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DOI: https://doi.org/10.1287/orsc.2016.1067

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Citation

TSCHANG, F. Ted and Gokhan ERTUG. New blood as an elixir of youth: Effects of human capital tenure on the explorative capability of aging firms. (2016). *Organization Science*. 27, (4), 873-892. Research Collection Lee Kong Chian School Of Business.
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New Blood as an Elixir of Youth: Effects of Human Capital Tenure on the Explorative Capability of Aging Firms

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(accepted for publication in *Organization Science*)

ABSTRACT

The relationship between firm age and innovation has been an enduring topic of interest. We contribute to this research by studying how the effect of firm age on the quality of explorative and exploitative innovations is affected by the firm-specific and industry tenure of the talent-resources (employees) that the firm utilizes. We start with the baseline predictions that firm age is related to the development of better exploitative innovations and worse explorative innovations. However, the tenure of employees intervenes in these relationships, by way of bringing in new knowledge, mental models, and beliefs. We predict that longer firm-specific and industry tenure of employees would enhance the positive effect of firm age on the quality of exploitative innovations, while amplifying the negative effect of firm age on the quality of explorative innovations. In addition, for both the baseline and the moderating effect, we also formulate a prediction comparing the quality of explorative innovations with those of exploitative innovations. We find support for the moderating effects of human capital tenure for the quality of explorative innovations, but not for the quality of exploitative innovations. We reason that the latter may be due to the need for some level of exploration even in exploitative innovations, at least in the setting we study – the video game industry. Our results suggest that the negative effects of firm age on the quality of explorative innovations can be mitigated by talent-resources (employees) the firm uses who have lower firm-specific and industry-wide tenure.

Published in Organization Science, 2016, 27(4), pp. 873-892.
https://doi.org/10.1287/orsc.2016.1067
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Acknowledgements: We would like to thank Jamal Shamsie, Mike Hitt, Vivek Tandon, Yonghoon Lee, Matteo Prato, Balazs Kovacs, Reddi Kotha, Heli Wang for their feedback on earlier versions of this work. We are also very grateful for the guidance of Dan Levinthal and the three anonymous reviewers.

INTRODUCTION

In times where innovation has become ever more important and product lifecycles ever shorter, firms are confronted by a panoply of problems, including the need to balance exploitative innovations that sustain existing product lines with the explorative innovation of new products (Eisenhardt and Tabrizi 1995, Christensen and Bower 1996). One key insight arising from innovation studies that address these tensions is that age shapes firms' innovative capabilities by making firms better at exploitation rather than exploration (Sørensen and Stuart 2000). Our study addresses a gap in understanding how human capital can help aging firms to produce better explorative innovations. Our aim is to further deepen the understanding of the link between human capital and the quality of exploration and exploitation produced by a firm.

Successful firms have recognized that as they age, they need to maintain and improve their skills at explorative innovativeness with new human capital. Accordingly, we study how human capital moderates a firm's tendencies to be better (or worse) at exploitative and exploratory innovations as the firm ages. In particular, we find that the relative newness, i.e., lower tenure, of creative talent, whether in the firm or in the industry, can "reinvigorate" a firm by mitigating the negative effects of firm age on the quality of its explorative innovations. This is critical for firms in high technology industries, and is made even more so when a firm enters into product areas requiring new kinds of talent, as was the situation that Apple faced recently: "As Apple moves from iPods, iPhones and iPads into an entirely new category of product [i.e., the watch], it is looking beyond its existing staff in Cupertino for the talent required to build it." (Bradshaw 2013).[1]

Since the early characterization of innovative activities as being explorative or exploitative in nature (March 1991, Levinthal and March 1993), one important issue has been to understand the conditions by which firms can face the future, i.e., can be explorative, while capitalizing on past advantages, i.e., can be exploitative (He and Wong 2004, Raisch et al. 2009). While this assumes that firms are able to manage these twin forces without any "vested interest" in either the future or the

[1] With the passing of Steve Jobs, Apple's co-founder Steve Wozniak expressed the concern that Apple might become complacent, "returning to just milking its existing markets and not astounding us with new categories of products, or totally astounding ones." (Fiegerman 2012). Wozniak further provided his thoughts on keeping a post-Steve Jobs Apple invigorated by noting that Apple: "did go through a period of introducing a lot of key younger talent when Steve Jobs returned…One suggestion is that we look at doing that again." (Fiegerman 2012).

past, in reality, a natural tendency has been for firms to emphasize and build on their past capabilities and routines, making them more adept at exploitative work rather than at explorative work (Sorensen and Stuart 2000). This being the case, the issue of how to improve capabilities to be better at explorative innovative activity – arguably the more challenging activity of the two – has been studied in various ways. Proposals range from investing in capabilities such as the ability to experiment with technologies (Ahuja and Lampert 2001) and the "forecasting" or developing of scenarios of the future (Brown and Eisenhardt 1997, Gavetti and Levinthal 2000), to the building of the actual technical capabilities themselves (Rothaermel and Hess 2007). The antecedents to these proposals involve capabilities and routines that can recognize the value of opportunities and new ideas, as well as the ability to reorganize resources to create solutions. These depend substantially on organizational members to introduce new knowledge, to readjust to changed situations, or to enhance the organizational capabilities to accomplish the same (Drazin and Rao 2002, March 1991, Peretti and Negro 2007, Tzabbar 2009). While the effects of human capital on organizational innovation are increasingly studied, we lack a systematic understanding of how aging firms might improve their explorative capability via new organizational members (Perretti and Negro 2007, Taylor and Greve 2006). Focusing on this problem, we theorize that human capital that is relatively new to the firm and to the industry can moderate the effect of firm age, such as by way of changing the capabilities and routines of firms. Specifically, aging firms can improve the quality of their explorative innovations, to the extent that their members have lower firm-specific tenure or low industry tenure.

We test our ideas in the context of the video game industry. The video game industry is rapidly transforming, even as games themselves influence more mainstream work environments (Edery and Mollick 2008). Specifically, we study the quality of original content games (explorative innovation), the quality of non-original content games (exploitative innovation), and the comparative quality of original content games and non-original content games' (exploration in comparison to exploitation) that are developed by game development studios. We find that, first, the studio's age has (a) a positive effect on the quality of exploitative innovations it develops, (b) a negative effect on the quality of the explorative innovations it develops, and (c) a negative effect on the quality of the explorative innovations, as compared to exploitative innovations, developed by the studio. Second, we

find that the negative effect of studio age on the quality of explorative innovations, both on their own and as compared to exploitative innovations, is mitigated by the studio having human capital with lower tenure in the firm, as well as human capital with lower tenure in the industry. That is, an aging firm's disadvantage at explorative innovations can be mitigated by the presence of "fresh voices" that can reinvigorate the firm's explorative capability. However, we find no such moderating effect of human capital tenure on the quality of exploitative innovations. As we note in our discussion section, the absence of such an effect on exploitation might be due to the fact that even exploitative products (i.e. those that are sequels or use licensed content) in this type of creative industry need to demonstrate some exploration to maintain users' interest and demonstrate quality.

The rest of this paper is organized as follows: Firstly, in the next section, we review work on the relationship between firm age and innovation, deriving our baseline predictions - that age reinforces use of a firm's existing routines and capabilities, making it better at exploitative innovations, worse at explorative innovations, and also worse at explorative innovations as compared to exploitative innovations. Secondly, in the three sections that follow, we establish the link between human capital and the firm. In particular, we discuss how human capital tenure, both in the firm and in the industry, can moderate the effect of firm age on the outcomes we study (quality of explorative innovations, quality of exploitative innovations, and the quality of explorative innovations as compared to exploitative innovations), by way of changes to routines, capabilities, and mental models. We then describe our setting, data, estimation, and results, concluding with a discussion of the implications of our findings.

THE RELATIONSHIP BETWEEN FIRM AGE AND INNOVATION

In the study of factors that are important determinants of innovative success in firms, the focus has shifted away from economists' early concerns with issues such as firm size to one dominated by managerial and organizational factors, such as capabilities.[2] Within the management tradition, the initial concerns focused on addressing the effects of organizations' structures and abilities to configure their resources, as well as on how these capabilities are affected by firm age

[2] Historically, while following Schumpeter's lead, the economics literature has found the relationship between firm size and innovation to be inconsistent (Cohen and Levin 1989, Cohen and Klepper 1996).

