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PEOPLE AND PROCESS, SUITS AND INNOVATORS: THE ROLE OF INDIVIDUALS IN FIRM PERFORMANCE

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Performance differences between firms are generally attributed to organizational factors rather than to differences among the individuals who make up firms. As a result, little is known about the part that individual firm members play in explaining the variance in performance among firms. This paper employs a multiple membership cross-classified multilevel model to test the degree to which organizational or individual factors explain firm performance. The analysis also examines whether individual differences among middle managers or innovators best explain firm performance variation. The results indicate that variation among individuals matter far more in organizational performance than is generally assumed. Further, variation among middle managers has a particularly large impact on firm performance, much larger than that of those individuals who are assigned innovative roles.

INTRODUCTION

Is firm performance driven by people or by process? The strategy literature has historically argued that a good process is the key to good performance. The result is a long tradition of using organizational factors rather than differences among individual employees to explain differences in firm performance. For example, routines (Nelson and Winter, 1982), firm capabilities (Teece, Pisano, and Shuen, 1997), and resources (Barney, 1991) all operate at the organizational, not the individual, level. Even approaches that explain performance differences from a human capital perspective usually view employees as an aggregate resource (Wright, Dunford, and Snell, 2001), and focus on organizational processes for developing human capital rather than individual firm members (Hitt *et al*., 2001). And yet, firms ultimately consist of people whose performance can widely vary. This opens the possibility that, especially in industries with high rates of entrepreneurship or where there are few economies of scale, firm composition—the people who actually make up the firm—may account for much of often widely varying differences in performance among firms. Yet despite the potential importance of individuals in explaining performance differences between firms, there are few prior studies that separate firm performance into individual differences versus organizational factors, with the exception of those studies examining the specialized cases of top management (Bertrand and Schoar, 2003; Crossland and Hambrick, 2011; Lieberson and O'Connor, 1972) and entrepreneurship (Gimeno *et al*., 1997; Johnson, 2007).

The absence of individual differences in explaining performance has an additional consequence. It has prevented a thorough understanding of which individuals actually play a role in determining firm

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performance. It would be reasonable to expect that not all variation among individuals contributes equally to explaining performance differences between firms. Top managers, for example, are generally considered to be important in determining firm performance, as evidenced by many studies on top management teams (Bertrand and Schoar, 2003; Hambrick, Cho, and Chen, 1996; Hambrick and Mason, 1984; Lieberson and O'Connor, 1972; Wiersema and Bantel, 1992). This impact is based on the expectation that the cognitive and personality differences among the most powerful executives in a firm have an influence over strategies and outcomes (Hambrick and Mason,1984), and so would ultimately explain variation in performance of the firms they lead. In other words, we would expect Apple to behave differently depending on whether Steve Jobs or John Scully was chief executive officer (CEO). Much less clear, however, is the impact of variation among the individuals who fill the less formally powerful role of middle manager.

Unlike top managers, middle managers are more constrained by existing organizational context, with the effectiveness of managers in product development depending in large part on the structure of the organization itself (Katz and Allen, 2004; Larson and Gobeli, 1989) and the interaction between top managers and middle managers (Burgelman, 1991, 1994). Although variation among mid-level managers can affect their subordinates (Bidwell and Burton, 2006), at the wider scale of organizational performance, the actions of middle managers are bounded by the nature of the firm (Wooldridge and Floyd, 1990). Therefore, we would expect to see that organizational factors rather than individual factors determine much of the impact of middle management on performance; and, in those cases where variation among individuals in mid-level managerial roles does explain firm performance, we would expect managers charged with creative or innovative tasks to matter more than the 'suits' (project managers), who are given more standardized managerial roles (Pfeffer, 1977). This is because creative, innovative, and knowledge work is generally expected to be highly variable at the individual level (Brooks, 1978; Stephan, 1996), as these types of work rely on skills where there is evidence of wide distributions in innate ability and inspiration. We can only speculate on the relative contributions of individual variation of middle managers to firm performance, however, because no studies measure the performance contribution of the two middle manager types—project managers and managers in charge of innovation—across firms.

This paper addresses that gap by determining the relative contribution of organizational and individual differences on performance with an analysis of the computer game industry. Besides the fact that this industry has features typical of many knowledge-driven industries, games represent a case where the tension between the firm and the individual should be at its most visible. On the one hand, the game industry is almost entirely organized around formal, relatively long-lived firms with well-articulated product strategies; yet, on the other hand, a large driver of industry performance should be the innovative output of key individuals. Additionally, success in the game industry relies not only on managers in charge of innovation but also on project managers capable of organizing dozens of programmers and coordinating budgets that often reach into the tens of millions of dollars. Thus, the computer game industry is an important research site for exploring the contrasts between organizational and individual factors in explaining performance differences, as well as the extent to which creative work (as opposed to managerial work) is responsible for any individual impact on performance.

To that end, the paper employs a multiple membership cross-classified multilevel model (MMCC) analysis of 854 products across multiple companies to examine the role of individuals in innovative and managerial roles as a component in the performance differences between firms. The potentially large role of individuals, however, is more than simply another way to explain performance differences between firms. It also offers a challenge to the expected role of organizational factors in explaining firm performance.

ORGANIZATIONAL FACTORS, INDIVIDUAL FACTORS

In a tradition leading back to Weber (1946) and the ideal of the rational bureaucracy incorporating individuals into a world of routines and structure, the intuition that organizational, industrial, and environmental factors—rather than individual differences—are responsible for variations in firm performance is deeply embedded in organizational

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theory and strategy. In traditional industries where economies of scale and scope are critical, such as manufacturing, there, indeed, seems to be little need to take individuals into account to explain performance. Take, for example, Toyota as described by Adler, Goldoftas, and Levine (1999). With a six-layered bureaucracy, cross-trained workers, and clearly delineated departments, Toyota built a manufacturing powerhouse that integrates workers into a complex mechanism to produce cars efficiently. In the Toyota production system, success is based on routines and organizational processes (Nelson and Winter, 1982) multiplying the effects of the individual workers who are ultimately replaceable and interchangeable with others who have received the same extensive training. The result is a consistent and reliable process that does not rely on any individual worker's skills, but rather firm-level processes to hire and train the appropriate individuals for the appropriate roles.

