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Going underground: bootlegging and individual innovative performance

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Abstract

In order to develop an innovation in a large, mature organization, individuals often have to go underground, secretly undertaking ?bootleg? R&D activities that have no formal organizational support. As yet, there have been few studies that examine how such efforts shape the ability of an individual to generate innovations for their organization. We argue that these underground R&D efforts will help individuals ? through greater exploration, bricolage and commitment ? overcome the challenges associated with the development of innovations in mature organizations. After carefully assessing the direction of causality, we find that individuals? bootlegging efforts are associated with achieving high levels of innovative performance, including radical innovations. Using a major organizational change towards formalization as our research setting, we find that those who increase bootlegging during times of intensifying

formalization are less likely to be recognized as being innovative, whereas their chances of developing radical innovations increase. We explore the implications of the management of innovation.

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GOING UNDERGROUND:
BOOTLEGGING AND INDIVIDUAL INNOVATIVE PERFORMANCE

Developing innovations in a large, mature organization can be difficult, as these innovations may go against established routines and cannibalize existing investments and assets (Dougherty & Heller, 1994). To develop these innovations, individuals are often forced to go around formal rules, procedures and monitoring systems (Burgelman, 1983; Kanter, 2000). These rules and systems may not allow individuals the flexibility they require to develop innovations, which often conflict with established modes of working and may fall foul of internal selection processes (Benner & Tushman, 2003; March & Simon, 1958; Van de Ven, 1986). Going underground, or secretly conducting R&D efforts may allow individuals to tinker around with new ideas, digging into valuable new opportunities (Abetti, 1997; Aram, 1973; Augsdorfer, 1996). They may also help sustain efforts on ideas that have been rejected by formal management systems (Mainemelis, 2010).

The existence of underground or informal R&D efforts by scientists and engineers is frequently commented upon, but only rarely measured or analyzed (for a review, see Augsdorfer, 2005). Named after the practice of hiding alcohol in one's boots during US prohibition in the 1920s, these underground activities are often referred to as 'bootlegging'. Following Augsdorfer (2005: 2), bootlegging can be defined as: "research in which motivated individuals secretly organize the corporate innovation process. It is usually a bottom-up, non-programmed activity, without official authorization from the relevant management, but nevertheless for the benefit of the company". Thus, bootlegging differs from the 'free-time' models of innovative support, such as 3M's 15% rule, in the sense that it has no formal organizational support (Gundling & Porras,

2000). Bootlegging efforts are initiated by individuals and therefore differ from skunk works and other structured initiatives that focus on radical innovation within separate dedicated units, working outside the normal rules of the organization (Rich & Janos, 1994; Tushman & O'Reilly, 1996). Bootlegging also appears to be focused on achieving organizational goals rather than individual ones, and therefore it is not a form of 'hobby' innovation (Dahlin, Taylor, & Fichman, 2004). Finally, the concept of bootlegging should not be considered unethical pro-organizational behavior (Umphress & Bingham, 2011); despite the fact that bootlegging is a form of deviant behavior directed towards organizational goals, it does not involve actions that violate societal norms, values or rules of proper conduct.

Although we have some insight into the presence of bootlegging in the R&D process, there have been few attempts to measure and assess the importance of these bootlegging efforts on an individual's ability to generate innovations for their organization. Drawing on a rich sample of R&D scientists and relying on the development of a new bootlegging measurement scale, we suggest – and empirically substantiate – that bootlegging efforts will increase the likelihood of an individual to generate innovations. We put forward that engaging in bootlegging provides three types of advantages to individuals: *explorative*, *bricolage* and *commitment*. Through bootlegging, individuals can explore more widely and deeply, as they are less liable to be constrained by formal systems and relationships. Bootlegging efforts may also imply that individuals are better at bricolage, improvising ways of working with limited resources to find new combinations (Baker & Nelson, 2005; Weick, 1993). In addition, due to the proactive nature of bootlegging, individuals who engage in bootlegging will demonstrate greater commitment to their ideas, helping them overcome the numerous hurdles that face an innovation in a mature, large organization (Amabile, 1996). In the case of radical innovation, the rewards of bootlegging for

individuals are also likely to be great as individuals who work outside the official system of R&D management will be able to behave more 'foolishly' than their non-bootlegging colleagues, allowing them to break away from existing categories and routines (March, 2006).