(Burns and Stalker 1961, Thompson 1965, Stinchcombe 1965). However, while early findings regarding firm age and innovation focused on the liability of newness, further study has found the effect to be more mixed, depending on the context of the firm (Anderson and Tushman 1990, Le Mens et al. 2011, Methe et al. 1996).[3]

Plumbing deeper into the new and old firm argument reveals another central issue, which is that aging firms' capabilities can become misaligned with changing environments such as newly emergent paradigms (Anderson and Tushman 1990, Barnett 1990, Barron et al. 1994, Christensen and Rosenbloom 1995, Dosi 1982, Tushman and Anderson 1986, Utterback and Abernathy 1975). The emergence of dominant designs promotes incremental innovations, and favors exploitative capabilities (Anderson and Tushman 1990). At heart is the issue of organizational inertia, involving the tendency of aging firms to engage in reliable or rationally accountable behavior at the expense of being more explorative (Hannan and Freeman 1984, Kelly and Amburgey 1991).[4] This highlights the broader distinction between exploration and exploitation, which has become a central concept for studying innovation at the organizational level (Levinthal and March 1993, March 1991). It describes the tradeoff between investing in existing capabilities addressed to their current market relative to new ones addressed to the firms' future. Employing this exploration-exploitation distinction, Sorensen and Stuart (2000: 106) demonstrated a fundamental age effect: that *"*Older firms build more on previous innovative activity*"* within established technological trajectories; and that as a result, firms get better at exploitative innovations rather than at explorative ones as they age. This argument was predicated on the firms' capabilities and routines becoming rigid and mismatched to changing environments (Christensen and Bower 1996, Gilbert 2005, Hannan et al. 1996, Levitt and March 1988, Leonard-Barton 1992). In the sections that follow, we will develop the premise that human capital tenure has a moderating influence on how firm age relates to how well firms perform at explorative and

[3] In contrast to the liability of newness argument (Stinchcombe 1965), later studies found that new firms may be better fitted to their environment, both technology-wise (i.e. capability-wise), and structurally (Katila and Shane 2005, Sine et al. 2006), and suffer less from inertial forces or founding conditions (Boeker 1989, Finkelstein and Hambrick 1990, Hannan and Freeman 1984). Other studies find older or established firms have advantages in knowledge and capabilities (Cohen and Levinthal 1990, Klepper and Simons 2000, Methe et al. 1996), and industry-specific effects (Criscuolo et al. 2012, Sine et al. 2006, Katila and Shane 2005).

[4] Inertia could be ascribed to factors that have to do with capabilities or routines, including the failure to *"*provide collaborative structures and processes to solve problems creatively and connect innovations with existing businesses,*"* or to make such projects an effective part of an overall strategy **(**Dougherty 1992, Dougherty and Hardy 1996: 1122).

exploitative activities. By "how well" (or "better"), we mean the quality of their innovative efforts in these two categories (and not the extent or level of the activity itself).

The understanding of firms as being about capabilities and routines (which involve local search and reduce uncertainty through rules and programs for action) was originally encapsulated in the behavioral theory of the firm (Cyert and March 1963). This became a basis for key follow-on perspectives, including the resource- and knowledge-based views (Kogut and Zander 1992, Sirmon et al. 2007). Both views consider innovation to be the result of the firm's ability to recombine resources, which is a major mechanism underlying innovations (Schumpeter 1934). The diversity of a firm's stock of knowledge affects its performance, in part by being the necessary material through which combinations occur (Kogut and Zander 1992, Spender 1996). With time, firms develop capabilities and routines that match the technology regimes that those firms initially arose within. These ease the firms' work with familiar technologies and markets, in effect, better enabling exploitation in those same areas (Ahuja and Lampert 2001, Christensen and Rosenbloom 1995). Contributing to this is the accumulated advantage that comes from learning and greater competence with a particular technology (i.e. capability) in a given area (Cohen and Levinthal 1990). In accumulating capabilities, a firm generates increasing returns through a positive reinforcement between a given capability and demonstrated economic returns from that competency (Levinthal and March 1993, March 1991).[5] This causes the firm to reinforce those exploitative capabilities (Christensen and Rosenbloom 1995, Sorensen and Stuart 2000). These interactions can lead to "learning" or "competency" traps, whereby firms continually augment their existing capabilities, making it harder for them to break out or better explore as they age (Ahuja and Lampert 2001, Levitt and March 1988, Sorensen and Stuart 2000).

The general thrust relating to exploitation highlighted by this broad range of studies is that firms will learn, create the relevant capabilities, and develop the appropriate routines to improve within a technological regime. As such, aging firms can be expected to be associated with mechanisms such as routines and capabilities that are better suited to producing better exploitative innovations, leading to our prediction:

[5] The routines and capabilities built up during successful periods are better suited for local search and the achieving of solutions in nearby problem areas (Cyert and March 1963, Martin and Mitchell 1998, Nelson and Winter 1982) such as those found in productivity enhancements, incremental innovations, and learning curves (Argote and Epple 1990).

Hypothesis 1a: Firm age is positively related to developing better exploitative innovations.

At the same time, studies on inertia suggest that the aging of firms will result in a negative effect on the capabilities to develop better explorative innovations. That is, following Sorensen and Stuart (2000), we expect that the ability to create products for a given era's or market segment's needs, which are positively related to firm age, will be ill-suited to exploring for a different era's or market segment's needs, leading to lower quality explorative innovations. Therefore, we predict:

Hypothesis 1b: Firm age is negatively related to developing better explorative innovations.

Finally, combining the previous two effects together, we expect that, as they age, firms would be able to develop higher quality exploitative innovations, as compared to explorative innovations (Sorensen and Stuart 2000). Therefore, we predict:

Hypothesis 1c: Firm age is negatively related to developing better explorative innovations, as compared to developing better exploitative innovations.

HUMAN CAPITAL AND EXPLORATIVE CAPABILITY

Many of the proposals suggested for improving firms' innovative potential invoke some form of argument involving human capital, either at the team level (Peretti and Negro 2007, Taylor and Greve 2006), or at the firm level (e.g., Ahuja and Lampert 2001, Brown and Eisenhardt 1997, Rothaermel and Deeds 2004, Rothaermel and Hess 2007). At the individual level, the failure to readdress organizational exploration is often ascribed to the inability to change mental models, "beliefs", and other cognitive constructs (Barr et al. 1992, Tripsas 2009, Tripsas and Gavetti 2000); these often being ascribed to decision-making at the higher, executive, levels in organizations. Such "beliefs" may be about the fit of a given technology to the current and anticipated market situations (Kogut and Zander 1992, Tripsas and Gavetti 2000). The beliefs may themselves be defined by attributes of individuals, such as leaders, who might also be hired for the "newness" of their perspective to an organization (Kraatz and Moore 2002, Tripsas and Gavetti 2000). While the

increasing age or stage in the lifecycle of leaders within the industry is associated with their degree of risk-taking (Miller and Shamsie 2001), the introduction of new members has also been recognized as a factor that refreshes teams' ability to innovate (Peretti and Negro 2007, Taylor and Greve 2006).

FIRM SPECIFIC HUMAN CAPITAL TENURE AND EXPLORATIVE CAPABILITY

While factors such as capabilities and routines are usually key influences on firms' innovative performance, recent calls for a human capital-based microfoundations of strategy have emphasized the importance of human capital as a basis for routines and capabilities (Felin et al. 2012). Human capital is the new "old" resource – one increasingly implicated as being crucial to firms' competitiveness (Hitt et al. 2001, Hitt et al. 2006). With rising market uncertainty, knowledge-based resources, and in particular, human resources, have become even more valuable to firms (Miller and Shamsie 2001). At the firm level, innovation studies have shown that the mobility of human capital between firms led to increases in the stock of knowledge in the target firms, and that refreshing the stock of knowledge through human capital helps firms stay innovative (Almeida and Kogut 1999, Rosenkopf and Almeida 2003, Rothaermel and Hess 2007, Tzabbar 2009). Human capital could also complement firms' overall innovative capability, suggesting that the effects of individuals can be seen to be separate from investments in capabilities (Rothaermel and Hess 2007). While these studies demonstrate the importance of the relationship between human capital and capabilities, they usually do not consider exploration and exploitation separately, and are considered independently of firm age. Studies have shown that the technological distance between new resources being introduced to the firm and the firms' own resources can help firms to innovate and to do so in further away fields (Rosenkopf and Almeida 2003, Tzabbar 2009).[6]

We theorize that the tenure of human capital affects the firm's capabilities and routines by way of the mental models and other knowledge that the human capital holds. As has been noted in the literature, not only does human capital constitute capability on its own, it also has implications for capabilities and routines (Rothaermal and Hess 2007). Our argument extends this by focusing on how

