Improvisation and Innovation in Teams: The Jazz Effect

Abstract

While numerous models examine the linkages between improvisation and innovation, the factors that moderate this relationship at the team level are unknown. Consequently, this study builds on principles and insights from the jazz jam session framework used by jazz musicians and regression analysis to examine the nature of the improvisation process and consider how it affects innovation. By using unbalanced panel data on 2,749 teams containing between two and eight employees in the United Kingdom during 2002–2016, this study demonstrates that the success of the improvisation process relies on both internal and external factors conducive to innovation. Subsequently, the conclusions drawn may help entrepreneurs and team managers think differently about the role improvisation plays in the innovation activity. As a result, important practical implications are drawn for team managers and entrepreneurs intending to cultivate a willingness to improvise in teams and nurture collaborative relationships with external partners for innovation.

Introduction

A standard model prevalent within the management literature suggests that the innovation process is mechanistic, in that innovative activity is the predictable output from knowledge inputs such as research and development (R&D) and human capital (Balconi, Brusoni and Orsenigo, 2010; Godin, 2006). By contrast, one alternative view suggests that innovation is not driven solely by innovation inputs, and any differences in innovative success are down to improvisation in teams and organizations (Baker and Nelson, 2005; Hmieleski and Corbett, 2008; Miner, Bassoff and Moorman, 2001; Vera and Crosson, 2004; Vera *et al*., 2016). Because improvisation is critical to an organization's learning and innovation (Hadida, Tarvainen and Rose, 2015; Hmieleski and Corbett, 2006, 2008), a substantial body of research has sought to identify how the improvisation process takes place (Balachandra, 2019; Cunha, Kamoche and Cunha, 2003, 2006; Suarez and Montes, 2019). For example, Hmieleski and Corbett (2008) explored the effects of improvisational behaviour on venture performance, Baker, Miner and Eesley (2003) studied the role of competencies and skills in the improvisation process and Vera *et al*. (2016) examined the moderating role of 'minimal structures' (goal clarity combined with autonomy) as a contextual factor supporting effective improvisation. While the improvisational process is central to innovation activity in firms (Balachandra, 2019) and teams (Vera and Crosson, 2005), improvisation as a process has been used by jazz musicians to create new music for over a century within the 'jazz jam' session setting. Practicing improvisation is a complex process that helps musicians to overcome self-consciousness, develop competencies, establish mentoring systems, exercise leadership and collaboration, along with developing community support (Belitski and Herzig, 2018; Herzig and Baker, 2014).

According to the jazz jam session framework to create new music, it is not the ability to improvise alone that matters as described in the improvisation literature, but rather the

context of the improvisation process and within-team interactions. Management research is focused on the use of indicators and measurements to predict innovation activity, with a primary focus on the organizational context and how firms respond to a changing environment, while there is a paucity of knowledge on how team improvisation along with other team specific attributes can (i) explain innovation and (ii) examine factors that moderate the relationship between improvisation and innovation. This study extends the model used for more than a hundred years by jazz musicians to the management science literature, adding to the substantial research of Cunha, Kamoche and Cunha (2003), Kamoche and Cunha (2003), Kamoche, Pina e Cuhna and Vieira da Cunha (2003) and Vera and Crosson (2005) on team improvisation and innovation.

Despite the fact that jazz jamming has been studied extensively in the entrepreneurship and organization science literature (Barrett, 2012; Diasio *et al*., 2016; Hatch, 1999; Kamoche and Cunha, 2003; Weick, 2002), the existing literature on how the jazz jam session setting can be used as a process of improvisation in teams is under-researched (Aldrich and Martinez, 2001; Liu *et al*., 2018; Visscher, Heusinkveld and O'Mahoney, 2018).

Team creativity and performance are often attributed to a team's ability to improvise and the interactions with external stakeholders who enhance the team's willingness to take risks to innovate (Hargadon and Bechky, 2006; Moorman and Miner, 1998a). However, there is no consensus on how improvisation–performance effects are shaped and moderated.

The extant literature has been remarkably silent about the role of improvisation in moderating the relationship between team-specific factors, external factors and innovation. Research has generally focused on the context where the R&D team members work (Vera *et al*., 2016), on knowledge resources such as organizational memory or expertise (Brown and

Eisenhardt, 1998; Moorman and Miner, 1998a, 1998b) or the individual-level training effects for improvisation (Vera and Crossan, 2005), often resulting in mixed evidence (Flach, 2014).

This study aims to bridge the gap in the management literature by applying the jazz jam session model (JJSM) framework to team innovation. First, by advancing our understanding of interactions within and outside teams. Second, by examining factors that moderate the relationship between the improvisation process and innovation (Suarez and Montes, 2019; Vera and Crossan, 2004, 2005). The JJSM framework could be helpful as a tool to further study the team innovation process and to investigate the moderators which shape improvisation–performance effects (Barrett, 1998; Diasio *et al*., 2016; Vera *et al*., 2016). We define team improvisation as a multipurpose collective capability (Eisenhardt and Martin, 2000; Helfat and Winter, 2011; Miner, Bassoff and Moorman, 2001) of teams (Akgün *et al*., 2007; Miner, Bassoff and Moorman, 2001).