Focusing on firm-level processes rather than individual variation as the source of performance makes sense in the context of large firms employing economies of scale and scope, as is the case in the Toyota production system. These traditional firms feature professional managers running formal organizations in which no individual, with the possible exception of a few top executives, are irreplaceable, and in which individual contributions account for little variation in performance. However, there is reason to suspect that in many industries, especially those focusing on knowledge work or where there are few economies of scale, individual factors play a critical role in explaining performance differences. Increasing evidence of the impact of individual differences on firm performance across many industries suggests that we may not be able assume that organizational-level processes are the lowest relevant level of analysis in explaining performance differences between firms. For example, we know individual actors can have a significant impact on the performance of large organizations, and even entire industries. The most common example of this is the entrepreneur, whose individual action may influence entire markets (Schumpeter, 1934) and who has a persistent impact on firms long after they are founded (Baron, Hannan, and Burton, 1999; Eisenhardt and Schoonhoven, 1990).

Outside of entrepreneurship, variation among individuals in innovative capacities seems to have a potentially large impact on firm performance. For example, star scientists who operate within firms and universities have significant individual effects on the performance of firms in the biotechnology (Zucker, Darby, and Armstrong, 1998, 2001) and semiconductor (Torero, 1998) industries. Further, the distribution of ability across innovative roles is highly skewed. Software development exhibits extreme individual differences, as studies have demonstrated that a top computer programmer typically produces the same amount of work as 10 to 20 average programmers during any given time period, and with fewer errors (Cusumano, 2004; Sackman, Erickson, and Grant, 1968). A similar skew is found in scientific research, where Lotka's Law observes that just six percent of publishing scientists are responsible for 50 percent of all publications, a difference due at least in part to varying abilities among scientists (Stephan, 1996). In general, there are substantial ranges of variation in performance among individuals in most fields that involve creative and knowledge work (Simonton, 2003). We would, therefore, expect that individuals in innovative roles would contribute to variation in firm performance.

More elusive is the effect of individual managers on firm performance. Recent research on top management teams has shown that CEOs, chief financial officers (CFOs), and other top- level executives can have an effect on large firms, although the magnitude of their impact is limited. Bertrand and Schoar (2003) find that these top positions explain less than five percent of the variation in firm performance among Fortune 800 companies, compared with between 34 percent and 72 percent of the variation explained by firm-level fixed effects. The impact of middle managers, those managers who operate in the levels below C-level executives but above line managers (Wooldridge and Floyd,1990), is much less clear. Middle managers with particular personality traits and positions inside the organization play a role in facilitating innovation (Moss, 1982), communication (Allen, 1971), and selecting projects to pursue (Burgelman, 1991), but the success of managers is heavily dependent on the structure of the organizations in which they are placed (Katz and Allen, 2004). According to this perspective, the impact of middle managers on performance is determined by firm structure and culture, rather than individual differences (King and Zeithaml, 2001; Westley, 1990). Thus, we would expect managers to

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contribute less than innovators to variation, and that much of the impact of managers on performance would appear as organization-level effects. I next test this presumed relationship between managers and innovators and between firms and individuals in the computer game industry.

ANALYSIS

Empirical setting: the game industry

While there are strong theoretical reasons to challenge the idea that variations in firm performance are explained primarily by organizational factors in knowledge work, actually separating individual and firm performance has historically been highly problematic. This is reflected in a literature on firm performance variation that focuses on contributions to firm performance from organizational or industrywide factors, rather than individuals. Instead, factors such as industry structure (Schmalensee, 1985), country-level effects (Makino, Isobe, and Chan, 2004), and routines and capabilities (McGahan and Porter,1997; Roquebert, Phillips, and Westfall 1996; Rumelt, 1991) have been important foci of analysis. The exceptions are a few papers that focus on the role of top managers or entrepreneurs in explaining performance variation (Bertrand and Schoar, 2003; Crossland and Hambrick, 2011; Hargadon and Douglas, 2001).

In particular, the paper by Bertrand and Schoar (2003), who focus on top-level managers in their study, offers the clearest effort so far in teasing apart the roles of individuals and organizations through variance decomposition. Bertrand and Schoar examined the role of top managers in Fortune 800 firms using a fixed effect regression to separate out the effects of individual leaders and firms. They found that the combined effects of CEOs, CFOs, and other top managers on Forbes 800 firm performance explains less than five percent of the variation in firm performance. This is in line with most theories of firm performance: in large, established organizations, the top managers, at least, contribute relatively little to firm performance.

Part of the difficulty of moving beyond top managers in understanding the contribution of individuals to firm performance is that it requires particularly rich data. The dataset must allow the tracking of a wide range of individuals and their jobs longitudinally, something best done with product-level data, with identifiable team members on each project. Firms must use multiple people for the same role and individuals also need to move across multiple firms so that performance is comparable both between and within firms, matching multiple combinations of individual team members and firms over time. Further, it would be useful if the types of roles varied, to encompass both innovative (and therefore more portable and variable) jobs and less portable traditional managerial jobs that presumably are more tied to firm-specific routines and knowledge. Finally, an appropriate industry would offer a dynamic environment of firms, with opportunities for both new ventures and larger, long-standing organizations.

The video game industry matches all of these requirements and offers a particularly valuable perspective into the world of firms and markets. That is because each game has an identifiable, credited team of creators, including a development team of designers, programmers, and artists. These teams, in turn, work for developers, game programming firms ranging from just a few people to several thousand employees. These firms may produce dozens of games a year. Because accurate credits at both the individual and firm level are available for many games developed within the industry, it is possible to precisely trace both the individuals and firms responsible for innovation and entrepreneurship within the industry.

Now nearly 30 years old, electronic gaming software is a major industry, with over $25.4 billion in software revenues in 2005, and over 144,000 full-time employees in the United States alone in 2004 (Crandall and Sidak, 2006). It also straddles the line between creative industries and knowledge-intensive industries, combining elements of entertainment and technological innovation. The dual nature of the game industry is best seen through its two key roles, the managerial role of producer and the innovative role of designer.

Producers, despite the similarity in name, have very little in common with the eponymous position in the entertainment world,[1] matching more

[1] This blurring was sometimes purposeful in the early days of the game industry, when it aspired to the luster of Hollywood. For example, the term 'producer' to describe the role of product manager was first used in 1982 by Trip Hawkins, founder of

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closely the role of project manager in the software industry. A producer 'is ultimately responsible for every aspect of the game. It is the producer's job to make sure that the project is completed on time and on budget, while maintaining a commitment to industry standards' (Irish, 2005: 41). This includes team management, resource allocation, team communication, and external relations ranging from public relations to interfacing with company management.