Drawing on a quasi-natural experiment in our research setting, we also explore how changes in bootlegging efforts during a period of formalization in the R&D process – an increase in the extent of written rules and procedures governing work - shapes the likelihood of innovating. We suggest that increasing bootlegging during this period lowers the likelihood that an individual will be recognized as being innovative; while it increases the chances they will develop radical innovations. We find support for these expectations.

The paper makes three contributions. First, we contribute to the development of theories of proactive and creative deviant behavior inside organizations (Crant, 2000; Mainemelis, 2010; Unsworth, 2001), demonstrating that underground innovation may be a crucial building block towards realizing large corporations' ambition to be leading (radical) innovators. Second, we advance our understanding of the tactics that individuals can use to overcome the hurdles that innovations face in mature organizations, providing insights in the source of corporate entrepreneurship and strategic renewal (Burgelman, 1983). Finally, our study helps unearth how movements toward formalization impact the value of deviance and conformance within organizations, using bootlegging by R&D scientists and engineers as an example of such behavior. This approach allows us to gain insights into how reactions to organizational change can stimulate or even retard innovative outcomes for individuals and their organizations (Bercovitz & Feldman, 2008).

BOOTLEGGING IN R&D ORGANIZATIONS

In the search for creative outputs from their staff, organizations often provide autonomy to individuals to enable them to take initiative on their own behalf (Amabile, 1996; Bailyn, 1985; Parker, Williams, & Turner, 2006). R&D organizations are characterized by the employment of highly skilled individuals, who work on complex and difficult projects. By providing individuals with space for 'slack search', organizations encourage 'a thousand flowers to bloom' as individuals will have the opportunity to initiate their own projects (Kanter, 2000; Levinthal & March, 1981). To support this, some organizations provide their R&D staff with a share of their time for personal projects. For example, Google provides 20% of staff time for personal projects and estimates that 50% of their innovations have arisen from these efforts (Iyer & Davenport, 2008).

The desire to ensure autonomy in the search for new ideas, however, needs to be balanced by the requirement to allocate resources effectively and to 'scale-up' any promising ideas (Burgelman & Grove, 2007). In other words, letting a thousand flowers bloom may produce a garden full of weeds (Kanter, 2000; Sharma, 1999). As a result, new models of R&D stress the importance of formal project and program management to ensure that the R&D budgets of large, mature firms are put to productive and efficient use. For example, large R&D spenders often use 'stage-gates' to manage their projects (Cooper, 1990; Roussel, Saad, & Erickson, 1991; Schilling, 2005). These processes are meant to ensure that individuals within R&D organizations devote their time to projects that are aligned with the needs and goals of the organization. They also provide a setting in which the ideas of different individuals can be judged against one another on the basis of neutral criteria, helping to alleviate bias in the selection process within organizations. These selection criteria – which are often based on expected financial returns and development

costs – help ensure that the R&D budget is distributed into a balanced portfolio that meets short- and long-term objectives. While most often applied to the management of downstream innovation projects, it is increasingly common to apply these formal methods also to the front end of the innovation process (Cooper & Edgett, 2009).

Although, in theory, R&D management helps overcome the dangers of too much autonomy leading to 'a garden full of weeds', they also create challenges for R&D staff. These programs require R&D staff to fit their projects into project management approaches that may not be well suited to capturing the specific features of the R&D process itself, with its inherent uncertainty. As Nelson and Winter (1977: 51) suggest:

> *The enormousness of the set of possible projects, the inability to make quick cheap reliable estimates of benefits and costs, and the lack of convenient topological properties to permit sequential search to hone in rapidly on good projects independently of where that search starts, means that project choice, as well as outcome given choice, must be treated as stochastic.*