To test our research hypotheses, we rely on unbalanced panel data of 3,589 observations and 2,749 firms containing between two and eight employees in the United Kingdom during 2002–2016, drawing on calls for empirical research of team improvisation (Suarez and Montes, 2019; Vera and Crossan, 2004, 2005; Vera *et al*., 2016).

The remainder of this study is organized as follows. Our next section, the literature review, introduces the theoretical framework, building on the extant management and innovation literature. The third section explains our analysis methodology, while the fourth section presents the major results and performs robustness checks. The fifth section discusses the findings and concludes.

Literature review

Improvisation and the JJSM

Drawing on Winter's (2003) view of a capability as a high-level routine and consistent with Miner, Bassoff and Moorman (2001) and Moorman and Miner (1998a,

1998b), improvisation is not embodied in individuals, but rather collective and team-level characteristics may endorse individuals to co-create new ideas using improvisation (Miner, Bassoff and Moorman, 2001).

Management scholars typically define the improvisation process as the spontaneous composition and execution of novel action (Hmieleski and Corbett, 2006, 2008; Moorman and Miner, 1998a), as well as the capacity for problem-solving and finding solutions in a crisis (Diasio *et al*., 2016; Kamoche and Cunha, 2003). Other scholars also argue that improvisation includes preparation taken ahead of time that enables greater flexibility (Conforto, Rebentisch and Amaral, 2016).

An individual can engage in the improvisation process in teams at any given moment to generate novel combinations of resource and market opportunities. For example, Eisenhardt and Tabrizi (1995) concluded that a hands-on improvisational approach to new product development was more effective than a rational approach, which contrasts with the economic theory of rational behaviour. Improvisation is an action-based approach and an integral component of the improvisatory process exercised by jazz musicians (Barrett, 2012; Berliner, 1994),which is observed during a jazz jam session. The JJSM focuses on the improvisational and collaborative behaviour of individuals playing together as a team (Humphreys, Ucbasaran and Lockett, 2012; Weick, 1995, 2002) and how jazz musicians collaborate and develop collaborative capabilities with a common goal (Herzig and Baker, 2014).

The JJSM framework consists of seven factors: practicing improvisation and overcoming self-consciousness; skills and competence in the field; establishing mentoring systems; establishing democracy and collaboration; leadership; community support; and a continuous evaluation system. As a result, the JJSM framework explains which factors facilitate new music creation with improvisation at the heart of it, linking the improvisation

process to team outcomes, as outlined in Figure 1, which also differentiates between internal and external factors that affect improvisation during a jazz jam session.

Hypothesis formulation

Prior research in management and organization science has advanced our understanding of the role of team improvisation in innovation and change (Akgün *et al*., 2007; Liu *et al*., 2018; Miner, Bassoff and Moorman, 2001; Vera *et al*., 2016). It is widely accepted, for example, that a firm's internal resources, leadership and role models and environmental support (Vera *et al*., 2016) can facilitate innovation in teams through the stimulation of improvisation practices.

Team improvisation involves new solutions, which are not fully planned in advance by each team member or altogether, while improvisation can also draw on related prior structures such as knowledge and the plans of a team to create a novel action or process (Cunha, Miner and Antonacopolou, 2016; Hall and Sena, 2015). Cunha, Miner and Antonacopolou's (2016) definition of improvisation incorporates three important conceptual pillars: first, the convergence of design and performance; second, the creation of some degree of novel action (innovation); and third, a design created through enactment (planning). Similarly, Vera and Crossan (2005) emphasize that effective improvisation requires readiness and training. Furthermore, Vera and Crossan (2005) discuss the role of innovative training in enhancing the incidence and effectiveness of improvisation. These findings debunk themisconception that willingness to improvise is a character trait and support improvisational training in entrepreneurship education. Improvisation exercises can be used to hone skills in the areas of business strategy, context, organizational members and organizational culture, and can be learnt via specific training for innovation.

Research on the improvisation process demonstrates that the process is neither inherently good nor bad (Hmieleski and Corbett, 2008; Vera and Crosson, 2004, 2005); rather, it facilitates new ideas and may lead to novel product creation. We hypothesize:

H1: Improvisation is positively associated with innovation.

The relationship between improvisation and innovation is moderated by other team-specific and external factors. Cunha, Kamoche and Cunha (2003) posit that the knowledge stock is important for improvisation, as it requires novel resources and unorthodox skills (Godin, 2018; Liu *et al*., 2018). In the same way that jazz musicians may spend hours practicing their instruments, transcribing solos and learning the language of jazz (Berliner, 1994), teams invest in training for innovation, which plays an enormous role in improvisation (Vera and Crossan, 2005). The discipline required to learn new skills and craft and the determination of musicians to do so exemplifies improvisation and results in more innovation (Herzig, 2020). Vera and Crosson (2005) found that the greater the team's expertise (domain- and task-relevant), the more positive is the relationship between team improvisation and innovation. Innovators with high levels of knowledge and skills might identify the potential benefits and challenges of combining strategic resources quickly and capitalize on the potential synergies of investment in knowledge and vice versa. This logic is captured by the following hypotheses:

H2a: Knowledge in the field is positively associated with innovation.