In fact, the scale of modern game projects rivals most enterprise software efforts, and uses many of the same techniques. Though the size and scope of games widely vary, one game from 2004 may serve as an example of the complexity of the game development process. In that case, the core team consisted of 35 people, who, over the course of 18 months wrote 480,000 lines of code, separated into 740 computer instruction files, with a budget of $7 million (Hardy, 2004). Games can easily reach over 3 million lines of code and cost up to $50 million with hundreds of employees involved, which represents a more significant effort than many business applications. Thus, while innovation and creativity are important in the game industry, the execution of the concept resembles standard software development. It is also critical to note that despite superficial resemblances to Hollywood in areas like job titles, the operation of game companies is much closer to that of other software companies, including incorporation of standard programming techniques, bug testing, and quality assurance.

The second role of interest is that of the designer, who invents game ideas and is in charge of guiding the development team to make his vision a reality. In the words of one guidebook to the industry, 'the game designer is the center of creativity in the game industry. From the designer's vision emerges the entertainment, in the form of game play and story... the game designer needs to be a Renaissance man or woman—they must be able to understand people and story and character, and also to understand logic and sequence and interaction in a very precise way' (Baldwin, 2006: 37, 38). Designers often start their careers as programmers, and are usually very involved in the day-to-day technical work entailed in building a game. While there are a handful of famous game designers, the vast majority is unknown, and, in interviews, even other game designers were not able to recall the names of designers of some of the best-selling games of the past few years.

Between them, designers and producers are responsible for the overall execution of a game. The average game design team in the sample has 56 people, and often several dozen more temporary workers such as voice actors and beta testers. There may be several designers and producers on each project. The designers fill the lead innovative roles, and the producers fill the managerial roles. Having both of these job descriptions allows us to examine the effects of individual differences by job function: innovative roles where we would expect individual variation to be quite high (designers) and managerial roles where presumably variation in performance is less (producers).

These individuals do not operate independently, they are part of firms known as game developers. Game developers are almost always organizations as well as firms; less than one percent of all games with identifiable revenues were the work of lone individuals, and less than 2.5 percent of all games credited fewer than five people. Since video game firms are stand-alone organizations, they are not directly comparable to the diversified companies featured in many variance decomposition efforts (McGahan and Porter, 1997; Roquebert *et al.*, 1996). However, game developers exhibit the characteristics we would expect to see in firms in most industries. For example, the firms in the sample have average life spans that exceed a decade, and, on average, over 200 uniquely identified individuals have participated in each firm's core teams during the life of the firm, though the actual number of employees is likely much larger than the number credited.

In addition to game developers, there is an additional role that firms play in the game industry; that of game publishers. Publishers fund game development and also distribute and market end products for a share of the revenue. Some game developers also operate as publishers, such as Electronic Arts, but the role is often separated into two different companies. Since publishers have little impact on the day-to-day process of game development, they are not dealt with in detail in this study, although potential effects are controlled for in later analyses.

Electronic Arts, who had previously worked as an early in employee of Apple. Despite no experience in films, he choose to use terms from the film industry, in a case of what one industry analyst called 'Hollywood envy.' (Crawford, 1995).

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Additionally, while there are several subsets of the video game market, I have chosen to focus specifically on one segment, personal computer (PC) games, as opposed to console games like those that run on the Nintendo, Xbox, or Sony systems. There are a number of advantages to examining PC games, which make up about 15 percent of all games sales in recent years. First, as compared to the console game industry, barriers to entry are quite small, as the PC is an open platform and there are no requirements imposed by manufacturers as there are with console games. Therefore, we would expect to see the widest diversity of organizational forms in this submarket. Secondly, PC games have tended to be the innovation leader in the game space, since PC technical characteristics were decisively ahead of consoles through 2006—almost all major game genres have begun on the PC first. This is supported by one well-regarded review of game-based innovation, 55 percent of important innovations in gameplay originated on the PC, compared with 17.5 percent on consoles, and the remainder in arcades or other platforms (Adams, 2007). Finally, PC games with low quality graphics but innovative gameplay have been very successful, allowing PC game developers with wide ranges of resources to compete in a market where highly innovative, if primitive looking, games can still find an audience. In contrast, almost all console games need to be at the technical frontiers of a particular system in order to be judged as relevant, making high graphics and sound quality a priority and requiring large teams and significant investment in almost every case, while often discouraging innovation.

Empirical approach

Given this rich research setting, actually decomposing variance in performance among firms, innovators (designers), and managers (producers) is a challenge. Traditional methods of performance decomposition, including nested analysis of variance (ANOVA) (Bertrand and Schoar, 2003; McGahan and Porter, 2002; Rumelt, 1991) and variance composition analysis (VCA) (McGahan and Porter, 1997; Schmalensee, 1985) are problematic. ANOVA can be sensitive to colinearity and the way in which the data is nested, and VCA can yield unreliable results (Hough, 2006). Indeed, a nested ANOVA approach using the data in the sample was highly sensitive to the order of entry, though it roughly confirmed the results of the model used in this paper. Multilevel modeling offers an approach to separating out variance components that avoids many of these issues (Crossland and Hambrick, 2011; Hough, 2006). The dataset has two features that complicate the calculation of the multilevel model, but also allow the estimation of both individual and firm-level effects simultaneously.

The first feature of the data is that it is cross-classified. Individuals move between firms, and are, therefore, not part of a strict hierarchy, as is usually assumed in multilevel modeling. The cross-classification of individuals and firms allows the observation of separate firm and individual effects, though they require techniques that do not assume nested data. The second feature of the data is multiple membership—over a third of games had more than one designer, and over a quarter had more than one producer. Multiple membership requires that the individual contributions to performance be weighted to account for the number of individual designers and producers. Multiple membership cross-classified multilevel models (MMCC), which encompass both of these conditions, have been used in education research to separate out the effects of primary schools, secondary schools, and neighborhoods on student performance (Browne, Goldstein, and Rasbash, 2001). Within this research tradition, recent work by Leckie (2009) on MMCCs with similar structure to this dataset offers an empirical approach to understanding the sources of performance differences among firms.

Since the cross-classification can quickly make the subscripts of the model unwieldy and difficult to parse,[2] the model is written using 'classification notation,' where each level of the model can be written with a single superscript (Browne *et al.*, 2001). The classifications themselves are shown in Figure 1, and the model, derived from Leckie (2009) is as follows:

$$y_i = B_0 + Bx_i + \sum_{j \in producer(i)} w_{i,j}^{(2)} u_j^{(2)} + \sum_{j \in designer(i)} w_{i,j}^{(3)} u_j^{(3)} + u_{firm(i)}^{(4)} + e_i$$

[2] Standard multilevel notation would be $y_{ijkl} = B_{0ijkl} + Bx_i + f_{0l} + v_{0kl} + u_{0jkl} + e_{0ijkl}$ where f is the firm level, v are the weighted producers, and u are the weighted designers for the ith game.