[6] The relationship between individuals and the firm's capabilities (as constituted by other individuals) is complex, as individuals can co-opt opportunities available to other individuals as well as "activate" those other individuals' efforts (e.g., Tzabbar and Kehoe 2014, Kehoe and Tzabbar 2015). It has also been shown that human capital forms a complementary stock of knowledge to collaborative capital, understood as the number of alliances (Tzabbar et al. 2008).

human capital tenure influences the relationship between firm age and the development of better (or worse) explorative and exploitative innovations. Some anecdotes show how human capital can rejuvenate aging firms' explorative ability: For example, despite repeated successes, Pixar hired Brad Bird as an additional director of animated features to renew its organizational abilities.[7] There is a duality in the role of human capital, not only as holders of organizational knowledge but also as a means for directly contributing knowledge to the combinative creation of products and services. A firm's combinative capability can age when its stock of knowledge is not being added to, since its existing *"*recombination potential…is…finite, … there are only so many ways that existing elements of knowledge can be fruitfully recombined*"* (Ahuja and Lampert 2001: 528). An extension of this idea is that the introduction of new talent and knowledge can help firms by promoting new combinations with their current stocks of knowledge (Tzabbar 2009). Such combinative capabilities are at the heart of important forms of innovation such as architectural innovation (e.g. Henderson and Clark 1990, Tushman and Anderson 1986) and recombinative innovation (e.g. Arthur 2009). Routines also play a valuable role in facilitating the resource recombinations used in innovation (Galunic and Rodan 1998, Hargadon and Sutton 1997, Zander and Kogut 1995).

By refreshing the firm's stock of knowledge, human capital shapes the firm's combinative capability (Hitt et al. 2001, March 1991, Sirmon et al. 2008). The underlying logic of recombining different knowledge elements, resources or technological components involves various forms of knowledge integration (Henderson and Clark 1990, Kogut and Zander 1992, Sirmon et al. 2007). Combinative activities are often visible at the project team and individual levels (Hargadon and Sutton 1997, Sirmon et al. 2008), as are the re-bundling of new combinations of knowledge and other resources (Obstfeld 2012, Taylor and Greve 2006). Lead talent such as "star scientists" can enhance collaborations in novel ways, suggesting that their value is as much in generating new knowledge combinations as in their individual efforts (Grigoriou and Rothaermel 2014, Zucker and Darby 1996). Sirmon, Hitt and Ireland (2007) also suggest that managers and resource management processes play

[7] "Bird joined Pixar in 2000, when the company was riding high… Concerned about complacency, senior executives Steve Jobs, Ed Catmull, and John Lasseter asked Bird… to join the company and shake things up" (Rao et al. 2008). The "shake up" that Bird created on Pixar's next animated feature film *The Incredibles* included developing new routines and capabilities that the studio lacked, such as expertise in traditional two-dimensional animation for the three-dimensional film environment, and routines to make the studio more efficient at using the content it created (Desowitz 2004, Kober 2007).

important roles in configuring resources, including acquiring new resources ("structuring"), combining them ("bundling"), and deploying or otherwise putting them to use ("leveraging"). In this situation, the entrepreneurial creation of new project teams is one means of bringing about new team compositions (Obstfeld 2012).

The interaction of the organizational and individual levels has also been identified in the literature by way of routines and mental constructs. Routines can create persistent practices, and it is also well-known that routines are "held" as knowledge by individuals, and that individuals produce as well as perform routines.[8] Research on video game studios has shown that producers - the human capital involved in enacting routines - can be more critical for firm performance than even the creative talent itself (Mollick 2012). The beliefs held by human capital can also obstruct organizations' innovativeness, or reinvigorate them (Akgun et al. 2006, Dougherty 1992, Skilton and Dooley 2010, Tripsas and Gavetti 2000). The literature on organizational inertia illustrates the ramifications, at organizational levels, of old beliefs formed from prior success with existing paradigms. In general, members with longer tenure within the organization, or experienced in the cultural milieu and existing socio-technical paradigms, will be better suited to sustaining and enhancing the abilities of aging firms, helping those firms in exploitative work, or in developing better exploitative innovations (Allen et al. 1988, Cirillo et al. forthcoming, Huckman et al. 2009). They reinforce this belief by perpetuating existing routines to target similar types of products, such as sequels. As an article noted of the exploitative nature of videogame studios that had created successful intellectual properties: "*Call of Duty* is pretty overdone as a series … There's only so much you can do in the warfare scenario." (Polson 2012).

Newer talent to a firm can be expected to bring in new knowledge and mental models, which can disrupt existing team mental models or beliefs, thereby moderating the negative effects of organizational age (Obstfeld 2012, Skilton and Dooley 2010). This increases the diversity of the

[8] An important part of an organization's stock of knowledge is individually held as procedural knowledge and individual schema (Galunic and Rodan 1998, Cohen and Bacdayan 1994). This stock is inured through the experience an individual gains in an industry or a firm. Routines enact their combinative role by various means, e.g. storing knowledge in organizational memory (Hargadon and Sutton 1997, Walsh and Ungson 1991), relating new knowledge sources to capabilities (Lewin et al. 2011), supporting the organizing of resources and implementation of new initiatives (Hargadon and Sutton 1997, Obstfeld 2012), and the stock of knowledge itself being used for generating new knowledge or routines (Cohen and Bacdayan 1994).

accumulated base of knowledge and permits a wider set of possible combinations of those knowledge resources, therefore mitigating the effect of aging firms being better at exploitative innovations. A video game industry article provides insight into how studios might rejuvenate themselves: "AAA [*i.e., games with high production and artistic quality*] publishers and developers should seek to add some indie genes [*i.e., developers not affiliated with mainstream studios*] to their own DNA" (Peterson 2015). On the other hand, without infusions of newer talent, and following from the literature on organizational inertia, firms can continue to build on and enhance their existing beliefs and knowledge base. We therefore derive the following moderating effect of human capital with longer firm-specific tenure on the effect of firm age on exploitation:

Hypothesis 2a: The positive effect of firm age on exploitation, as described in H1a, will be stronger with longer firm-specific employee tenure.

We next consider how the firm-specific tenure of employees might moderate the prediction we formulated in H1b. The dominance of existing team and lead developer mental models may be broken up by the presence of members with lower tenure in those teams and industries (Peretti and Negro 2007, Skilton and Dooley 2010). In contrast, human capital with longer firm-specific tenure is likely to adhere to their existing mental models, this being the case with the human capital individually acting by itself (Audia and Goncalo 2007). In turn, this can make the firm less capable at developing good explorative innovations, reducing their quality. Conversely, human capital with low firm-specific tenure should mitigate the negative effect of firm age on the quality of explorative innovations. Therefore, we predict:

Hypothesis 2b: The negative effect of firm age on exploration, as described in H1b, will be stronger with longer firm-specific employee tenure.

Finally, reasoning from the preceding two hypotheses (as with H1c), we expect that the effect of human capital with longer firm-specific tenure should further amplify the negative effect of age on the quality of the explorative innovations of a firm, relative to their exploitative innovations:

Hypothesis 2c: The negative effect of firm age on the firm's ability to develop better explorative innovations, as compared to developing better exploitative innovations, as described in H1c, will be stronger with longer firm-specific employee tenure.

HUMAN CAPITAL TENURE IN THE INDUSTRY AND EXPLORATIVE CAPABILITY

The industry tenure of human capital can also moderate the effect of firms' aging on the quality of their explorative and exploitative innovations. Such a "tenure in industry" effect (in what we term the "focal" industry) is different from the "newcomer-to-the-firm" effect, since it is possible that employees that are relative newcomers to the firm may still have had long tenure within the industry. While employees who are inexperienced may require on the job training, at the same time they are likely to bring with them skills and experiences honed in settings outside the focal industry. These employees might also possess beliefs that have not internalized the industry-wide practices (such as routines found throughout the industry and "industry recipes"); practices that could constrain their firms' exploration (Spender 1996). Outsiders to the industry may bring in new "frames", that is, perspectives on the potential of new technologies, as well as a greater capacity for entrepreneurial action (Kaplan and Tripsas 2008). Industry mental models may emerge around knowledge such as classification schemes and what is perceived to be industry structure (Porac et al. 1989, Porac et al., 1995), thereby helping outsiders perceive new opportunities that lie outside of the focal industry.[9] In the video game industry, interviews conducted indicate that established publishers tend to focus on conventional approaches, and studios are aware of this as they prepare their proposals (Tschang 2007).