H2b: Knowledge of the field moderates the relationship between team improvisation and innovation.

Teams learn through active collaboration and from role models. Experienced jazz musicians share their knowledge through mentorship on and off the bandstand through a modelling approach (Herzig, 2020). Evidence for effective learning through mentorship is

documented by Simonton (1984), who found that successful artists generally had many mentors of different types.

In the search for new knowledge, managers learn directly through teamwork and indirectly (e.g. observing others, collaboration with external partners and knowledge spillovers). Team members interact with each other and with external partners (teams, organizations) to develop the ability to create a shared understanding of new knowledge, search for new experiences of working together and develop their ability to gather and transfer knowledge and relevant experience (Vera *et al*., 2016). While actively learning from collaborators (Audretsch, Belitski and Caiazza, 2021; Junni *et al*., 2015), a mentor is instead an internal actor (Moon, 2014) who enables the sharing of relevant team knowledge and has full access to information and profiles of team members. Mentorship in this sense allows teams to quickly introduce a mentor's knowledge and experience into intra-team interactions, learning from someone more competent and whom they trust, which enhances their capability for risk-taking and develops confidence in experimentation.

Team knowledge sourcing within an enterprise group can serve as a role model for a team, simultaneously increasing the level of improvisation and innovation effort. Due to the technological and cognitive proximity of the innovation within a group, the learning methods will strengthen the improvisation–innovation effect. The reduction of such collaboration will therefore reduce innovation effort (Hmieleski and Corbett, 2008). We hypothesize:

H3a: Mentoring and role models are positively associated with innovation.

H3b: Mentoring and role models moderate the relationship between team improvisation and innovation.

Team improvisation is not just 'a function of having the "right" expertise on the team' (Vera and Crosson, 2005: 206), but must be coordinated within the team and the collaboration in teams must be managed effectively (Faraj and Sproull, 2000). The process of

performing jazz music as a collaborative team requires a true democratic setting and give-and-take leadership. In the jam session setting, each musician contributes equally to improvisation, aiming to create new music (Herzig and Baker, 2014). Mutual acceptance of the 'democracy and collaboration' principle facilitates improvisation, making the process of innovation equally important and accessible to every team member. Related to this argument, Lewin, Massini and Peeters (2011) argued that practicing democracy and collaboration in teams is conducive to taking risks, as well as improving the form of interactions within a team, allowing an exchange of new ideas leading to innovation. Suppressing delegation and teamwork impedes democratic participatory leadership and weakens the improvisation–innovation link. Democratic participatory leadership requires establishing business structures or practices, which create new ways of organizing work responsibilities to enable improvisation through open decision-making and participative leadership (Shepherd and Cardon, 2009). We hypothesize:

H4a: Democracy and collaboration are positively associated with innovation.

H4b: Democracy and collaboration in teams moderate the relationship between team improvisation and innovation.

Kamoche, Pina e Cuhna and Vieira da Cunha (2003) suggested that improvisation was unlikely to take place in teams where there is a power disparity, as this could lead to role imposition. For innovation in teams, leadership shapes business strategy and managerial practices that include all new and significantly improved forms of organization, business structures or practices (Hitt *et al*., 2001; O'Toole and Meier, 2009; Skaggs and Youndt, 2004). Therefore, team leadership aims to raise internal efficiency via business reengineering, knowledge management, people management and others.

Team leadership significantly increases the chances of new idea creation (O'Toole and Meier, 2009) if diversity is embraced by leadership (Cumming and Leung, 2021). The

literature suggests that leaders manage people by motivating and engaging them in improvisation processes and collaboration with external partners (Barker and Mone, 1998). Leaders improve forms of organization, business structures or practices for team members to deploy resources for innovation (Castrogiovanni, Baliga and Kidwell, 1992; Salancik and Meindl, 1984). Leaders will support and manage staff to reduce their fear of experimentation and facilitate their improvisation, resulting in a stronger link between improvisation and innovation and vice versa (Cacciotti and Hayton, 2015). We hypothesize:

H5a: Team leadership is positively associated with innovation.

H5b: Team leadership moderates the relationship between team improvisation and innovation.

For jazz musicians, the environment where they perform rejuvenates and motivates them – known as community support (Herzig and Baker, 2014). For innovation in teams, this means that team members interact with external partners on new ideas and discuss them with the community. These interactions are often referred to as collaboration breadth – the range of external sources of new knowledge and channels for innovation (Laursen and Salter, 2006). A diversity of collaboration partners creates a variety of new non-trivial solutions (Cumming and Leung, 2021), enabling further team improvisation for innovation (Argote and Miron-Spektor, 2011). If knowledge breadth is low, there is little knowledge diversity to choose from to improvise, limiting new solutions and innovation. If knowledge breadth is high, then improvisation–innovation effects will benefit from the complexity and combinations of new knowledge (Baker, Miner and Eesley, 2003; Magni *et al*., 2013). Kobarg, Stumpf-Wollersheim and Welpe (2019) also argued that the breadth of knowledge collaboration may determine the level of risk. An increase in knowledge breadth leads to sharing a cost of experimentation and improvisation, reduces time from idea to innovation and increases innovation. We hypothesize:

H6a: Community support is positively associated with innovation.