This means that formal rules and procedures may constrain the flexibility and creativity that are required for the exploration of new valuable opportunities and therefore limit the scope for experimentation (Benner & Tushman, 2002; Burns & Stalker, 1961; Jansen, Van Den Bosch, & Volberda, 2006; March & Simon, 1958). Therefore, in order to resolve these challenges, researchers may need to work underground for a considerable time, nurturing an idea before bringing it into the daylight of the formal management system (Augsdorfer, 1996). Since the uncertainty in a project can only be resolved with greater search and development efforts, there is a tendency for individuals to continue working on projects even if they are formally rejected by the organization (Mainemelis, 2010). In this respect, R&D professionals are well aware of the unpredictability of project outcomes and therefore may be unwilling to abandon their efforts on the basis of a negative committee evaluation. Moreover, such management systems may restrict

the development of novelty, as innovative ideas that cannot demonstrate a clear market are often rejected in the stage-gate process (O'Connor & DeMartino, 2006). In doing so, they may lead large firms to undertake incremental projects, in turn leading to the often-cited inability of large firms to develop radical innovations (Ahuja & Lampert, 2001).

In this context, bootlegging can be seen as a behavior whereby individuals take personal initiative at work, which is associated with an active and self-starting approach to work (Frese, Kring, Soose, & Zempel, 1996). Those individuals who exhibit such proactive behaviors are likely to make persistent efforts, often in the face of considerable barriers and going beyond formal requirements. As part of such efforts, individuals may engage in proactive creativity, actively searching for problems to solve and generating unsolicited new solutions (Unsworth, 2001). Even though bootleggers work for the benefit of the organization, it qualifies as a risky behavior because individuals deviate from their formal work plans, and work without formal consent and possibly the awareness of their relevant managers. In extreme cases, bootlegging can even be seen as a form of creative deviance, where individuals continue to undertake work on projects that have been formally stopped by management (Mainemelis, 2010).

Although the literature on bootlegging and the associated concepts of proactive creativity and creative deviance have received increasing attention in recent years, there are few, if any, studies that investigate how these behaviors may impact on individual's performance in terms of generating innovations for their organizations. Moreover, there are no attempts to explore how the value of such efforts may change during periods of formalization in the organization. To meet this challenge, we explore two questions: *does bootlegging pay for individuals and for their wider organizations* and *how do attempts to increasing formalization of the R&D process shape the value of bootlegging for individuals?*

HYPOTHESES

The primary purpose of R&D is to generate practicable ideas that can be commercialized or implemented into new products and processes and therefore individuals in R&D organizations are assessed on the basis of their efforts contributing to this goal. However, given the tensions between the R&D process and the management processes that attempt to govern it, individuals have to proactively shape their work environment, balancing opportunities for creativity with the integration of new ideas into their organization's formal processes. In response to this requirement, researchers differ in how they approach the R&D process, allocating their time between different sources (internal and external) and activities (Allen, 1977). Such choices can have important implications for individual's abilities to find new products, processes and services. In this context, bootlegging is not simply a one-off activity; it is rather an approach to R&D work whereby individuals partly operate outside the formal system to develop new ideas through informal pre-project work or continuation with rejected projects (Augsdorfer, 2005).

There are three reasons to suggest that bootlegging may be associated with individual-level innovativeness. Drawing from theories of organizational learning, we label these advantages: *explorative*, *bricolage* and *commitment*. First, bootleggers have an advantage over their non-bootlegging colleagues because they can work more flexibly, as they operate outside the 'straightjacket' of formal management systems. Such formal systems may constrain the flexibility and creativity that are required for the exploration of new valuable opportunities (Benner & Tushman, 2002). By working outside these systems as well as within them, bootleggers can explore ideas without the requirement to document, justify and codify elements of the idea until it is reasonably well developed. This gives them a secondary channel to informally elaborate new ideas (Mainemelis, 2010). Bootleggers can also develop informal

relationships with external actors, often operating at the margins of the organization's formal networks. This can be a particular advantage in a large multinational, which may have strong intellectual property requirements that need to be satisfied before individuals are allowed to work with external parties (Alexy, Criscuolo, & Salter, 2009). By working in this manner, bootleggers will have more freedom to undertake more expanse search efforts than non-bootleggers, enabling them to gain an *explorative advantage* over their more constrained colleagues (March, 1991).