Human capital that is newer to the focal industry can bring fresh perspectives and knowledge that might not have been previously captured in the industry, thereby increasing an aging firm's diversity of knowledge and aiding it in creating better explorative products and strategies (Crossland

[9] In games, as elsewhere, industry trends occur and are widely adopted (Koster 2015) to the point that firms require specific skill sets tagged to the (then) dominant designs – says a designer about the current state of jobs: "you needed to be a game designer... [for example, one] with mobile experience... with a knowledge and passion for every infinite runner game on the planet..." (Wondra 2015). On the innovation side, there is anecdotal evidence in studies of technology showing that outsiders' lower degree of industry knowledge, coupled with their different base of domain knowledge, allows them to disrupt existing industry-conforming routines within firms (e.g., "business as usual" investments in the existing capabilities) - such were the cases with Polaroid's digital imaging group, Xerox PARC's computing group, and other "skunk works" projects (Bennis and Biederman 2007, Tripsas and Gavetti 2000).

et al. 2014, March 1991, Perretti and Negro 2007, Rosenkopf and Almeida 2003). Perretti and Negro (2007) showed that members in project teams who were new to the film industry, i.e. with less experience, can affect a team's innovation by moderating the homogenizing effect that "old-timers" might have on the knowledge of film production teams. The underlying idea may be that the human capital's experience in other domains provides new perspectives on and new combinations with the domain that they are coming into (Crossland et al. 2014, Hargadon and Sutton 1997, Tzabbar 2009).

Lower industry tenure within a focal industry is also associated with knowledge that is different from that of the focal industry's. These perspectives and means for new combinations are likely to enable aging firms to transcend or forego existing routines and capabilities (especially as encoded in industry recipes) that are generally causing them to be better at exploitative innovations than at explorative ones. Even in creative industries such as film and games, the approaches for making different kinds of projects involve "recipes" (Mezias and Mezias 2000, Tschang 2007).[10] In the video game industry for instance, many firms chased ever larger, complex projects involving high production values (termed as "AAA" titles). However, commenting on development trends, one industry article noted: "While the first-person shooter is one of the most popular video game genres around, it often relies on tried and true mechanics and concepts". Said independent game developers who were interviewed: "Reliance on stale ideas can often lead to creative stagnation… FPS games (evolution) got slower because of how *Halo* dominated the console market. I think multiplayer is fun in *Halo* and *Call of Duty*, but not every game needs to mimic them." (Polson 2012). Many games collectively fell off the proverbial "cliff" in the late 2000s to mid 2010s, when technological disruptions occurred and consumer interest starting growing around the multitude of new platforms. One way of countering this inertia is to introduce inventors and designers who are newer to the industry, and who think disruptively while bringing different skill sets. Two well-known cases in video games are Masaya Matsuura, the rap musician who made one of the first music genre games, *Parappa the Rapper*, and Keita Takahashi, a sculpture student who, within two years of joining

[10] An example of such encoding in "industry recipes" is the shift by Hollywood movie studios, based on scale and scope, towards B movies and a vertically integrated production structure, embodying production efficiencies made possible by industry level production techniques. The more flexible post-war form of production network that resulted allowed independent producers more leeway to "disrupt" the conventional production model (Caves 2000, Robins 1993). In games, many examples abound of how a certain genre becomes "standard," or a feature becomes "standard" across much of a genre of games (Koster 2015).

Namco, was embarked on his revolutionary game *Katamari Damacy* (Takahashi 2004, Tschang 2007).

In terms of the mechanism at work, the premise behind the updating of outdated capabilities (Sorensen and Stuart 2000, Miller and Shamsie 2001) has traditionally rested on the treatment of inventions as combinative outcomes of individuals' different knowledge bases, as shown in case studies and other studies of technology and industry (Arthur 2009, Fleming and Sorenson 2004, Hargadon and Sutton 1997, Henderson and Clark 1990, Schumpeter 1934, Usher 1929). Given that capabilities comprise individuals' knowledge that are recombined, more novel knowledge combinations arise when knowledge from farther flung domains can be brought into the firm via such individuals (Rosenkopf and Almeida 2003, Tzabbar 2009). This effect of divergent thinking as arising from exposure to different domains is well established in studies of individual creativity, with analogical thinking cross-fertilizing these different domains, leading to new mental models (Gruber 1974).[11] Analogical thinking is also posited as a key mechanism by which diverse and new knowledge, including from non-focal industry domains, is brought into the work of teams (Dunbar 1997, Gruber 1974, Hargadon and Sutton 1997, Perretti and Negro 2007),[12] and in historical studies of innovation which show "industries constantly combining their practices and processes with functionalities drawn from newly arriving toolboxes – new domains." (Arthur 2009: 164).

Our premise is that, at the firm level, newer industry recipes and combinative knowledge can arise from having organizational members with lower industry tenure. Thus, the positive effect of age on organizational exploitation seen in H1a can be accentuated (mitigated) by having members who have higher (lower) tenure in the focal industry. Human capital with longer tenure in the focal industry is likely to be more familiar with, and able to further refine, existing industry recipes, aiding the quality of an aging firm's exploitative efforts. Conversely, human capital that has shorter industry

[11] Thagard (2012) points out that, of the instances of historical invention for which analogies are documented, most are "long" analogies, that is, coming from outside of the domain that they infuse. Cases of historical inventions also illustrate how important inventions and theories arise from inventors exposed to knowledge from "outside" of a traditional industry. This includes the inventors and creators of the means of measuring nautical longitude (Sobel 2010), the theory of evolution (Gruber 1974), and geological mapping (Winchester 2009). Simonton's studies of historically great artists illustrate that "the domain in artistic disciplines often incorporates ideas from outside the domain per se" (Simonton 2010: 160).

[12] The question is whether this effect is stronger when individuals have less tenure. While studies of individual creativity trace this over the historical lifecycle of individuals, these cases show that their "impact on the domain" is arguably relatively most at odds with the field at their initial point of productive entry, i.e., when their tenure is lowest.

tenure might be less entrenched in existing industry recipes and is likely to bring in other knowledge and perspectives. While these are likely to be helpful for the development of better exploratory innovations, as we will formalize in H3b and H3c, they are not likely to aid an aging firm to produce better exploitative innovations (especially as compared to human capital with longer industry tenure, who would be in a better position to further refine and extend the industry recipes that they are more familiar with). Therefore, we propose the following:

Hypothesis 3a: The positive effect of firm age on exploitation, as described in H1a, will be stronger with longer industry employee tenure.

On the other hand, human capital with low tenure in the focal industry should mitigate the negative effect of firm age on the quality of exploratory innovations, as we formulate in H1b. This would have happened through new knowledge, new combinations, and possibly the bringing in of recipes from other industries, all of which are more likely to allow a focal firm to adapt and change the consequences of recipes in its focal industry. Conversely, human capital with longer tenure in the focal industry is likely to further amplify the negative relationship between firm age and the quality of the firm's exploratory innovations. Therefore, we predict:

Hypothesis 3b: The negative effect of firm age on exploration, as described in H1b, will be stronger with longer industry employee tenure.

Finally, we look into the implications of human capital industry tenure for the prediction we formulate in H1c. Considering the preceding two hypotheses together, we conclude that the effect of human capital with longer industry tenure on the ability of an aging firm to produce better exploratory innovations, as compared to better exploitative innovations, would also be negative:

Hypothesis 3c: The negative effect of firm age on the firms' ability to develop better explorative innovations, as compared to developing better exploitative innovations, as described in H1c, will be stronger with longer industry employee tenure.

DATA

To test our hypotheses, we use data on the video game industry. The video game industry emerged over 40 years ago (Wolf 2008). As an entertainment setting, games are similar to movies, but encounter more frequent technological discontinuities (Koster 2015). Firms and employees alike have to keep up not only with technologies, but also consumer preferences, and need the ability to envision, design and implement highly complex products with millions of lines of programming code and with more art than some animated feature films. For instance, there was a one million percent increase in game program size between the days of the Sega Genesis console in the 1980s and games seen in the late 2000s (Fullerton 2008). The industry is turbulent and has historically involved much turnover of firms, with many new firms coming about from spinoffs by industry veterans, often starting afresh by adding new team members to a core team, or startups by newcomers (Hotho 2013, Tschang 2007, White and Searle 2013). While veterans and newcomers alike may innovate or make incrementally innovative products in the new firm (i.e. exploit), at the same time "old firms" may also have to develop new intellectual property (IP) (i.e. explore) in light of falling sales for older IP and the changing environment. As such, this industry is a compelling setting to study the "new firm, old employees" and "old firm, new employees" blends of firm age and employee tenure that we focus on.