H6b: Community support moderates the relationship between team improvisation and innovation.

Consequently, teams that want to become more innovative need to learn to be attentive and alert to environmental cues (Vera and Crossan, 2005), paying close attention to signals from their external partners – customers, suppliers, consultants and other stakeholders (Audretsch and Belitski, 2020a; Kobarg, Stumpf-Wollersheim and Welpe, 2019).

External evaluation systems usually represent a system of signals and responses from external partners and knowledge collaborators, to track a team's learning progress.When evaluation systems are low, we expect the reflection on improvisation will be limited and firm performance stiffened. An increase in the intensity of collaboration leads to an increase in external knowledge sourcing, practices and further improvisation and innovation. An increase in evaluation systems and intensity of collaboration results in knowledge becoming more observable and open (common knowledge). Evaluation systems further an exchange of relevant information in real time via networks, in addition to the establishment of effective feedback, assessment and evaluation of new ideas, which rewards risk-taking behaviour and improvisation. Evaluation systems include customers and clients, consultants and partner research institutions willing to exchange knowledge and cocreate new ideas. While evaluation systems facilitate innovation, a high level of evaluation systems will reduce a team's ability to innovate. Why? The cost of the knowledge depth of collaboration is an oversaturation with knowledge, which can send conflicting signals to team managers, affecting speed and/or their decision-making, raising the complexity, transaction and operational costs (Audretsch and Belitski, 2020a; Roper, Love and Bonner, 2017). These costs of collaboration will limit a team's ability to indefinitely benefit from evaluation systems and further use of knowledge for innovation. As evaluation systems increase, one

may expect (a) less innovation, resulting in an inverted U-shaped effect and (b) a weaker relationship between improvisation and innovation.

H7a: There is an inverted U-shaped relationship between evaluation systems and innovation.

H7b: Evaluation systems moderate the relationship between team improvisation and innovation.

Figure 2 provides a conceptual model for our hypotheses.

Data and method

Data and sample

To test our research hypotheses, we used seven cross-sectional surveys from two datasets: the Business Registry (BSD) and the UK Innovation Survey (UKIS) during 2002–2016. First, we collected and matched six consecutive UKIS waves conducted by the Office of National Statistics (ONS): UKIS 4 2002-04, UKIS 5 2004-06, UKIS 6 2006-08, UKIS 7 2008-10, UKIS 8 2010-12, UKIS 9 2012-14 and UKIS 10 2014-16. Second, we used BSD data for the years 2002, 2004, 2006, 2008, 2010, 2012 and 2014. The data were matched to the corresponding UKIS survey. Firm age and ownership, employment, industry, firm size and firm location were matched from BSD. The match was possible due to a unique identifier – a firm (at reporting unit level and enterprise level).

Taken together, the non-missing sample results in 3,589 observations, and 2,749 firms with only a fraction of firms have been observed for two periods and more. The following criteria were applied to select the firms. First, we only selected micro firms with between two and eight full-time employees, drawing on the management literature (Kamoche and Cunha, 2003; Kamoche, Pina e Cuhna and Vieira da Cunha, 2003). Second, firms that are subsidiaries were excluded. The data in the sample embrace a wide spectrum of industries, regions and time periods, and are illustrated in Table 1.

Variables

Dependent variable. Our dependent variable is innovation, which is calculated as a percentage of total turnover over the last 3 years from goods and services that are new to the market. It varies between 0% and 100%. The average share of new-to-market products in our sample is 3.98% of sales for all firms in a sampler and 12.75% for innovators of new products (services). Dougherty and Bowman (2014) interpreted 'new products to the market' as an indicator of product innovation. Operationalizing the innovation variable is consistent with innovation studies in related contexts (Audretsch and Belitski, 2020b; Kobarg, Stumpf-Wollersheim and Welpe, 2019; Laursen and Salter, 2014; Roper, Love and Bonner, 2017).

Explanatory variables. We draw on Crossan, Lane andWhite (1999) and Vera *et al*. (2016) as we operationalize improvisation with investment in internal or external training for personnel, specifically for the development and/or introduction of innovations. Innovative training enhances a team's ability to create new knowledge by combining prior skills and experiences and building new ones that are innovation-related, balancing exploration and exploitation (Vera and Crossan, 2005). We operationalize team knowledge of the field by using the share of employees holding BSc and MSc degrees in science and engineering as legal proof of formal specialized education (Kobarg, Stumpf-Wollersheim and Welpe, 2019).

Mentorship is operationalized as the intensity of collaboration with other local units or consultants within the enterprise group. Mentoring is internal as it indicates the intensity of collaboration on innovation between the focal firm and other units within an enterprise group (Ahuja, 2000; Argote and Miron-Spektor, 2011; Schilling and Phelps, 2007).

The democracy and collaboration factor is operationalized with a binary variable that equals one if a team has introduced new methods of organizing work responsibilities and decision-making based on democratization and collaboration – teamwork, decentralization and integration – and zero otherwise. Democratization and collaboration in teams increase

personal trust among team members, which reinforces their decision-making and responsibilities (Crossan, 1998).