Second, by going underground, individuals lose formal access to resources that they may need to establish the validity of their idea. Although such loss of resources may be harmful to the development of new ideas, it also opens opportunities for individuals to creatively work around the formal system, gathering resources from wherever they may be found. In these efforts, individuals may be able to secure resources from other colleagues to further develop the idea, without having to obtain senior buy-in through the formal management system, which can be time consuming and difficult to obtain (Garud & Karnøe, 2003). This means that they are able to improvise solutions by working with available materials and resources or 'making do with what is at hand' through bricolage (Baker & Nelson, 2005; Levi-Strauss, 1966; Weick, 1993). They may "act as scavengers, reaching for hidden or forgotten resources to demonstrate feasibility" (Burgelman, 1983: 238). In contrast, those individuals who rely on more formal systems may be less able to improvise solutions, as they have to wait for formal approvals from potentially resistant groups in the firm. In sum, those individuals who engage in bootlegging are able to operate faster and even stealthily to further their ideas and, in doing so, they may able to obtain *bricolage advantage* over their colleagues.

Third, to ensure that an innovation progresses in a mature organization, individuals have to undertake considerable efforts to overcome many entrenched barriers (Dougherty, 1992). Critical

to this effort will be the level of commitment, energy and enthusiasm shown by individuals for their ideas (Howell & Higgins, 1990). Since bootleggers work on ideas that have arisen from their creative, proactive efforts, they are likely to have a greater commitment – or self-determination – to overcome these hurdles (Amabile, 1996). Such commitment – what we call a *commitment advantage* – may lead them to invest more time and endeavor in revising, honing and trialing their ideas than their colleagues who engage in less bootlegging. They may even persist with ideas in the face of repeated antagonism by colleagues (Markham, 2000). Such persistence and enthusiasm will help to ensure that they construct a more compelling story about the merits of their idea to convince their organizational counterparts of its validity, helping to surmount the numerous barriers that stand in the way of the idea being realized by the organization. Taking the three types of advantage together, we posit:

Hypothesis 1: There will be a positive relationship between individuals bootlegging activity and their innovative performance.

Within the literature on bootlegging, there is contradictory evidence on whether bootleg efforts are more incremental or radical in nature. Knight (1967) suggests that bootlegging leads to radical innovations, whereas Augsdorfer (1996) suggests they lead to more incremental ones. However, given that radical innovation in large and mature organizations is often illegitimate (Dougherty & Heller, 1994), we argue that bootlegging may be a necessary element to ensure the development of radical, breakthrough ideas. First, Smith (2003) showed that creatively deviant activities within organizations often follow unconventional pathways of development. These pathways lead them away from established norms and ways of working, and may allow

individuals to establish new categories within the organization (Mainemelis, 2010).[1] In addition, as Burgelman and Sayles (1986) note, radical ideas often emerge from the bottom-up in organizations, as a result of the pro-active efforts of individuals rather than as a product of structured decision-making or managerial strategy. This means they are likely to arise from bootlegging, as these innovative efforts arise outside the framework of managerial control and are not directed to meeting short-term strategic considerations (Burgelman, 1983). Second, since bootleg efforts tend to be unstructured and resulting from personal initiative, they are likely to involve wider search efforts along unconventional paths, as they do not require individuals to link their search efforts to the requirements or needs of the organization from the outset (O'Connor & McDermott, 2004). In this sense, bootleg projects allow individuals to be 'foolish', overcoming established norms (March, 2006). Third, as bootleg efforts occur outside formal selection mechanisms, they are able to overcome the 'tyranny of measurement' that besets many R&D projects in large, mature firms (McDermott & O'Connor, 2002). In formal selection processes, novel ideas may be rejected as they cannot provide sufficient evidence of their future rewards or because they are discordant with what is already known (Cheng & Ven, 1996; March, 1991). In the case of radical innovation, such imprecision may, however, be a necessary precursor to true novelty. Thus,

Hypothesis 2: There will be a positive relationship between individuals bootlegging activity and their ability to generate radical innovations.

Through the use of formal R&D management approaches, many organizations have sought to place more formal structure around the fuzzy front end of the innovation process (Cooper & Edgett, 2009; Kim & Wilemon, 2002; Reid & de Brentani, 2004). However, these attempts to

[1] For example, a bootleg project may require different methods of manufacturing than those routinely undertaken by the organization. Internal manufacturing managers are likely to resist attempts to change their processes without clear, unambiguous evidence of future benefits, as such changes will be administratively and financially costly to them (Dougherty 1992).

formalize the early stages of the innovation process can represent a major change in the way many scientists and engineers' work (Bercovitz & Feldman, 2008). Such efforts at formalization require individuals to bring their early R&D ideas in 'from the cold' to be subjected to formal scrutiny and assessment by their colleagues and the wider organization. As a response to this formalization, some individuals may do less bootlegging, signaling their conformity to the organizational change (Warren, 2003), whereas others may deviate from this requirement and increase their bootlegging efforts.