Game development is organized in a project setting. While many articles have been based on the film industry, film projects are newly constituted each time from a "floating pool" of labor by the "movie studio", which is effectively a shell company with a few key executive heads. In contrast, the typical game studio operates more like a firm (such as with technology firms), with its own enduring (human and otherwise) resource base. The longer project durations of game projects and the need to build capabilities (e.g. if studios build their own technology for reuse across projects, or to specialize in unique gameplay approaches) creates a need for the game studio to hold onto its core talent, and to keep its talent engaged on a project pipeline (Muzyka 2002). This is corroborated by the industry's main periodical's survey of 2500 game developers, which showed that in 2011, layoffs after completion of a project were only about 13 percent (Miller and Bulkley 2013). By engaging with multiple projects, firms are able to use knowledge and resources across multiple projects.

While most new games face much uncertainty during the development process, new titles

within a series (sequels) or using established (licensed/franchised) content within a familiar style of gameplay still have to be sufficiently refreshing to warrant consumers' interest (Tschang 2007). Even so, games based on original IP pose more "exploratory" challenges than a sequel or games that use franchised content. Consider this postmortem of a (new content IP) project, *Tropico,* by Poptop, a studio that had made a successful sequel of another game prior to it: "These were uncharted waters for Poptop. RT2 (*Railroad Tycoon 2*) had been based very closely on Sid Meier's classic *Railroad Tycoon* ... The upside was that a good part of the design work had been done for us. The downside, as we were to find out on our next project [*the new title*], was that it left us a bit naïve about the effort it would take to create a new game from an original idea." (Smith 2001).

This setting is appropriate in terms of aligning our theoretical elements to our purposes (understanding the effects of human capital tenure on moderating firm age effects). For example, inertial effects are observed in this industry, with success begetting sequels - becoming the "curse of success" (Tschang 2007). An established designer, Raph Koster, rued this situation in a well-known talk, referring to the need for developers to break free of their habits of producing games for themselves and other niche game players (Wallace 2006). Combinative innovation is a common mechanism by which studios seek to bridge the familiar and the new. Innovations are created by, among other means, borrowing content or themes from other media, and combining them in new ways or with other new elements (Tschang and Szczypula 2006). Examples include the reapplication of a kind of game mechanic from one game to another, or the adoption of the same type of content (e.g. the type of world, such as a fantasy setting, or content such as a comic book's superheroes) from one game to another.[13] Along with these, the continuing technological changes within the industry, and the increasing complexification of products and efforts, require new routines and practices to be created.

Unlike movies, game consumers have to pay as much as $50 per title (Fullerton 2008), and routinely spend more than ten hours on a single game, ensuring that they are careful with their choice. Thus, critical reception, written up in online venues, often by such game consumers acting as freelance reviewers themselves, as well as more limited-circulation print magazines, are a dominant

[13] Tschang (2007) notes how designers iteratively thought through the process of applying the mechanics of a "city building game" to different historical and cultural settings, as well as to different types (series) of city building games.

mode of assessment. There were, and still are, hardly any "professional" reviewers in this industry akin to famed movie reviewers (e.g. Gene Siskel and Roger Ebert), so users also seek their information online through various websites, some of which have long-standing reputations.[14] We adopt the use of online reviews in much the same spirit as other studies in marketing and management (see for instance Dellarocas et al. [2007]).

Our data were coded from Mobygames, an online database for information on games (e.g. Mollick 2012). Mobygames is as extensively used by studies on the game industry setting (and game industry professionals) as the Internet Movie Database (IMDb) has been used by scholars in similar studies of the film industry. The website is run by a private firm that sells services with the data, but the content itself is user-contributed. Most user input comes through their checking the developer (name and position), studio and publisher information on a particular game, and then inputting it into the appropriate fields through an interface. Mobygames also lists review scores on games from online periodicals, print magazines, and game review websites. We can trace data for games released back to 1977 (we omit casual games, games released only as apps, or smartphone only games). Therefore in the construction of our variables for studio age or the tenure of employees there is no left censoring.

Dependent variables

Quality of exploitative games. We measured the quality of exploitative games developed by a studio by using the average scores of the media reviews for these games. We define exploitative games as games that are either part of sequels or games that use franchised content (i.e., non-original-content games). We do not suggest that these games involve no exploration at all by the studio. However, it is well understood in this context that, relative to games that are neither part of sequels nor use franchised content, the games that do these are more exploitative (and less exploratory).

Quality of exploratory games. We measured the quality of exploratory games developed by a studio by using the average scores of the media reviews for these games. As we note above, we categorize exploratory games as those that are neither parts of sequels nor use franchised content (i.e., original-content games). Even though any kind of creative and innovative endeavor is likely to

[14] For example, three of the most well-known sites - GameSpy Gamespot and IGN - were all founded in 1996.

include some level of exploration (both for this setting as well as others), games that are neither part of sequels nor use franchised content are characterized as involving greater exploration.

Relative quality of exploratory games. We measured the relative quality of a studio's exploratory games, as compared to exploitative games, by using the average scores of the media reviews for the games in each category. Specifically, we subtracted the average score of the media reviews of non-original content (i.e., exploitative) games released by the studio in a given year from the average score of the media reviews of original content (i.e., exploratory) games released by the studio in that year. Even though a studio might get better (or worse) in developing high-quality games as it ages, our measure captures the difference in the quality of original-content (i.e., exploratory) games as compared to non-original-content (i.e., exploitative) games in a given year.[15]

Independent variables

Studio age is the number of years since the studio has first released a game. We use this variable to test H1a, H1b, and H1c.

Studio tenure of lead team is the average studio-specific tenure of all employees who were part of the lead team for any games released by the studio in that year. The studio-specific tenure for an employee who is part of any lead team is the number of years since that employee has first appeared as being credited in any role in a game that was released by the focal studio (i.e. the studio for which studio-specific tenure is being calculated). We use the interaction term between this variable and *Studio age* to test H2a, H2b, and H2c.

Industry tenure of lead team is the average industry tenure of all employees who were part of the lead team for any games released by the studio in that year. The industry tenure for an employee who is part of any lead team is the number of years since that employee has first appeared as being credited in any role in a game (regardless of the studio that had developed that particular game). We use the interaction term between this variable and *Studio age* to test H3a, H3b, and H3c.

[15] Even though we refer to the exploratory and exploitative games as "original content" and "non-original content" games, respectively, it is important to note that games that use franchised content or that are sequels still include varying degrees of original content. Our contention is that, consistent with the clear understanding in this setting, games that are neither sequels nor use franchised content are on average "more original" and closer to capturing the characteristics of explorative innovations than games that are either sequels or that use franchised content (the latter two being "less original" and closer to capturing the characteristics of exploitative innovations).

Control variables

We control for studio size in two ways. First, we control for *Lead team size*, which is the total number of (unique) employees who have appeared as part of any lead team in any game released by the studio in that year. We also control for the *Cumulative number of games released*, which is the total number of games the firm has released up to the present year. As we already have a measure for *Studio age*, this cumulative count provides an indicator of the overall, age-adjusted, activity of the studio, based on the idea that studios with more resources might release more games.

We also control for the *Proportion of original content games released*, which is a time-varying measure of the proportion of all games the studio has released up to the present year that use original content (i.e., games that contain neither franchised content nor are sequels). While we use studio fixed-effects estimations, it remains possible that a particular studio might shift its activity over time to have its production comprise a larger or smaller proportion of games using original content. Such a drift might affect the quality of the exploitative or exploratory games released by the studio (as well as, by implication, the relative quality of exploratory games).

While we use two measures of the average firm-specific and industry-wide tenure of employees to test our hypothesized effects (H2a/H2b/H2c and H3a/H3b/H3c), the dispersion of the tenure of these employees is also important to account for (Sørensen 2002). Employees with different levels of dispersion of tenure might have the same average tenure, and therefore this is relevant to control for. In other words, a group of employees that is more homogenous with respect to their tenure might have different implications for the quality of different types of games developed by the studio than a group of employees that consists of individuals whose tenure varies widely, even if the average tenure for both groups is the same. Accordingly, we calculate two control variables: *Standard deviation of industry tenure of lead team*, which is the standard deviation of the industry tenure of employees who have appeared in any lead team in games released by the studio in that year, and *Standard deviation of studio tenure of lead team*, which is the standard deviation of the studio tenure of employees who appeared in any lead team in games released by the studio in that year.

In addition to the control variables we describe above, which are entered in all of our models, the models we use to test H1a/b, H2a/b, and H3a/b (the predictions about the [absolute] quality of

exploitative and exploratory games on their own, rather than in comparison to each other) also include an additional control variable each. For the predictions about the quality of exploitative games (H1a, H2a, H3a) we also include a variable control for the *Quality of exploratory games* developed by the studio, while for the prediction about the quality of exploratory games (H1b, H2b, H3b) we also include a variable to control for the *Quality of exploitative games* developed by the studio.