Leadership is a binary variable that equals one if, over the last 3 years, a business has made major changes in new business practices for organizing procedures (e.g. supply chain management, business re-engineering, knowledge management, lean production, quality management, people management), and zero otherwise. The measure may still have limitations and it is quite broad, however, this is an internal measure of leadership representing how people are managed. This measure demonstrates the extent to which someone (e.g. firm-manager, founder, CEO) takes a leading role in people and resource management.

We operationalized community support as knowledge collaboration breadth (Kobarg, Stumpf-Wollersheim and Welpe, 2019). It is measured by the number of external partner types for a team to collaborate with. A variety of knowledge sources facilitates the effect of team improvisation on innovation (Alves, Galina and propensity to innovate (Coad, Segarra and Teruel, 2016). Younger firms are more likely to use external knowledge and invest less in internal R&D for innovation (Asimakopoulos, Revilla and Slavova, 2020). We control for foreign ownership, which is a binary variable that takes the value one if a firm is foreign-owned, and zero otherwise. We control for process innovation, which is a binary variable equalling one if the firm has introduced any new or significantly improved processes for producing or supplying goods or services, and zero otherwise (Salge et al., 2013). We controlled for firm survival, as a binary variable which equals one if a firm has survived until 2018, and zero otherwise – including the case of acquisition (Audretsch, Belitski and Caiazza, 2021).

Further, we included industry (two-digit) dummies (mining and agriculture as reference category), time-period (wave) dummies (2002–2004 as reference year) and regional

dummies for 128 regions in the UK (York city as reference category). For the full list of variables used in the study, refer to Table 2. The correlation between variables is illustrated in Table 3.

Method

Innovation production function. We estimate the innovation production function using Tobit regression with a dependent variable yit (innovation) and mit (improvisation intensity):

$$yit = \beta 0 + \beta 1mit + \beta 2rit + \beta 3mit * rit + \beta 4zit + \lambda t + \tau s + aj + uit \quad (1)$$

We can also call it a structural equation to emphasize that we are interested in β1, which is the size of the effect of improvisation on innovation and β3 , which is a vector of interaction coefficients related to our H2–H7. Vector rit indicates six additional team and external factors that may directly and indirectly affect innovation; zit is a vector of exogenous control variables not correlated with uit , while mit is likely to be correlated with uit (Wooldridge, 2009: 517), where uit is an error term. λt and τs are time and industry fixed effects, aj is region (borough) fixed effects where the firm is located. We use a multivariate Tobit regression model when predicting innovation performance as our dependent variable is left-censored.

Results

Improvisation and innovation

We present our results in two sections. First, we discuss the results for H1–H7. Second, we perform the robustness check to deal with two important issues. First, we apply the instrumental variable (IV) Tobit method to deal with potential endogeneity between improvisation and innovation. Second, we introduce a different model, where we assume that each factor of the JJSM leads to greater improvisation then innovation, with improvisation intensity as a mediator in the JJSM–innovation relationship.

Table 4 presents the Tobit estimation, suggesting that all elements except the democracy element of JJSM contribute directly to innovation (specifications 2–4, Table 4). The results in Table 4 (specifications 2–4) support H1, as a one-unit increase in improvisation intensity increases innovation between 6.64% (β = 6.64, p < 0.01) and 10.56% (β = 10.56, p < 0.05). Given that the average innovation sale for firms in our sample is 532,205 British pounds (GBP) a year, an increase in improvisation intensity of 1% will result in an average 35,338 GBP (532,205 * 0.0664) additional sales of new products (specification 3, Table 4). Our findings extend what we know from the prior research of Hmieleski and Corbett (2006, 2008) and Hmieleski and Ensley (2004), who found that start-ups led by entrepreneurs with a greater improvisational effort outperformed their counterparts. Their studies demonstrated that controlling for firm age with both young and mature teams who improvise is equally likely to lead to product and service innovation. Our study does not treat improvisation as a binary outcome, as we demonstrate that innovation changes as a response to a different extent of team's improvisation effort.

Our H2a is supported, as an increase in the share of employees with BSc and MSc degrees by 1% is associated with 0.18–0.23% higher innovation (specifications 2 and 3, Table 4). An increase in the role of mentoring by 1% is associated with an increase in innovation by 7.28– 8.54%, supporting H3a (specifications 2 and 3, Table 4). Our H4a is not supported, as the coefficients of democracy and collaboration are insignificant (specifications 2 and 3, Table 4). H5a is supported, as the presence of internal leadership is associated with an average 4.10–7.19% increase in innovation (specifications 2 and 3, Table 4). An increase in collaboration breadth by one partner is associated with an additional 7.17–9.39% innovation, supporting H6a (specifications 2 and 3, Table 4). Finally, our H7a is supported, as we demonstrate an inverted U-shaped relationship between knowledge depth as a proxy for evaluation systems and innovation. The inflection point is 1.93, which means that teams

with a medium intensity of knowledge collaboration have the highest level of innovation, while those with lower and greater intensity are associated with lower innovation activity. Our finding further advances what we know from Audretsch and Belitski (2020b) and Kobarg, Stumpf-Wollersheim andWelpe (2019), who researched the limits to external knowledge collaboration, as we were able to explain it further and apply it to innovation in teams.