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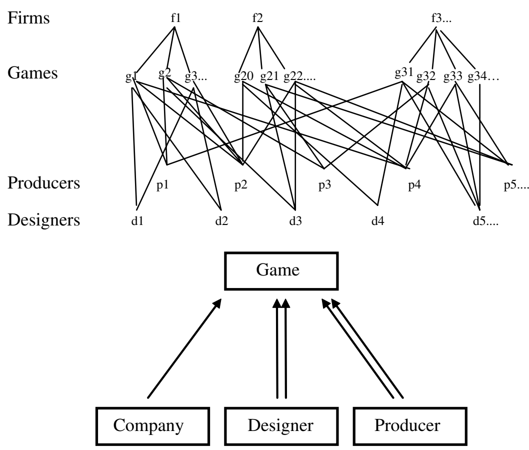

Figure 1. Cross-classification diagram

where:

$$producer(i) \subset (1, \ldots, J^{(2)}); designer(i) \subset (1, \ldots, J^{(3)}); firm(i) \in (1, \ldots, J^{(4)}); i = 1, \ldots, N \sum_{j \in producer(i)} w_{i,j}^{(2)} = 1$$

$$\sum_{j \in designer(i)} w_{i,j}^{(3)} = 1$$

In this case, y_i is the revenue of a game, and $\mathrm{B}x_i$ is the matrix of game-level controls or predictors. There are three levels of classification, identified by the raised parenthetical superscripts and subscripts: (2) for producers, (3) for designers, and (4) for firms. $\sum_{j \in producer(i)} w_{i,j}^{(2)} u_j^{(2)}$ and $\sum_{j \in designer(i)} w_{i,j}^{(3)} u_j^{(3)}$ are producer-level and designer-level random effects weighted for the number of designers and producers working on a game, $u_{firm(i)}^{(4)}$ are firm-level random effects, and e_i are game-level random effects.

The classification functions *producer(i), designer(i),* and *firm(i)* give the set of the producers, designers, and firm for the ith game. As can be seen from the functions, games can have more than one producer or designer, but only one firm. Finally, $w_{i,j}^{(2)}$ and $w_{i,j}^{(3)}$ are the weights for the number of producers and developers on each project, which sum to 1. The model is run using Markov chain Monte Carlo (MCMC) methods in MLwiN for 5,000 iterations with a 500 iteration burn-in (Browne *et al.*, 2001). The MCMC algorithm, as developed by Leckie (2009), is used to estimate the cross-classified multilevel model.

After calculating the model, I then generate the variance partition coefficient (VPC) by taking the variance of each level over the sum of the variance of the other levels and error term (Goldstein *et al.*, 2002). VPC is the proportion of the total variance accounted for by one level of the model compared to the other levels of the model and the level 1 variation that remains once the predictors are accounted for. It is a measure of the residual correlation between two individuals within the same level of the model, and thus it is also known as intra-unit correlation. After controlling for game-level effects, VPC will give us the proportion of variance in game performance explained by designers, producers, and companies, as well as the proportion of variance not explained by any level of the model.

Dataset

For this analysis, I used a unique dataset, the MobyGames database. An Internet repository of game information, MobyGames lists their goal as: '*To meticulously catalog all relevant information about electronic games (computer, console, and arcade) on a game-by-game basis, and then offer up that information through flexible queries and data mining. In layman's terms, it's a huge game database*'[3] MobyGames has information on over 34,000 games, all entered by users of the site on a volunteer basis according to a detailed set of coding instructions. To ensure accuracy, MobyGames requires peer review for all data entered into the database before such data is accepted. Though the database is not complete in that there is not full information for all games, the data are of high quality and normalized to well-established standards established by MobyGames. The dependent variable data come from additional sources, as discussed later.

The full dataset on the PC games industry covers 25 years from 1981 to 2006 and contains 5,794 games with full credits and normalized titles. As will be discussed, the data are further matched with revenue information. Since performance data was limited to commercial games sold between 1994 and 2006, this culled the sample somewhat:

[3] Moby Games FAQ, available at http://www.mobygames.com/info/faq (18 June 2011)

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1,970 credited games had revenue information. These games involved a substantial number of individuals in the development process. Core team sizes ranged from 1 to 395, with a mean of 52 people in the core team for games that have both credits and performance information.

In order to differentiate between firm and individual effects, the analysis includes designers and producers who worked on more than one game, and who worked with other combinations of designers and producers rather than repeatedly being part of the same team at the same company. Dropping games with individuals that did not meet those criteria resulted in a final sample of 854 games using revenue information, accounting for just over $4 billion of revenue. This ultimately allowed me to incorporate 537 individual producers, 739 individual designers, and 395 companies in the revenue model. While designers and producers analyzed will obviously tend to have a longer industry tenure and more games to their credit than the average individual who is not part of the analysis, their project history is generally not significantly different. However, the limit of the analysis to only those individuals who worked on more than one game, and often at more than one company, is a potential cause of concern because of recent research that has discovered that under some conditions skills are not portable between firms (Groysberg, Lee, and Nanda, 2008; Huckman and Pisano, 2006). Comparisons between the sample group and the general population, which can be seen in Table 1, give us some confidence that the sampled designers and producers remain representative.

Table 1. Means for sampled individuals compared to all individuals (sd in parentheses)

	N games	Log(revenue)/game
All designers	4.2	6.15
(N = 3805)	(4.8)	(0.72)
Sample designers	7.5*	6.20
(N = 739)	(6.5)	(0.68)
	N games	Log(revenue)/game
All producers	5.7	6.10
(N = 2827)	(6.0)	(0.72)
Sample producers	9.64*	6.10
(N = 537)	(7.73)	(0.62)

* $p < 0.05$.

Variables

Using the data on individual games, we will use the MMCC model to separate out the extent to which project success is attributable to individual designers, producers, and firms, as opposed to all other factors. I use the revenue generated by a game as a dependent variable, as well as a wide variety of control (or predictor, in MMCC parlance) variables used in the analysis, as can be seen in Table 2.