Finally, in all of our models, we enter a set of indicator variables to control for year-specific effects, and our estimations incorporate studio-fixed effects to account for any time invariant studio level heterogeneity.[16]

Selection variable. In order to enter our estimation sample for each year, a studio needs to release at least one game with original content (i.e., exploratory game) and at least one game that is either a sequel or that uses franchised content (i.e., exploitative game), in that year. Even though our estimation models account for studio age and studio size, the studios that are more likely to have at least one release in each category in a given year might still be of a different "type" than studios that do not have at least one game in each category in a given year. To take this possibility into account and adjust our estimation for possible sample selection issues that might result from it (Heckman 1979), we calculate the inverse Mill's ratio (labeled as Lambda, λ) and include this variable in all of our specifications. In order to calculate this variable, we add, as an exclusion restriction, the *Number of past years in which the studio released both categories of games* (meaning at least one game that used original content and at least one game that was a sequel or that used franchised content) to Model 6 as in Table 2, and use that specification to implement a Probit estimation to predict the likelihood that a studio would enter our estimation sample in a given year (the result of this estimation is reported in the Appendix). We suggest that this is an appropriate variable to use in this manner because (a) it is expected to be related to whether a studio enter our estimation sample in a given year, on the basis that studios that have released both types of games on more occasions in the past are likely to do so subsequently as well and (b) it is not expected to influence the dependent variables in

[16] One might also consider adding a lagged-dependent variable to control for variation that might not be captured by our model specification and the control variables. To look into this matter, we ran a Wooldridge panel-autocorrelation test (Wooldridge 2010) for our dependent variables. The statistic provided by this test was not significant ($p > .20$), suggesting that the null hypothesis (i.e. that there is no autocorrelation) could not be rejected. Therefore, we do not incorporate a lagged-dependent variable in our models.

our main (second-stage) estimations, on the basis that having released both types of games on more occasions in the past is not expected to influence the relative quality of games in each type. Consistent with this reasoning, we see that in the first-stage Probit estimation, this variable has a positive and significant coefficient ($p < .01$) on a studio's likelihood of releasing at least one game in both categories in a given year, and therefore of entering our estimation sample. On the other hand, this variable has no significant effect on any of the three of our dependent variables in our second-stage (main) estimations (as we confirm by adding it to Models 4, 5, and 6 in Table 2). We also note that the above observations, with respect to significance and non-significance, remain the same if we include a set of year indicators in the selection equation. Likewise, the findings from our main estimations with the resulting inverse Mill's ratio from this slightly different model also exhibit the same patterns of significance and non-significance as we discuss below.

Estimation

We use panel regression models with robust clustered errors and studio-fixed effects to test our hypotheses. The Hausman test indicates that fixed-effects estimation is preferable to random-effects estimation (chi-sq (31) = 49.95, $p < .05$). Our estimation sample consists of an unbalanced panel, and, as has been noted (e.g., Hayashi 2000: 340-341) linear panel fixed-effects estimations extend to unbalanced panels with the same assumptions and implications as for balanced panels. The fixed-effects specification allows us to partial out time invariant studio level heterogeneity, yielding "within" estimators and a corresponding interpretation. In addition, the robust standard errors, as clustered on studios, adjusts for possible non-independence across observations that belong to the same studio over time in calculating the coefficients. All of the independent variables and control variables are lagged by one year. As noted, our final estimation sample is an unbalanced panel of 462 observations, with data on 202 studios, covering games released between 1987 and 2009.[17]

[17] There were more than 7,000 unique lead developers working on the games released by these studios in the years in which they appear in our estimation sample. Even though they are key human talent for the studios and in the development of video games, most lead developers have nowhere close to the fame of CEO's, sports players, or movie actors, and therefore detailed demographic data for any reasonable level of data coverage were not available.

RESULTS

Table 1 presents the means, standard deviations, and correlations for the variables in our estimations. The variance inflation factors (VIFs) do not suggest that multicollinearity might present a problem in interpreting the results from our estimations. The average VIF in our models does not go above 6, while there is no individual variable with a VIF above 10.

Table 2 presents the results of our estimations. Models 1-3 include all of our control variables for the three dependent variables. Models 4-6 introduce *Studio age* to test H1a, H1b, and H1c. In Model 4, *Studio age* has a positive and significant coefficient ($p < .001$), providing support for H1a. In Model 5, Studio age has a negative and significant coefficient ($p < .05$) providing support for H1c. And in Model 6, *Studio age* again has a negative and significant coefficient ($p < .001$), providing support for H1c. These results provide consistent support for our baseline predictions about the relationship between *Studio age* and the quality of exploratory and exploitative games.

In Models 7-9 we add the interaction term between *Studio age* and *Studio tenure of lead team* to test H2a, H2b, and H2c. These two variables were centered around their sample means before the interaction term was constructed. In Model 7, the interaction term is not significant (and not close to significance, $p > .70$). Therefore, we do not find support for H2a. The effect of *Studio age* remains positive and significant ($p < .01$). In Model 8, the interaction term has a negative and significant coefficient ($p < .05$), providing support for H2b. The main effect of *Studio age* remains negative and significant ($p < .05$). In Model 9, the interaction term has a negative and significant coefficient ($p < .05$), supporting H2c. Here, too, the main effect of *Studio age* remains negative and significant ($p < .001$). In summary, we find support for H2b and H2c, but not for H2a. In addition, the baseline effects of *Studio age* (as in H1a, H1b, and H1c) remain significant in the predicted dimensions once the possible moderating effect of *Studio tenure of lead team* is accounted for.

In Models 10-12 we add the interaction term between *Studio age* and *Industry tenure of lead team* to test H3a, H3b, and H3c. As before, the two variables were centered around their sample means before the interaction term was constructed. In Model 10, the interaction term has a positive coefficient, as in the predicted direction, but it is not significant (although the case here is not as stark as in H2a above, $p = .14$). Therefore we do not find support for H3a. The main effect of Studio age

remains positive and significant ($p < .001$). In Model 11, the interaction term has a negative coefficient, even though it is marginally significant ($p < .07$), lending some support to H2b. The main effect of *Studio age* remains negative and significant ($p < .05$). In Model 12, the interaction term has a negative and significant coefficient ($p < .05$), supporting H3c. The main effect of *Studio age* remains negative and significant in this model ($p < .001$). In summary, we find marginally significant support for H3b, significant support for H3c, and no support for H3a. This pattern of significance (and non-significance) is consistent with our findings for H2a-H2c, and it is a matter we will return to shortly. In addition, as before, the baseline effects of *Studio age* also remain significant in the predicted direction in these models.[18]

Additional analysis

In our tests of the predicted moderation effects (H2a-H2c and H3a-H3c) we enter each interaction term separately to our models. This is because entering the two interactions together leads to high multi-collinearity, as indicated by variance inflation figures (VIFs) being well above the figure of 10 that is generally suggested (one implication of such high multi-collinearity is that it leads to inflated standard errors, making it more difficult to estimate coefficients precisely and thus to detect significance). However, we can present additional evidence that is consistent with our reasoning and

[18] We also looked into the possibility that our results might be an artifact of "hot" firms attracting new talent (so talent with lower firm-specific and industry-level tenure), where these hot firms also achieve higher quality in their exploratory efforts. We first note that it is not necessarily the case that "hot" firms are "young" firms (since we investigate firm age). Nevertheless, to look into this matter, we first run models to see whether there might be reverse causality. As we detail below, we do not see an indication of this. Second, we test for endogeneity using an instrument for our two human capital tenure variables. This test fails to reject the null hypothesis of exogeneity in our estimations with respect to either of our tenure measures. First, regarding estimations that might give an indication of reverse causality: For each studio-year observation in our estimation sample, we calculate the changes (current year minus the previous year) in the *Industry tenure of lead team* and *Studio tenure of lead team*. We then use these two new variables (*Change in industry tenure of lead team* and *Change in studio tenure of lead team*) as dependent variables, which we predict using the performance of a studio (as below). We use studio-level fixed effects regressions and year indicators, as in our main models, and capture the performance of a studio with, alternatively, (a) media review scores (i.e., the average review ratings, in the same way that we calculate the dependent variables in main models) of all games released by the studio, (b) media review scores of exploratory (original content) games released by the studio, (c) media review scores of exploitative (non-original content) games released by the studio, and (d) media review scores of explorative games as relative to media review scores of exploitative games. In none of the eight regression models (two dependent variables crossed by the above four possible measures of "*Studio performance*") is any of the four "*Studio performance*" measures a significant predictor of either "*Change in industry tenure of lead team*" or "*Change in studio tenure of lead team*". Thus, these models do not provide an indication that the quality of the exploratory or exploitative games (or all games in general) developed by a studio drives subsequent changes in the tenure composition of its lead team – suggesting that a reverse causality of this kind is unlikely to influence our results. Second, we instrument the tenure of employees with the "*Average team size*" of games produced by the studio (we use team size as an instrument for both *Industry tenure of lead team* and *Studio tenure of lead team* in separate models). In our estimation sample, "*Average team size*" is correlated positively and significantly ($p < .001$) with both *Industry tenure of lead team* and *Studio tenure of lead team*, but it is not significantly correlated with our dependent variable ($p > .85$). When we use this instrument and test for endogeneity with respect to either *Industry tenure of lead team* or *Studio tenure of lead team*, we fail to reject the null hypothesis of exogeneity ($p > .30$).