As the beta coefficients in Table 4 (specifications 1–4) provide averaged results of model estimation, they are limited in capturing non-linear effects associated with factors that may moderate the relationship between improvisation and innovation. In order to test our H2b–H7b, we calculated six post-estimated predictive margins for each interaction variable, drawing on Williams (2012), using the estimated results (specification 4, Table 4). To build the predictive margins, we employed six interactions of improvisation with binary and continuous variables. Continuous variables such as knowledge in the field (competences), mentoring, community support and evaluation systems were standardized.

Our H2b is supported, as knowledge in the field (a share of employees with science and technology degrees) positively moderates improvisation–innovation effects (β = 0.11, p < 0.05) (specification 4, Table 4). Figure 3A illustrates that an increase in knowledge in the field (above the mean) has a greater effect on innovation as improvisation increases, furthering what we know from Vera and Crosson (2005) about the non-linearity between team improvisation and innovation.

Our H3b is not supported. The interaction coefficient between mentoring as collaboration within an enterprise group and improvisation is insignificant (specification 4, Table 4). Figure 3B shows overlapping confidence intervals, when improvisation intensity is high, and different effects when improvisation is low. This result demonstrates that teams with a high level of improvisation will achieve similar innovation performance at different

levels of mentoring. It also demonstrates that low improvisation levels and high mentoring are still associated with higher innovation.

We do not find support for H4b, which states that democracy and collaboration are a moderator of improvisation–innovation effects (Lewin, Massini and Peeters, 2011) (specification 4, Table 4 and Figure 3C).While prior research demonstrated that creating a more inclusive democratic environment (Shamir and Melnik, 2002) makes teams improvise and innovate more, we do not find support for this thesis using innovation data.

Our H5b is supported, as the interaction coefficient between leadership and improvisation is positive and significant (β = 3.45, p < 0.05), while the direct effect of leadership on innovation is also positive and statistically significant (β = 5.31, p < 0.05) (specification 4, Table 4). This finding demonstrates that an increase in improvisation propensity of 1% given strong team leadership is associated with an additional increase in innovation by 8.76% (3.45 + 5.31). Figure 3D illustrates these findings and adds to prior research on leadership (Mueller and Barker, 1997).

Teams with weak leadership will experience lower improvisation–innovation effects, which is consistent with the literature that examines employee performance (de Leeuw, Lokshin and Duysters, 2010) and innovation (Dougherty and Bowman, 1995).

We find that community support measured as collaboration breadth does not moderate improvisation–innovation effects, not supporting H6b. Figure 3E also illustrates that teams with a greater number of partner types are on average more innovative.

Our H7b is not supported – the evaluation systems, measured as collaboration depth, do not moderate the improvisation–innovation effects (specification 4, Table 4). Figure 3F demonstrates overlapping confidence intervals, while we also find that more developed evaluation systems are more likely to increase innovation.

Robustness check

Resolving the endogeneity problem. While estimating the model in Equation (1), there could be an endogeneity issue related to the team's decision to improvise. A team decides whether to invest in improvisation or not. Highly innovative teams may invest more in training and intangibles to sustain their innovation. This can create endogeneity in the relationship between improvisation and innovation (Wooldridge, 2009).

First-stage estimation. The first stage concerns the decision to invest in innovative training to enhance improvisation activity or not, and the extent of this investment.We instrument *mit* (improvisation intensity) with two exclusion restrictions (exogenous IVs) _1 (intra-industry R&D spillover) and _2 (inter-industry R&D spillover) that do not appear in Equation (1) and are uncorrelated with the error *ui*.

Intra-industry knowledge spillover is calculated as the ratio of R&D expenditure (in thousand GBPs, two-digit SIC) within the sector where the firm is located and in the region where the firm is located (nominator) to the total R&D expenditure (two-digit SIC, excluding firm's expenditure) in a country (denominator) weighted by the degree of input–output sales within the sector.

Inter-industry knowledge spillover is calculated as the ratio of R&D expenditure (thousand GBPs, two-digit SIC) in sectors outside the sector where the focal firm is located and in the region where the firm is located (nominator) to the total R&D expenditure (two-digit SIC) in a country by all outside sectors (denominator). An input–output matrix was used to weight interindustry sales in intermediate products, as the size of the spillover is different between and within industries. Both spillovers are associated with the team's decision on further investment in training for innovation, given the availability of external knowledge; however, an investment in internal R&D by other firms within and between industries is unlikely to affect team innovation behaviour. The reduced equation form in Table A1 (see the Appendix) is estimated as

$$mit = \pi 0 + \beta ixit + \pi 1\_1 + \pi 2\_2 + vit \quad (2)$$

where $E(vit) = 0$, $cov(\_1t, vit) = 0$ and $cov(\_2t, vit) = 0$. For this IV to not be perfectly correlated with $\_1t$ we need $\pi 2 \_= 0$, and for it to not be perfectly correlated with $\_2t$ we need $\pi 1 \_= 0$. The identification requires that $\pi 1 \_= 0$ and $\pi 2 \_= 0$, or both (Wooldridge, 2009: 523).