Dependent variable

Revenue. Between 1995 and 2006, research company NPD Funworld tracked the sales data of every PC game sold through U.S. retail channels for most major retailers, and projected revenues for the rest. This dataset was matched with the MobyGames dataset, and a total of $8.2B worth of revenue was identifiably linked with games in the database. As PC games are, in part, a hit-driven industry (average revenue was $3.2M, but the best-selling PC game of all time, *The Sims*, sold $260M, more than twice its closest competitor), I used the more normally distributed log of revenue (lrevenue) for my analysis.

I excluded from my analysis of revenue all expansion packs, which are value-added games that will only operate with the original software package and that add features or additional gameplay elements. Since the performance of expansion packs on the market is circumscribed by the sales of the games upon which they expand, they are not easily comparable. I did not include ‘casual games’ that consist of card games and puzzle games, ‘adult’-oriented titles, and educational games, as they are generally considered to represent separate markets from the standard PC games industry.

Control/predictor variables

In order to isolate the effects of individuals and firms, I controlled for a number of factors:

Team size: Core team size is a good estimate of cost and effort associated with a game, as personnel costs are the primary expense of most development companies (Rosmarin, 2006). Additionally, a large core team size would indicate a more challenging managerial environment, with more need for coordination among multiple individuals. I use the concept of core team so as to

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Table 2. Descriptive statistics for games in the sample (sd in parentheses)

	Mean	SD	Action	Strat.	Sports	Edu.	RPG	Licensed	Sequel	Pub.	lRev.	Core
Action	0.56		1									
Strategy or simulation	0.50		−0.66	1								
Sports	0.11		−0.24	−0.11	1							
Educational	0.01		−0.01	0.00	0.03	1						
RPG	0.14		0.17	−0.13	−0.09	−0.04	1					
Licensed	0.21		0.07	−0.13	0.17	−0.03	−0.02	1				
Sequel	0.39		−0.08	0.07	0.09	−0.02	0.01	0.06	1			
Publisher	47.18	62.3	−0.14	0.06	0.15	−0.01	0.02	0.12	0.21	1		
Log(revenue)	6.08	.74	−0.07	0.05	−0.02	0.02	0.11	0.10	0.27	0.33	1	
Core team size	53.0	41.2	0.10	−0.15	−0.02	−0.01	0.19	0.06	0.16	0.27	0.36	1
Year	1999.8	0.06	3.5	−0.05	−0.02	−0.02	0.07	0.03	0.16	0.11	0.04	0.31

$N = 854$.

include only those credited individuals who are involved throughout the development of a typical product. This excludes specialized roles such as testers, researchers, voice actors, and movie production crew that are limited to a subset of games. The core team includes designers, producers, programmers, artists, and management. The median team size for games with known revenue is 53, though they range from 2 to 293 in size.

Year: The market for games can vary from year to year, as both the economy and related markets, such as video game consoles, vary. Year controls for the release date of each game in the United States, or the worldwide release date for games that launch in multiple countries.

Genre: Games can be published in a number of genres, ranging from business simulations to 'shoot-em-up' arcade games. These genres may attract different audiences and thus have different market receptions. Since designers and producers could potentially specialize in particular types of games, I control for five separate genres and the combinations thereof: action-adventure, racing and driving, sports, role-playing games (RPGs), and simulation-strategy games. Individual games can be coded with multiple genres, such as a game that includes both role-playing and sports elements. While designers and producers may have particular genres of interest, game developers in the sample as a whole do not tend to specialize in particular genres, and every genre but educational games had at least one third of firms working, at least in part, in that genre. These genres are coded by individuals entering them into MobyGames, and go through at least one peer review before being accepted.

Publisher: In addition to developers, game publishing firms play an important role in the PC game industry. Though the financial effects of publisher funding is captured by team size, there could potentially be an effect where larger publishers, with more resources and more experience, have better ability to develop top titles. I use the total number of games published by a particular publisher through the year prior to the game's launch as a control for any publisher effects on game performance.

Sequel and licensed: Two additional game-level characteristics are whether a game is the sequel of a previous game, and whether it includes licensed content. Licensed content refers to intellectual property from an outside source (such as a movie

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Table 3. Revenue MMCC results

	Coefficient	SE
	Fixed portion of the model	
Core team size	0.005**	0.001
Publisher	0.002**	0.000
Action genre	−0.083	0.066
Education genre	0.410*	0.211
RPG genre	0.169**	0.071
Strategy/Simulation genre	0.015	0.066
Sports genre	−0.186*	0.083
Licensed	0.152**	0.061
Sequel	0.213**	0.047
	Random portion of the model	
Company	0.092**	0.028
Producer	0.096**	0.029
Designer	0.032+	0.025
Error	0.211**	0.022

$^{+}$ $p < 0.10$ * $p < 0.05$ ** $p < 0.01$.
Model includes year controls in fixed portion.
Bayesian deviance information criterion (DIC) = 1345.22 (See Spiegelhalter *et al.*, 2002).

or television program) that has been incorporated into the game. Sequels and licensed content could offer additional name recognition to games, thus boosting their appeal relative to new or unlicensed games.

RESULTS

Table 3 shows the results of the MMCC model. The results are divided into fixed effects and the random effects at the levels of producers, designers, and firms. In Table 3, the fixed game-level controls and the random effects are not comparable, since the values associated with the random portion of the model are not coefficients, but rather components of the overall variance. To understand the contribution of producers, designers, and firms to the variance in revenue, I show the VPC, or the proportion of variance explained by each level of the model controlling for game-level effects (Goldstein *et al*., 2002), in Table 4. Thus, when the paper refers to the proportion of variance explained by a level of the model, it is the proportion of variance in revenue controlling for the effects of genre, year, core team size, and the other control variables mentioned above. The VPC is given for a model containing all individuals, and for a subset of data, discussed below, which includes only those individuals who move between firms.

Table 4. Partition of variance

	Individuals who move firms only	All individuals
Firm	0.155	0.213
Producer	0.241	0.223
Designer	0.063	0.074
Error	0.541	0.431

The analysis shows that behind the veil of the firm, variation in individual managers and innovators has both a large and a significant effect on the success of individual projects. The impact of producers—the mid-level project managers—is especially high. Individual producers account for 22.3 percent of the variation in revenue, after accounting for game-level predictors. Individual designers, perhaps surprisingly, had only a marginally significant impact on revenue, explaining 7.4 percent of variation.[4] In total, the individuals in just these two roles accounted for 29.7 percent of the variation for the products for which they were responsible. Additionally, the individuals with the managerial role of producer explained more of the variation in performance than the individuals who filled the innovative role of designer.