The decision to conform – to lower one's bootlegging efforts in the face of organizational pressures towards greater formalization – may provide individuals with some significant advantages in terms of perceived innovative achievements over colleagues who deviate from these requirements. Individuals who reduce their bootlegging during a period of formalization – while still undertaking some bootlegging efforts[2] – may find that their innovative efforts are increasingly seen as valid and beneficial. Their decision to do less bootlegging signals their alignment with organizational norms and expectations. In contrast, in an attempt to retain their autonomy – and potentially in frustration with the implemented organizational change – individuals may respond to the organization's desire to control their behavior by increasing their level of deviance (Lawrence & Robinson, 2007). Those individuals who increase their bootlegging efforts during this period of formalization may find that many of their innovative efforts deemed illegitimate, and therefore will be less likely to be recognized by the organization for the outcomes of these efforts. Bootleggers may also find that when they seek to turn their bootleg efforts into formal projects or reintroduce previously rejected ideas, these options likely to be unacceptable to the wider organization as the products of these increased bootleg efforts –

[2] To be clear, the logic here is not inconsistent with our argument for H1 as here we focus on *changes* in the levels of bootlegging efforts during periods of formalization, whereas in H1, we focus on the *level* of bootlegging effort.

regardless of their merits – are spurned to ensure compliance with the goal of greater formalization. In such a work environment, managers may not be willing (or even allowed) to tolerate their staff from deviating from established rules. Moreover, bootlegging during a period of formalization may increase the likelihood that individuals are punished from breaking away from their official work allocation and these sanctions may limit the ability of an individual to be able to convert their ideas into innovations. Thus,

Hypothesis 3a: Individuals who increase their bootlegging activity during a period of increased formalization will be less likely to achieve high innovative performance.

These patterns, however, may differ in the case of radical innovation. The increasing formalization of the R&D process, especially at the early stages, may strangle radical ideas before they have had the chance to mature. As March (2006: 210) suggests "[m]ost attempts to distinguish creative instances of craziness from useless or dangerous ones at an early stage impose criteria of conventionality on craziness and thereby impose self-defeating filters that reduce novelty". Thus, the requirementto document, justify and demonstrate potential outcomes can go against undertaking radical initiatives that break away from established operating routines and whose value cannot be determined without subsequent development (Garcia & Calantone, 2003; McDermott & O'Connor, 2002). In this context, increasing bootlegging efforts during a period of formalization in the organization may provide individuals with opportunities to take greater risks than their colleagues. In contrast, those individuals who lower their bootlegging as a response to the requirement for formalization may choke off opportunities for exploration and bricolage in their R&D efforts. Moreover, increasing efforts at bootlegging during a period of formalization might also be signal of an individual's overriding commitment to their ideas, helping to further equip them for the challenges of overcoming internal barriers to a radical idea

being implemented. Thus,

Hypothesis 3b: Individuals who increase their bootlegging activity during a period of increased formalization process will be more likely to generate radical innovations.

RESEARCH CONTEXT, DATA AND METHOD

The present study was undertaken in Neptune, a pseudonym for a large, technology-intensive multinational company that has built a strong reputation for developing innovative products and processes and operates in multiple, highly competitive product markets. Through multiple R&D sites spread over various continents, Neptune heavily invests in research and development. Despite its reputation as a leading innovator, senior management expressed concern that Neptune struggles to develop radical innovations. In fact, a considerable share of Neptune's R&D efforts is focused on sustaining and improving the existing portfolio of products and technologies rather than developing fundamentally new ones.

In its R&D organization, Neptune employs a dual career ladder system that distinguishes technical and managerial ladders. Members of the technical career ladder are all senior scientists and engineers who contributed significant innovations to the firm. They are expected to be subject matter experts and almost all hold doctoral degrees. They perform a number of different job roles, including product development, process engineering and design. To free them from administrative duties, these individuals hold no formal project management responsibilities.