We included several control variables, which are not part of Equation (1), such as R&D intensity and knowledge appropriability (Kobarg, Stumpf-Wollersheim and Welpe, 2019), measured by drawing on the role of intellectual property protection for investment decisions in innovative training (Hall and Sena, 2017). Table A1 (see the Appendix) illustrates the first-stage estimation and provides a post-estimation test ($\chi 2$) of the joint significance of the chosen instruments. The first condition is satisfied with the coefficients of the chosen instruments, and significantly and positively associated with the endogenous variable *mi ceteris paribus*.

We perform an additional robustness check for the quality of the found instruments. First, we saved *uit* from Equation (1) to provide evidence of the second condition for IVs to hold: _1 and _2 uncorrelated with *ui*, corr(_*it*, uit) = 0; any linear combination is also uncorrelated with *uit* (Wooldridge, 2009). Second, we estimated Equation (3), where the dependent variable is *ui* from Equation (1) regressed on the chosen IVs ($\_1t$, $\_2t$):

$$uit = \beta 0 + \rho 1\_1t + \rho 2\_2t + \lambda t + \tau s + \psi jit \quad (3)$$

where *uit* is the error from Equation (1). Variables λt and τs are controlled for region and year fixed effects, and *it* is an error term. Coefficients $\rho 1$ and $\rho 2$ were not statistically significant and we conclude that corr(_*i*, uit) = 0, thus $\rho 1$ and $\rho 2$ are valid instruments for improvisation.

Second-stage estimation. Table 4 (specifications 5–8) reports the second-stage IV Tobit estimation with *mit* and *xit* as explanatory variables. Now, instead of *mit*, we use the

predicted values of improvisation intensity *mit* in Equation (1). We compare the significance and size of coefficients from Equation (1) for *mit* between specifications 2–4 and 6–8 in Table 4. While the overall results are consistent between the two models, we found the following differences. First, the interaction coefficient of evaluation systems and improvisation intensity are positive and significant, demonstrating that an increase in evaluation systems moderates improvisation and contributes positively to innovation (β = 2.56, $p < 0.01$). Second, the direct effect of team improvisation on innovation has increased from 6.64–10.56% (specifications 2–4, Table 4) to 33.35–35.80% (specifications 6–8, Table 4). Finally, we found that democracy negatively moderates the improvisation–innovation link in teams (specification 8, Table 4).

Team improvisation as a mediator between the jazz jam session elements and innovation. In addition to team characteristics, the effectiveness of improvisation and innovation is subject to various contextual factors (Vera *et al*., 2016). These contextual factors nurture an improvisation culture, which results in greater innovation efforts. In teams, creating a business environment that nurtures improvisational culture can be an incredibly useful way to leverage the improvisation process and spur innovation activity (Baum and Locke, 2004; Cunha, Clegg and Kamoche, 2006; Visscher, Heusinkveld and O'Mahoney, 2018). As part of the robustness check of our conceptual model, we tested an alternative model where in the first stage we used team attributes and external environment (six elements of the JJSM) to predict team improvisation.

In the second stage, improvisation was used to explain team innovation. Estimating a model, where team improvisation is not a moderator but a mediator in the relationship between JJSM elements and team innovation, enables us to compare the results of the conceptual model (Figure 2) estimated in Equation (1) with the alternative model. The first stage concerns the decision to invest in innovative training to enhance team improvisation.

We instrument *mit* with six elements of the related JJSM we used as explanatory variables to test our H2a–H7a. We included several control variables such as firm age and employment, as well as year and regional fixed effects decision on investment in innovative training (Hall and Sena, 2017) (see Table A2 in the Appendix).

Table A2 demonstrates that all factors of the JJSM model except community support (β = 0.057, p > 0.05) are positively associated with team improvisation. We perform an additional robustness check for the quality of the instruments, assuming corr(*_it* ,*uit*) = 0 (Wooldridge, 2009), and find that the instruments are correlated with uit in Equation (1). The JJSM elements are directly related to team innovation, again supporting H2a–H7a.

Table 4 (specification 9) reports the second stage IV Tobit estimation, where improvisation *mit* is a mediator between explanatory variables representing the JJSM framework and team innovation. Now, instead of *mit* , we use the predicted values of improvisation intensity *mit* from stage 1. The main outcome of the second-stage estimation across two different models (specifications 2–4 and 9, Table 4) is that the relationship between team improvisation and innovation remains statistically significant and positive (β = 38.10, p < 0.01) (specification 9, Table 4). The goodness-of-fit of the model where improvisation is used as a mediator is lower (specification 9, Table 4) compared to models where the JJSM elements moderate the improvisation–innovation link (specifications 1–4 and 5–8, Table 4). The results of the robustness check demonstrate that Equation (1) and our conceptual model in Figure 2 better predict the relationship between team improvisation and innovation.

Discussion and conclusion

This study examined the relationship between improvisation and team innovation by integrating the JJSM into management science research. Two main findings of this study emerge. First, the improvisation–innovation main effect is positive and statistically

significant across all model specifications and estimation methods. Second, the magnitude of the improvisation–innovation effect is contingent on the positive influencing effects of four out of seven predicted moderators – elements of the JJSM. Our results support the view that the improvisation process follows the team improvisation and interaction principles. The jazz jam session setting helps team members to master this skill (e.g. 'mentoring', 'community support', 'competencies' and 'evaluation systems'). This is applicable in start-ups and can be learned and effectively applied by organizational teams at different stages of firm growth. We extend what we know from prior research (Belitski and Herzig, 2018; Meyer, Frost and Weick, 1998; Suarez and Montes, 2019; Vera and Crosson, 2005).