Firms are also significant, though they explain slightly less variation, 21.3 percent, than do individual producers. Additionally, the variation explained at the firm level likely overstates the importance of organizational-level processes relative to individuals because they likely incorporate some of the impact of people whose names and job descriptions do not appear in the credits, such as marketers and company leaders, in addition to other factors that may have been left out of the controls. While some variations in revenue are, of course, attributable to firm-level effects directly, the variations in the performance of individuals for these two roles alone is at least as important.

To test the robustness of this result, the model was applied to only those producers and designers who moved between firms during their career, excluding those who only moved internally within

[4] Removing the developer level from the revenue model, however, reduces the fit and parsimony of the model. The Bayesian deviance information criterion increases from 1345 to 1370 when the developer level is removed. Differences of 10 or more are considered substantive (Spiegelhalter *et al*., 2002).

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organizations, as can be seen in Table 4. This sample of only peripatetic individuals should result in fairly similar contributions from designers and producers, but a lower contribution from firms, since including only moving individuals would likely underemphasize in-firm learning and improvement. As expected, the producer and designer components of variance proved robust compared to the full model (producers explained 24.1% of the variation in revenues, a slight increase, and designers 6.3%, a slight decrease). Also as expected, the contribution of firms to performance variation dropped somewhat to 15.5 percent. These results suggest the robustness of the individual-level measures, and that firm-level contributions to variance, may be, in part, shaped by within-team learning and improvement, rather than only firm-specific routines.

There are a number of limitations to this study. First, the game industry may serve as a special case, with its low capital requirements, low barriers to entry, and relatively fluid employment systems making it more suited to individual achievement than other industries. However, the game industry does echo aspects of other highly innovative industries where entry barriers are low and entrepreneurship is common, such as software, Web services, and biotechnology, and which might serve as future models for study. Also, the fact that managerial producers explained more of the variation in performance than innovative designers indicates that the importance of individuals is not limited to innovative roles, and so is likely not purely an artifact of creative industries.

A second limitation is that some of the characteristics controlled for in the product level of analysis, such as the game genre or publisher, may be the result of selection or strategy by firms, and thus may be part of the firm-level variance. Though developers in the sample did not tend to specialize in any genre, and the average sample developer had 2.8 publishers, it is likely that firms have some control over genre and publisher selection. As a conservative test of the effects of firm strategy over these elements, I reran the MMCC model without publisher or genre controls. This resulted in an increase in the percent of variation explained by the firm from 21 percent to 31 percent, while designer (21%) and producer (6%) contributions to variance stayed roughly similar to the full model. If the increase in variance is explained by firm selection of publisher or genre, 31 percent of variance establishes a useful upper bound for firm contribution, and the differences between managers and innovators is unchanged. However, this change in the variance explained at the firm level may be due to the fact that these controls affect firm-level characteristics. For example, firms have publishers, individual designers and producers do not, so even if firms do not select their publisher, a lack of publisher control will likely affect firm-level variance.

Finally, there is the possibility that some of the variation explained by designers and producers is due to selection by firms, that firms pick the best (or worst) designers or producers for their best (or worst) games, thus increasing the variation explained by individuals at the expense of firms. For most game companies, however, the selection issue is less relevant, because the generation of ideas for games is usually the job of individual designers, sometimes in conjunction with producers. This, in turn, determines initial staffing in most cases, ensuring that selection of producers and designers is not the function of high level firm executives alone. Regardless, the results of the analysis of only those individuals who move between firms (see Table 4) provides some comfort that this effect is likely to be limited. Since moving individuals are less likely to have deep performance records with their new firms, we would expect any team selection by firms to be less informed. If selection does play a major role, we would expect to see some decrease in the variation explained by producers or designers for this sample, but, as Table 4 indicates, the differences are minor.

DISCUSSION AND IMPLICATIONS

These results exceed by a large margin the threshold of the performance derived from individuals that we would expect to see from traditional views of the firm where organizational and environmental, rather than individual, factors drive performance. Especially given that variance is not also partitioned to cover the individual-level contribution from other important team members (such as programmers and artists), it is unclear how significant firm-level processes actually are in explaining performance, but they are, at most, on the same scale as the role played by just one individual

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within the product team. The effects of individuals in this case also greatly exceed those found in Bertrand and Schoar (2003) for top-level executives. Far from being interchangeable, individuals uniquely contribute to the success or failure of a firm.

Additionally, the relative contribution of the two roles—innovators and managers—to firm-level variation is also unexpected. Even in a young industry that rewards creative and innovative products, innovative roles explain far less variation in firm performance than do managers. This is surprising for two reasons. First, we would expect that individual variation in innovative roles would be greater than that of more standardized managerial roles. Second, given the research tradition on the importance of organizational factors to facilitate the success of middle managers (Westley, 1990; Wooldridge and Floyd, 1990), the finding that individual managers account for more variation in performance than firm-level factors on some occasions is particularly intriguing.

Rather than acting as cogs in the machine dwarfed by organizational-level effects, the effect of managers on firm performance was actually larger than that of organizational factors, implying that individual managerial differences play an outsized role in firm performance, even over the $4 billion in revenue generated by games in the sample. Though this finding might seem surprising at the scale of firms and industries, it is supported by intrafirm-level research on the role of middle managers in the innovation process.

Recent research on the role of individuals and groups in industries as diverse as consulting (Hargadon and Bechky, 2006) and comic books (Taylor and Greve, 2006) supports a longer literature on project management (see Brown and Eisenhardt, 1995) that has demonstrated the complex interaction between individuals and teams in successful innovation. The finding that managers have significantly more impact on firm performance than individual innovators aligns with this tradition. It suggests that high performing innovators alone are not enough to generate performance variation; rather, it is the role of individual managers to integrate and coordinate the innovative work of others.

One insight into this phenomenon can be found in the work of Bower (1970) and Burgelman (1983, 1991) on the often complex internal ecologies of firms. Drawing on the evolutionary model of variation, selection, and retention (Aldrich, 1999), Burgelman (1991) views middle managers as the agents of selection, while innovative managers serve as sources of variation, generating the ideas from which the 'suits' select. Burgelman's (1991) process model would suggest that the large amount of variation explained by the managers relative to the innovators may be due to this selection role. From this perspective, innovators may still be the source of all new game ideas and concepts, but since the managers decide which ideas are actually allocated resources, it is the managers' selection ability that is ultimately measured in the model.