In order to understand the nature of work in this environment, we collected data about the community of technical R&D staff, following a two-step approach. First, we interviewed 25 senior members of the technical career ladder and 10 R&D managers. Each interview lasted approximately one hour and was meant to better understand the context in which these individuals work. Interviews were semi-structured and we provided opportunities for the

interviewees to describe their professional history, the nature of their innovative efforts, their personal approaches to conducting R&D, and the techniques and tactics they used to search for new ideas.

The second stage of the research process involved a survey of all 600 senior scientists and engineers in the technical career system. In developing this survey, we carefully reviewed the literature on the factors that shape individual creativity and innovativeness that have been documented in previous research. The survey itself asked individuals about their innovative efforts and outputs, and their attitude towards the climate for innovation inside the organization. We implemented the electronic survey in 2010 and, after three reminders, we received 408 responses, yielding a response rate of 67 percent. The response population closely mirrored the overall population in terms of grade, tenure and location. We also compared early and late responders to the survey to determine whether non-respondents were likely to significantly differ in their response to our main questions and found no statistical differences (Armstrong & Overton, 1977). After removing the responses with incomplete and missing variables, we are left with a final sample of 257 individuals.

During interviews with senior technologists, it was noted that – similar to many other large corporations – Neptune's ability to develop innovations often appears compromised because innovation projects may be stranded in the stage-gate process. Management is likely to label such radical innovation initiatives as too high risk, as they may cannibalize the valuable assets in the company's existing product portfolio that were carefully built up over decades (Chandy & Tellis, 1998; Danneels & Sethi, 2011). Such innovations may also disrupt the conventional roles and understandings that often govern relationships between R&D and other functions (e.g. marketing, manufacturing, etc.) within the organization (Dougherty, 1992).

In this setting, many senior scientists and engineers in Neptune decide to engage in bootlegging. Unlike R&D staff in companies such as Google and 3M, scientists and engineers in Neptune are not provided with dedicated time - or 'slack time' – to work on their 'skunk projects'. In fact, researchers have to declare how they spend their working time across the various projects on their formal work plans, which are audited by their managers. In response, some scientists and engineers try to work their way around this system, going underground in their pursuit of new opportunities. As one senior product developer noted:

> *We should spend everything in declared space that should be on our work plan. But, like with all creative and opportunistic work that I'm involved in, sometimes things pop up that seem like too good an opportunity to have a little bit of a dig. And then it could be that one of those then actually turns into one of your big rocks, which is what has just happened to me, with one of my projects.*

On the basis of our survey, we found that on average senior technologies spent around twelve percent of their time in the year prior to the survey on bootlegging activities, down from fifteen percent three years before the formalization of the front end of the innovation process was introduced. Levels of bootlegging also greatly varied across our sample, where around seven percent did not engage in any bootlegging at all and roughly three percent spent more than 30 percent of their time 'underground'.

In Neptune, bootlegging is undertaken for many reasons. The first and most common form comes close to the concept of personal initiative (Frese et al., 1996) and mostly involves underground innovation activities where individuals or small teams decide to do some pre-research work, for example collecting empirical evidence to support the validity and potential of an idea, before exposing it to management (see also Augsdorfer, 2005). As one technologist explained:

> *We made a small amount of the material, then showed technically that it worked, then started to involve some of our colleagues who I work very closely with (...). We made some*

> *sort of prototype, we went and gave it to consumers, got some consumer data, and at that point, when it all started to look reasonable, we then let the organization know about it.*

A second, more extreme form of bootlegging involves continuing to pursue ideas that have been rejected by management, and is, as such, closer to the concept of creative deviance (Mainemelis, 2010). An example of such behavior is illustrated by the following comment, where a novel idea was initially rejected by management, but the technologist decided to gather additional data underground:

> *If the senior manager says that's no good, he's more powerful than me. If I then go and get some data, then it changes the whole power balance.*

In both cases, the main driver for these activities is the passion and enthusiasm for discovery. Often researchers had to be very resourceful to advance their bootleg efforts. In our interviews, researchers described their efforts as: "*you kind of beg, borrow and steal*" or *"you did [with] what you scraped…together".*

Based on these interview comments, we sought to develop a new measure of bootlegging to explore its relationship to innovative performance. Although scales have been developed that attempt to capture individual-level exploration (e.g. Mom, Van Den Bosch, & Volberda, 2009), these scales were unsuited to our research question, which examines individuals' underground and possibly deviant forms of exploration, and setting, in which all R&D staff routinely engage in high levels of exploration. Given that bootlegging covers activities carried out in secret and without formal organizational support, we made the survey completely anonymous. We were also careful to explain to respondents that we would only report aggregate information to their organization, further protecting their identity.