predictions. Specifically, we calculate a new measure "*Average proportion of industry tenure of lead team that is accumulated in the present studio*" – which is the average proportion of a lead team's industry-wide tenure that has been accumulated in the focal studio. The higher this proportion is, the more the studio's lead team members have spent their overall industry experience in that studio (therefore, having had less occasion to directly learn about and experiment with practices and knowledge that might reside in other studios). An extension of our ideas suggests that, like the absolute values of *Studio tenure of lead team* and *Industry tenure of lead team*, this proportion should also moderate the effect of *Studio age* on the quality of exploitative games, exploratory games, and the relative quality of exploratory games. Specifically, we would expect that this proportion (a) would enhance the positive effect of *Studio age* on the quality of exploitative games, (b) would amplify the negative effect of Studio age on the quality of exploratory games, and (c) would again amplify the negative effect of Studio age on the relative quality of exploratory games, as compared to exploitative games. When we add this new proportion variable and its interaction with *Studio age* (to test the three moderating effects specified above) to Models 4, 5, and 6, we see that (a) in Model 4, the interaction, as expected, has a positive coefficient but is not significant ($p = .16$), therefore the first prediction, that is akin to H2a and H3a, is not supported, (b) in Model 5, the interaction has a negative and significant coefficient ($p < .05$), lending support to the second prediction, and finally (c) in Model 6, the interaction again has a negative and significant coefficient ($p < .05$). These mirror the results in our main regressions, using the absolute levels of studio-specific and industry-level tenure as moderators for the age effect. We offer these results as additional evidence for the idea that human capital tenure influences the relationship between firm age and the quality of exploitative and exploratory products of the firm.

CONCLUSION

Our research adds complementary insights to a number of research streams by shedding light on the innovative roles that are undertaken by new human capital. Our findings contribute to the stream of research on inertia, and the problem of what firms should do when they want to improve the quality of their exploratory efforts over inertial forces. This culminated from Sorensen and Stuart's

(2000) finding that firms were relatively better at conducting exploitative work as they age. While inertia studies have focused on a range of specific organizational-level mechanisms (e.g. Christensen and Bower 1996, Dougherty and Hardy 1996, Hannan and Freeman 1984), and while it has already been established that human capital such as that embodying high experience or expertise can positively affect firm performance (Kor and Leblebici 2005, Kraatz and Moore 2002, Miller and Shamsie 2001), we add the nuance that the tenure of the human capital matters in this interaction with firm age and performance. While our study contributes to the knowledge-based view that describes how talent can interact with organizational capabilities (e.g. Rosenkopf and Almeida 2003, Rothaermel and Hess 2007, Tzabbar 2009), we also add to the research stream on how newcomers can benefit innovation in teams (Perretti and Negro 2007, Skilton and Dooley 2010, Taylor and Greve 2006). Our results generalize these findings to the firm level and show that the moderating effects on the relationship between firm age and the quality of exploratory products separately holds for both "newer human capital to the firm" and "newer human capital to the industry", but also holds wrinkles when we consider the reverse (i.e., effects of longer tenure on the exploitative side). Finally, we note that while many studies of exploration and exploitation are focused on the level (or quantity or amount) of activity, behavior, or output in terms of whether it is exploratory or exploitative, we consider the quality (and not the extent) of these explorative and exploitative outcomes.

Our approach of treating human capital as being a key constituent of capability is in line with suggestions to study the "micro foundations" within theories of strategy (Barney 2011 et al., Barney and Felin 2013), and also adds to the literature on resource-bundling mechanisms that are important to marshal organizational resources (Sirmon et al. 2007, Sirmon et al. 2008). At their heart both views involve integrating core concepts such as capabilities and routines with new human capital in order to understand firms' ability to better create and capitalize on new opportunities (i.e. explore better). Future work may aim to provide a more detailed study of the relationship between human capital and more direct measures of organizational capability, such as capabilities and routines.

Another issue that can be explored further is the implications of interactions between types of position. Further study of inter-position or work interactions, such as Mollick's (2012) may be necessary to advance our understanding of the nuances of how different types of human capital

contribute to the firm and interact with firm-level resources. Mollick (2012) found that positions involving the routinization of work (producers) provided greater explanatory power over (relatively more) exploratory (e.g. designer) positions. For our investigation of the moderating effects of human capital tenure on firm age, we did not find such differences between positions. However, future work could analyze the blend between types of old and new talent and their performance implications. In one of the authors' recent interviews, a former CEO and his ex-staff of a console game company (shut down in 2012), freely admitted that they themselves did not play apps or smart phone games – and hence did not have intimate knowledge of that emerging market segment that was disrupting the entire game industry at the time. In contrast, in another studio that the author studied, the CEO started a new studio with a core team to enter the smartphone game market, and called on the assistance of partners (including a publisher's producer) who had familiarity with the new kinds of games. These efforts helped the team to effectively reposition itself with a new product for the new (smartphone) market.

We now turn to the limitations of our study, so that future research using other data and research designs can investigate or address their implications. Despite the merits and suitability of our setting and the data that we have access to, they still impose limitations that can be overcome with access to different data or other research designs. For example, we do not have the exact date at which employees join or leave a game development studio. As a result, we are unable to calculate precise measures with respect to the employee composition (and therefore, for example, the average tenure) of a given studio at a point in time. In a related manner, while there are mergers and acquisitions between game development studios, systematic data on these are not available, with the implication once again that we have inexact measures of employee composition for a given studio at a given point in time (yielding noisier measures of average tenure, for example). In addition while we implement a first-stage selection model and look into some implications of possible endogenous "hot-firm" effects (as we note in footnote 18), with our data it is not possible to conclusively rule out alternative explanations that might relate to selection or endogeneity. Settings that might allow researchers to leverage exogenous shocks to enable a quasi-experimental setup, or possibilities to intervene and implement field experiments, will go some way towards addressing these concerns. While we have no reason to believe that the mechanisms we discuss would be absent in those different circumstances,

we acknowledge that this ultimately remains an empirical question. We also acknowledge that our measure of quality, as indicated by the scores given by reviewers, embodies just one way of considering the matter. Not all settings might provide such extensive data on the assessments by reviewers of particular product types. Similarly, there might be settings in which there are multiple ways of assessing quality and, furthermore, where these measures are only weakly related. As a general matter, the measurement of quality is rather context-specific, and while in the video game industry, review scores are widespread, attended to (by both gamers and game developers themselves), and relate well to sales of games, one or more of these might not be true in other settings, and researchers should make the appropriate adjustments. Finally, more extensive and in-depth datasets would allow researchers to also incorporate and leverage the background of human capital further, in the ways that these might interact with firm-level mechanisms in influencing the quality of different kinds of innovations.

To conclude with a summary, firms are increasingly interested in welding human capital to strategy, as witnessed by the increasing interest of both practice and literature in the issue (Coff and Kryscynski 2011, Thomas et al. 2013). Our theory and results suggest that the newness of human capital is an important factor for improving aging firms' explorative potential. We first confirmed the baseline situation that firms do better at exploitative products and worse at explorative products as they age. We then showed that human capital with lower firm-specific and lower industry tenure moderates these firm-age effects on the quality of explorative products. However, we do not find the same effects on the quality of exploitative products. A consideration of the setting yields a possible explanation for this lack of support for the exploitation side of the argument. In the video games industry, exploitative products, such as sequels and those using franchised content, have to carefully manage a balance of the old (e.g. "tried and true") features with at least some new (i.e., exploratory) features (as noted in footnote 15). This was pointed out in a reflection of the making of a sequel to a popular franchise: "The game business is brutal to those who fail to move forward with the times, but it's also equally brutal to those who experiment too much and stray from the expectations of the players" (Pritchard 2000). Thus, in settings that are continually changing and evolving, even exploitative products may require some level of explorative effort and creativity, as may be spurred

by new talent to the firm or to the industry. At the same time, exploitative products in such industries can provide a "blueprint" that young but relatively capable firms and their employees are able to follow, even without too much experience. As was noted in the earlier cited postmortem of a young firm's production of a sequel, "a good part of the design work had been done for us [in the original's design]" (Smith, 2001). As a result of such considerations, in settings such as ours, one might consider whether the deeper experience needed to ensure the quality of exploitation would still need to be balanced by some inventiveness that may come from having new talent.