Indeed, this resource allocation perspective likely explains part of why middle managers account for more variation in performance than innovators, but it is not a complete picture. In the video game industry, the separation between the variation and selection roles is less clear than at Intel and other large firms. Designers are not merely sources of variation but also, by necessity, are responsible for part of the selection process as well. Since games represent a complex system, designers have to be able to optimize their work within constraints, or risk having the entire system collapse when a single element is removed due to resource limitations. In the words of Rouse, 'It is a very rare case indeed for a designer to be able to think of whatever game she wants and then search out the perfect implementation of that idea. In almost all cases, the designer is limited by the situation that is presented to her... Though the producer is primarily responsible for making sure that the game is on time and on budget, the designer must concern herself with all of the limitations she is faced with' (2005: 53).

Additionally, the performance variation explained by middle managers is relatively constant even if we consider only those managers who move between firms. Previous process models, which examine resource allocation at larger firms (Bower, 1970; Burgelman, 1983, 1994), place considerable emphasis on the ways in which middle managers, as agents of selection, understand and execute the strategy developed by senior management. Where firms with farsighted top managers are able to communicate strategy to middle managers, the selection process is more likely to be beneficial (Burgelman, 1994). In this case, however, the importance of middle managers persists across multiple firms, each of which has its own

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strategy and process for carrying out that strategy. This suggests that differences in middle managers themselves, and not just their selection role in the internal ecology of particular firms, explains part of the variation in performance.

The selection function of middle managers is still salient for producers, and explains part of why they account for so much variation in performance. However, the selection role played by middle managers is of a different tenor than that of organizations where economies of scale or scope are important. It is more likely to occur working in conjunction with innovators, rather than as a separate selection process between frontline managers and top management that determines which ideas are to be pursued (Burgelman, 1994). The result is a process that depends heavily on the individual skills of middle managers to facilitate and guide innovative teams through the selection process, and less on their role as the layer between top management and innovators. Middle managers may ultimately decide which ideas proceed, and which are not selected, but they may do so best by working with innovators directly, as happens in the game industry. For example, good managers may be able to help whittle down a designer's product ideas into a realistic project plan, while a less capable manager working with a more capable designer may be unable to translate a better design into reality.

In addition to their selection role, middle managers may play a greater part in producing variation than is often credited to the much maligned 'suits' in creative industries. Indeed, the role of middle managers in facilitating team performance is supported by the product development literature (Brown and Eisendhardt, 1995), which suggests that managers may play a crucial role in motivating team creativity and performance. Additionally, it is likely that certain managers are good at facilitating the sort of collective creativity that results in high quality products (Hargadon and Bechky, 2006), while others are less capable of making their teams more than the sum of their parts. Finally, producers may also interact directly with designers to contribute creative concepts themselves. Regardless of the details of the mechanism, it suggests that the oft overlooked middle manager may play a far greater role in industrywide innovation than is typically acknowledged.

CONCLUSION

While any population of firms is ultimately heterogeneous at some level of analysis, the general assumption has been that variations in firm performance are largely the result of processes, rather than people. Using MMCC, this paper argues that the performance of organizations may actually vary greatly as the individuals within the firms vary. Further, it is the individuals who fill the role of middle managers—the 'suits'—rather than the creative innovators that best explain variation in firm performance. While these findings may vary across and even within industries, they suggest that scholars should pay more attention to the individual makeup of organizations, rather than focusing solely on organizational-level characteristics. Finally, this paper underlines the importance of middle managers, who are critical to firm performance even in highly innovative industries, and suggests the need for further research into the mechanisms by which middle managers influence firm performance.

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REFERENCES

Adams E. 2007. 50 greatest game design innovations. *Edge Magazine*: 1 November.

Adler PS, Goldoftas B, Levine DI. 1999. Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science* **10**(1): 43–68.

Aldrich HE. 1999. *Organizations Evolving*. Sage Publications: Thousand Oaks. CA.

Allen TJ. 1971. Communications, technology transfer, and the role of technical gatekeeper. *R&D Management* **1**(1): 14–21.