We conclude that the lack of strong support for democracy and collaboration (Cunha, Miner and Antonacopolou, 2016) for innovation could be associated with the specific characteristics of the team. Regarding the negative effect on leadership, we consider that improvisation is unlikely in teams where power disparities exist. Managers who aim at market leadership and the first-mover advantage purposefully speed up innovation and converge the improvisation process to introduce innovation to the market quickly, while choosing speed over creativity.

In our robustness check section, comparisons between factual and predicted values of improvisation intensity showed that the effects of training in innovation are consistent when controlling for endogeneity. In addition, the effect of innovative training was stronger for the contextual factors (Vera and Crossan, 2004; Vera *et al*., 2016) related to building new relationships with external partners and employing new methods of external engagement, creating an effective system of collective improvisation (Cunha, Kamoche and Cunha, 2003, 2016; Moorman and Miner, 1998a, 1998b).

Theoretical implications

This study builds on prior research on the role of improvisation in innovation in the following important ways. First, we contribute to the works of Vera and Crosson (2004, 2005), who argued that the spontaneity of improvisation tends to be overemphasized. We use regression analysis to conceptualize and examine the effect of investment on innovative training as a mechanism for enhancing the effectiveness of improvisation and improvisation intensity for innovation performance. This study, consequently, moves beyond the organizational settings of Vera and Crosson (2005) and Vera *et al*. (2016) to demonstrate which other intra-team and external factors could moderate the relationship between improvisation intensity and innovation.

Second, there is a general assumption that improvisation always leads to positive performance (Baker and Nelson, 2005; Balachandra, 2019; Hmieleski and Corbett, 2006, 2008). This study clarifies the conceptual confusion about improvisation by employing the JJSM framework and laying out the various aspects of the improvisation process required for an effective link between improvisation and innovation. In our JJSM framework, we delineate how the improvisational jazz principle of 'taking risks' links to other team interactions and external stakeholders (e.g. suppliers, customers, consultants, universities, alliances, other partnerships) to develop new products to market.

Third, comparing two estimation methods showed that the relationships are similar, and our results are robust. Our findings are consistent with the literature on collective improvisation regarding innovation performance and improvisation that examines contextual factors (Balachandra, 2019; Belitski and Herzig, 2018). In view of this, our study also advances the literature on the role of heterogeneous mechanisms within and outside the team that moderate improvisation for innovation.

Finally, this study discusses the critical role of improvisation in the management literature as a legitimate and recommended choice when team managers face uncertainty and

risk (Crossan and Sorrenti, 1997; Crossan, Lane and White, 1999; Crossan *et al*., 2005). In doing so, this study defines and conceptualizes new elements of the improvisation process such as ‘mentoring’, ‘team competencies’, ‘community support’ and ‘evaluation systems’, with the effect between improvisation and innovation being both linear and curvilinear.

Managerial implications

The findings from our research have several significant implications for practitioners. First, when drawing on Herzig and Baker (2014), the JJSM framework used in this study can explain how the new piece of music (innovation) reflects the most novel combination of resources that contribute to the improvisation process. Therefore, when considering jazz musicians who work together to improvise a new piece of music, we can, in fact, conceptualize teams within organizations improvising together, substantially transforming the often limited available resources for maximum impact as a result (Herzig and Baker, 2014; Weick, 1995).

Second, the JJSM framework helps practitioners, particularly those who manage people, think differently about how improvisation processes for innovation, team collective capabilities and environmental context contribute to innovation’s impact within an organization.

Third, managers could use the JJSM as a framework to co-create new products and services together with external partners by pooling their resources. Consequently, managers who apply the seven-factor model can shape the improvisation process, accounting for interdependences intra-team and with external partners to achieve more innovative and effective improvisation results.

Limitations and future research

Despite its theoretical developments and novel findings, this paper has a number of limitations. First, due to the anonymous nature of the UKIS, no additional sources of

information on external partners could be added to the database, which could have been used to supplement the data. Second, although this study focuses on innovation as the major outcome, innovation is in fact a heterogeneous phenomenon and may require a combination of various mechanisms of improvisation. Third, for several firms, the data were cross-sectional. There will be firm types and industries for which the JJSM may not be applicable.

Further research is needed to understand alternative methods, which could be used to examine the link between improvisation and innovation. We hope that researchers and team managers will be able to further investigate the black box of the improvisation process by integrating and testing a variety of improvisational models that come from music and theatre, as well as experimental and applied research, to advance the theory and practice of innovation. We are interested in one particular aspect of organizational learning and the improvisation process: business model reconfiguration and the time effect of switching between different business models, industries and markets by employing the improvisation process in teams. Subsequent empirical research should use more sophisticated longitudinal data to unpack the black box of the improvisation process across different contexts. Future research may focus on improvisation techniques that indirectly benefit innovation, for example, by opportunity selection and encouraging leaders to accumulate experiences and implement them quickly. More research is needed to identify the types of resources and leadership models conducive to improvisation.