.202) [0;1]	0.029 (0.167) [0;1]	0.053 (0.224) [0;1]	0.040 (0.197) [0;1]	0.061 (0.240) [0;1]
Trade/Repair	0.080 (0.271) [0;1]	0.136 (0.343) [0;1]	0.065 (0.247) [0;1]	0.232 (0.423) [0;1]	0.067 (0.251) [0;1]	0.043 (0.205) [0;1]
Business Services	0.096 (0.295) [0;1]	0.154 (0.361) [0;1]	0.183 (0.387) [0;1]	0.090 (0.286) [0;1]	0.141 (0.349) [0;1]	0.148 (0.356) [0;1]
Personnel Services	0.135 (0.342) [0;1]	0.160 (0.367) [0;1]	0.102 (0.303) [0;1]	0.146 (0.353) [0;1]	0.087 (0.283) [0;1]	0.070 (0.256) [0;1]
Healthcare Services	0.114 (0.318) [0;1]	0.068 (0.251) [0;1]	0.128 (0.334) [0;1]	0.090 (0.286) [0;1]	0.128 (0.335) [0;1]	0.174 (0.381) [0;1]
Public Services / Education	0.167 (0.373) [0;1]	0.103 (0.305) [0;1]	0.204 (0.403) [0;1]	0.108 (0.311) [0;1]	0.188 (0.392) [0;1]	0.235 (0.426) [0;1]
Obs	438	755	382	323	149	115

Figure A1

Mean Deviations in Sector Compositions across Technology Portfolios

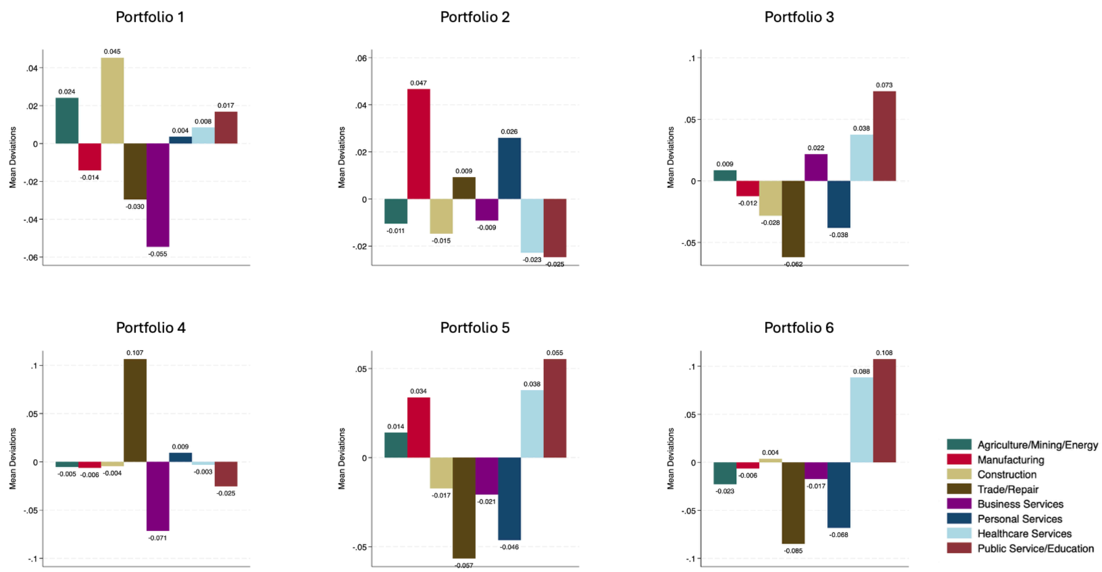


Figure A2

Mean Deviations in Team Characteristics across Technology Portfolios