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Table 1: Means, Standard Deviations, and Correlations [•]

variable	mean	s.d.	1	2	3	4	5	6	7	8	9	10
1. Quality of exploitative games	84.87	13.10										
2. Quality of exploratory games	82.11	13.07	.27									
3. Quality of exploratory games relative to exploitative games	-2.77	15.74	-.60	.60								
4. Studio age	7.47	5.86	.20	.17	-.03							
5. Lead team size	15.60	20.77	.09	.07	-.01	.36						
6. Cumulative number of games released	24.34	29.68	.17	.18	.01	.78	.52					
7. Proportion of original content games released	0.46	0.25	-.11	-.02	.08	.01	-.22	-.03				
8. Industry tenure of lead team	3.88	2.57	.08	.05	-.02	.36	.16	.25	-.24			
9. Standard deviation of industry tenure of lead team	3.21	1.80	.07	.03	-.03	.31	.23	.23	-.32	.77		
10. Studio tenure of lead team	1.60	1.75	.19	.18	-.01	.58	.07	.48	.01	.57	.29	
11.Standard deviation of studio tenure of lead team	1.70	1.46	.18	.16	-.02	.69	.18	.56	.01	.48	.40	.81

[•] n = 462. Correlations greater than |.15| are significant at $p < .01$.

Table 2: Studio-Fixed Effects OLS Regressions Estimating the Quality (i.e., average review score) of Games [•]

Dependent variable	*Quality of Exploitative Games*	*Quality of Exploratory Games*	*Quality of Exploratory Games Relative to Exploitative Games*	*Quality of Exploitative Games*	*Quality of Exploratory Games*	*Quality of Exploratory Games Relative to Exploitative Games*
Hypothesis tested	*baseline*	*baseline*	*baseline*	*H1a*	*H1b*	*H1c*
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Studio age				1.515**	-1.131*	-2.538***
				(0.474)	(0.471)	(0.662)
Lead team size	-0.001	-0.061	-0.058	-0.001	-0.061	-0.058
	(0.027)	(0.031)	(0.037)	(0.027)	(0.031)	(0.037)
Cumulative number of games released	-0.185**	0.122	0.295***	-0.185**	0.122	0.295***
	(0.067)	(0.073)	(0.081)	(0.067)	(0.073)	(0.081)
Proportion of original content games released	1.753	-13.554**	-14.745	1.753	-13.554**	-14.745
	(5.536)	(4.741)	(7.540)	(5.536)	(4.741)	(7.540)
Industry tenure of lead team	0.275	0.645	0.359	0.275	0.645	0.359
	(0.722)	(0.976)	(1.356)	(0.722)	(0.976)	(1.356)
Std. dev. of industry tenure of lead team	0.254	-0.26	-0.493	0.254	-0.26	-0.493
	(0.709)	(0.767)	(1.039)	(0.709)	(0.767)	(1.039)
Studio tenure of lead team	-0.524	-0.368	0.146	-0.524	-0.368	0.146
	(0.869)	(1.197)	(1.369)	(0.869)	(1.197)	(1.369)
Std. dev. of studio tenure of lead team	-1.541	0.076	1.545	-1.541	0.076	1.545
	(0.936)	(0.999)	(1.198)	(0.936)	(0.999)	(1.198)
Lambda (λ, inverse mills)	2.588	-0.422	-2.879	2.588	-0.422	-2.879
	(1.542)	(1.442)	(2.065)	(1.542)	(1.442)	(2.065)
Quality of exploratory games	0.037			0.037		
	(0.067)			(0.067)		
Quality of exploitative games		0.046			0.046	
		(0.079)			(0.079)	
Constant	60.026***	99.489***	38.593**	79.670***	84.829***	5.692
	(9.497)	(8.911)	(12.502)	(8.052)	(8.601)	(8.093)
R-squared (within)	0.242	0.149	0.192	0.242	0.149	0.192

[•] n = 462. Robust clustered standard errors are in parentheses. All models include unreported year indicators. All tests are two-tailed. *** $p < .001$, ** $p < .01$, * $p < .05$, + $p < .07$

Dependent variable	*Quality of Exploitative Games*	*Quality of Exploratory Games*	*Quality of Exploratory Games Relative to Exploitative Games*	*Quality of Exploitative Games*	*Quality of Exploratory Games*	*Quality of Exploratory Games Relative to Exploitative Games*
Hypothesis tested	*H2a*	*H2b*	*H2c*	*H3a*	*H3b*	*H3c*
	Model 7	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
Studio age	1.529**	-1.154*	-2.559***	1.515**	-1.135*	-2.521***
	(0.472)	(0.474)	(0.660)	(0.468)	(0.468)	(0.648)
Studio age * Studio tenure of lead team	0.048	-0.085*	-0.128*			
	(0.045)	(0.039)	(0.055)			
Studio age * Industry tenure of lead team				0.066	-0.074+	-0.133*
				(0.044)	(0.041)	(0.052)
Lead team size	0.01	-0.079*	-0.085*	0.013	-0.077*	-0.086*
	(0.027)	(0.034)	(0.039)	(0.027)	(0.035)	(0.038)
Cumulative number of games released	-0.203**	0.154*	0.341***	-0.204**	0.144	0.330***
	(0.070)	(0.078)	(0.085)	(0.067)	(0.079)	(0.083)
Proportion of original content games released	1.618	-13.200**	-14.202	1.451	-13.116**	-13.934
	(5.627)	(4.741)	(7.748)	(5.693)	(4.713)	(7.786)
Industry tenure of lead team	0.386	0.442	0.058	0.188	0.735	0.525
	(0.712)	(0.949)	(1.319)	(0.716)	(0.968)	(1.322)
Std. dev. of industry tenure of lead team	0.138	-0.054	-0.183	0.209	-0.21	-0.399
	(0.708)	(0.790)	(1.066)	(0.711)	(0.778)	(1.057)
Studio tenure of lead team	-1.026	0.525	1.478	-0.916	0.08	0.944
	(1.203)	(1.172)	(1.589)	(1.039)	(1.057)	(1.298)
Std. dev. of studio tenure of lead team	-1.437	-0.099	1.269	-1.389	-0.081	1.237
	(0.985)	(0.958)	(1.221)	(0.967)	(0.972)	(1.188)
Lambda (λ, inverse mills)	2.688	-0.611	-3.139	2.607	-0.464	-2.913
	(1.535)	(1.416)	(2.016)	(1.530)	(1.440)	(2.042)
Quality of exploratory games	0.043			0.045		
	(0.068)			(0.068)		
Quality of exploitative games		0.053			0.055	
		(0.079)			(0.080)	
Constant	78.645***	85.312***	7.18	77.320***	85.991***	9.136
	(8.105)	(8.563)	(7.693)	(8.162)	(8.650)	(7.802)
R-squared (within)	0.244	0.157	0.202	0.248	0.156	0.205

APPENDIX: First-Stage Probit Regression •

	Model A1
Studio age	-0.003
	(0.012)
Lead team size	0.004
	(0.003)
Cumulative number of games released	-0.070***
	(0.006)
Proportion of original content games released	-0.222***
	(0.112)
Industry tenure of lead team	-0.074*
	(0.023)
Std. dev. of industry tenure of lead team	0.009
	(0.029)
Studio tenure of lead team	-0.010
	(0.040)
Std. dev. of studio tenure of lead team	0.009
	(0.044)
Number of past years in which the studio released both categories of games	*0.753*** (0.043)*
Constant	-1.442***
	(0.100)
Log-likelihood	-1060.426
Wald-chi-squared	436.99

• n = 4660. The dependent variable is coded as 1 if the studio released at least one explorative and one exploitative game in a given year and is coded 0 otherwise. Standard errors are in parentheses. All tests are two-tailed. *** $p < .001$, ** $p < .01$, * $p < .05$.

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