DOI: 10.1002/smj

Baldwin M. 2006. Career paths in the game industry. *Journal of Advancing Technology* **4**(Summer): 35–43.
Barney J. 1991. Firm resources and sustained competitive advantage. *Journal of Management* **17**(1): 99–120.
Baron JN, Hannan MT, Burton MD. 1999. Building the iron cage: determinants of managerial intensity in the early years of organizations. *American Sociological Review* **64**(4): 527–547.
Bertrand M, Schoar A. 2003. Managing with style: the effect of managers on firm policies. *Quarterly Journal of Economics* **118**(4): 1169–1208.
Bidwell M, Burton MD. 2006. *Thinking about employment: how managerial reward assumptions shape the employment relationship*. Working paper MIT: Cambridge, MA.
Bower JL. 1970. *Managing the Resource Allocation Process*. Harvard Business School Press: Boston, MA.
Brooks FP Jr. 1978. *The Mythical Man-Month and Other Essays on Software Engineering*. Addison-Wesley Longman: Boston, MA.
Brown SL, Eisenhardt KM. 1995. Product Development: past research, present findings, and future directions. *Academy of Management Review* **20**(2): 343–378.
Browne WJ, Goldstein H, Rasbash J. 2001. Multiple membership multiple classification (MMMC) models. *Statistical Modelling* **1**(2): 103–124.
Burgelman RA. 1983. A process model of internal corporate venturing in the diversified major firm. *Administrative Science Quarterly* **28**: 223–244.
Burgelman RA. 1991. Intraorganizational ecology of strategy making and organizational adaptation: theory and field research. *Organization Science* **2**: 239–262.
Burgelman RA. 1994. Fading memories: a process theory of strategic business exit in dynamic environments. *Administrative Science Quarterly* **39**: 24–56.
Crandall RW, Sidak JG. 2006. Video games: serious business for America's economy. Report, Entertainment Software Association. Available at: Available at SSRN: http://ssrn.com/abstract=969728 (18 June 2011).
Crawford C. 1995. Hollywood envy. *Interactive Entertainment Design* **8**.
Crossland C, Hambrick DC. 2011. Differences in managerial discretion across countries: how nation-level institutions affect the degree to which CEOs matter. *Strategic Management Journal* **32**(8): 797–819.
Cusumano MA. 2004. *The Business of Software: What Every Manager, Programmer and Entrepreneur Must Know to Succeed in Good Times and Bad*. Simon and Schuster: New York.
Eisenhardt KM, Schoonhoven CB. 1990. Organizational growth: linking founding team strategy, environment, and growth among U.S. semiconductor ventures, 1978–1988. *Administrative Science Quarterly* **35**(3): 504–529.
Gimeno J, Folta TB, Cooper AC, Woo CY. 1997. Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms. *Administrative Science Quarterly* **42**(4): 750–783.
Goldstein H, Browne W, Rasbash J. 2002. Partitioning variation in multilevel models. *Understanding Statistics* **1**(4): 223–231.
Groysberg B, Lee L-E, Nanda A. 2008. Can they take it with them? The portability of star knowledge workers' performance. *Management Science* **54**(7): 1213–1230.
Hambrick DC, Cho TS, Chen MJ. 1996. The Influence of top management team heterogeneity on firms' competitive moves. *Administrative Science Quarterly* **41**(4): 659–684.
Hambrick DC, Mason PA. 1984. Upper echelons: the organization as a reflection of its top managers. *Academy of Management Review* **9**(2): 193–206.
Hardy Q. 2004. Ordinary Hero. *Forbes*, 4 October. Hargadon AB, Bechky BA. 2006. When collections of creatives become creative collectives: a field study of problem solving at work. *Organization Science* **17**(4): 484–500.
Hargadon AB, Douglas Y. 2001. When innovations meet institutions: Edison and the design of the electric light. *Administrative Science Quarterly* **46**(3): 476–501.
Hitt MA, Bierman L, Shimizu K, Kochhar R. 2001. Direct and moderating effects of human capital on strategy and performance in professional service firms: a resource-based perspective. *Academy of Management Journal* **44**(1): 13–28.
Hough JR. 2006. Business segment performance redux: a multilevel approach. *Strategic Management Journal* **27**(1): 45–61.
Huckman R, Pisano G. 2006. The firm specificity of individual performance: evidence from cardiac surgery. *Management Science* **52**(4): 473–488.
Irish D. 2005. *The Game Producer's Handbook*. Thomson Course Technology: Boston, MA.
Johnson V. 2007. What is organizational imprinting? Cultural entrepreneurship in the founding of the Paris Opera. *American Journal of Sociology* **113**(1): 97–127.
Katz R, Allen TJ. 2004. Organizational issues in the introduction of new technologies. In *The Human Side of Managing Technological Innovation: A Collection of Readings*, Katz R (ed). Oxford University Press: New York; 450–463.
King AW, Zeithaml CP. 2001. Competencies and firm performance: examining the causal ambiguity paradox. *Strategic Management Journal* **22**(1): 75–99.
Larson EW, Gobeli DH. 1989. Significance of project management structure on development success. *IEEE Transactions on Engineering Management* **36**(2): 119–125.
Leckie G. 2009. The complexity of school and neighbourhood effects and movements of pupils on school differences in models of educational achievement. *Journal of the Royal Statistical Society: Series A (Statistics in Society)* **172**(3): 537–554.
Lieberson S, O'Connor JF. 1972. Leadership and organizational performance: a study of large corporations. *American Sociological Review* **37**(2): 117–130.
Makino S, Isobe T, Chan CM. 2004. Does country matter? *Strategic Management Journal* **25**(10): 1027–1043.
McGahan AM, Porter ME. 1997. How much does industry matter, really? *Strategic Management Journal*, Summer Special Issue **18**: 15–30.

DOI: 10.1002/smj

McGahan AM, Porter ME. 2002. What do we know about variance in accounting profitability. *Management Science* **48**: 834–851.

Moss KR. 1982. The middle manager as innovator. *Harvard Business Review* **60**(7): 94–106.

Nelson RR, Winter SG. 1982. *An Evolutionary Theory of Economic Change*. Belknap Press: Cambridge, MA.

Pfeffer J. 1977. The ambiguity of leadership. *Academy of Management Review* **2**(1): 104–112.

Roquebert JA, Phillips RL, Westfall PA. 1996. Markets vs. management: what 'drives' profitability? *Strategic Management Journal* **17**(8): 653–664.

Rosmarin R. 2006. Why Gears of war costs $60. *Forbes*, 19 December.

Rouse R III. 2005. *Game Design: Theory and Practice*. Wordware Publishing: Sudbery, MA.

Rumelt RP. 1991. How much does industry matter. *Strategic Management Journal* **12**(3): 167–185.

Sackman H, Erikson WJ, Grant EE. 1968. Exploratory experimental studies comparing online and offline programming performance. *Communications of the ACM* **11**(1): 3–11.

Schmalensee R. 1985. Do markets differ much. *American Economic Review* **75**(3): 341–351.

Schumpeter JA. 1934. *Theory of Economic Development: An Inquiry Into Profits, Capital, Credit, Interest, and the Business Cycle*. Harvard University Press: Cambridge, MA.

Simonton DK. 2003. Exceptional creativity across the life span: the emergence and manifestation of creative genius. In *The International Handbook on Innovation*, Shavinina LV (ed), Elsevier: Oxford, UK; 293–308.

Spiegelhalter DJ, Best NG, Carlin BP, van der Linde A. 2002. Bayesian measures of model complexity and fit. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)* **64**(4): 583–639.

Stephan PE. 1996. The economics of science. *Journal of Economic Literature* **34**(3): 1199–1235.

Taylor A, Greve HR. 2006. Superman or the Fantastic Four? Knowledge combination and experience in innovative teams. *Academy of Management Journal* **49**(4): 723–740.

Teece DJ, Pisano G, Shuen A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* **18**(7): 509–533.

Torero M. 1998. Analyzing the spillover mechanism on the semiconductor industry in the Silicon Valley and Route 128. *Essays on Diffusion of Technical Change*. PhD. diss. Department of Economics, University of California at Los Angeles, Los Angles, CA.

Weber M. 1946. Bureaucracy. *From Max Weber: Essays in Sociology.* Routledge: Oxfordshire, UK; 196–266.

Westley FR. 1990. Middle managers and strategy: microdynamics of inclusion. *Strategic Management Journal* **11**(5): 337–351.

Wiersema MF, Bantel KA. 1992. Top management team demography and corporate strategic change. *Academy of Management Journal* **35**(1): 91–121.

Wooldridge B, Floyd SW. 1990. The strategy process, middle management involvement, and organizational performance. *Strategic Management Journal* **11**(3): 231–241.

Wright PM, Dunford BB, Snell SA. 2001. Human resources and the resource-based view of the firm. *Journal of Management* **27**(6): 701–721.

Zucker LG, Darby MR, Armstrong J. 1998. Geographically localized knowledge: spillovers or markets? *Economic Inquiry* **36**(1): 65–86.

Zucker LG, Darby MR, Armstrong JS. 2001. *Commercializing knowledge: university science, knowledge capture, and firm performance in biotechnology*. NBER Working paper no. 8499. National Bureau of Economic Research: Cambridge, MA.

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