In addition, during the middle of our study, the organization brought in a new system to try to formalize the front end of the innovation process (Cooper & Edgett, 2009, for a description of

similar initiatives). This system created a structured process for judging the merits of an early stage R&D effort, requiring R&D scientists and engineers to document and justify their ideas to the wider organization. Under this new regime, there was widespread perception among our interviewees that there was significantly less tolerance for individuals to engage in unofficial projects and efforts, as illustrated by the following quote:

> *The front end of innovation used to be a lot more, kind of, woolly, and … people were just working on what they fancied, and that isn't the most effective way to run. But I also think that one of the watch-outs with this is that there is no real space for seedlings, or the kind of unexpected, because everything's quite orchestrated, now.*

To probe the effect of these changes on the relationship between bootlegging and innovation, we use this change in organizational practice as a quasi-natural experiment to provide insights into how increases in bootlegging during a period of formalization shape performance outcomes.

Measures

Dependent variables

Innovative performance. We use *managerial rating* as our measure of innovative performance. Scientists and engineers in Neptune are rated on a yearly basis by a panel of line managers for their contributions to the business in the form of new products, processes, technologies or designs. The rating system classifies individuals in two bands with a forced distribution. In our sample, 26% of individuals received the highest rating score, which is representative of the total population. Although the managerial rating was self-reported in the survey, we do not consider it a self-assessed measure of performance since the evaluation was done by others. We asked individuals to declare their managerial rating for each of the last three years to allow us to control for past performance and perform additional analyses regarding the direction of causality.

Radical innovation. We assessed the ability of an individual to generate radical innovations by modifying a 5-item scale proposed by Gatignon, Tushman, Smith and Anderson (2002) for individual innovations. This scale captures the extent to which an innovation represents a departure from existing products or technologies and a significant advancement in a particular technology area. Respondents were asked to evaluate the radicalness of their most important innovation over the last three years expressing their level of agreement to the different items on a 7-point scale. The scale has high internal reliability with Cronbach's alpha of 0.94.

Independent variables

Bootlegging activity. To measure the extent to which individuals engaged in bootlegging, we developed a new measurement scale building on the interview material and on existing studies (Abetti, 1997; Augsdorfer, 1996; Augsdorfer, 2005). We generated a five-item scale, which captured an individual's underground R&D efforts taking place outside their formal work plan but with the aim of contributing to the discovery of potentially valuable business opportunities and seed future official projects. All items were measured on a 7-point scale ranging from 1 for "strongly disagree" to 7 for "strongly agree". An exploratory factor analysis of the five items using the principal factor method resulted in a one-factor solution (with eigenvalue above 1), signaling the uni-dimensionality of our scale and explaining 98% of the variance. Four out of the five items had factor loadings above 0.4 (see Table 1), and therefore we removed the item with factor loading below 0.4. The resulting bootlegging scale has strong internal reliability with Cronbach's alpha of 0.80.

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As an additional measure, we consider the amount of *time* individuals allocated to bootlegging. This question was posed immediately following the bootlegging scale described

above, as we sought to guide respondents about the types of activities that are associated with bootlegging. The question asked individuals how much of a typical week over the last year was devoted to unofficial side projects, outside their official work plan. We repeated the same question regarding the situation three years prior to our survey. This approach provides us with a measure of individuals' bootlegging time for 2010 and 2007. This information is also used for our measure *growth in bootlegging time,* calculated as percentage of time allocated to bootlegging in 2010 minus the same percentage for 2007.

Control variables

Building on the literature on the determinants of individual-level innovativeness, we control for a number of individual and contextual factors. First, an individual's perception of the work environment as being supportive to creative and innovative efforts has been shown to affect individual innovative behavior (Scott & Bruce, 1994). To control for this, we used a reduced version of the original 22-item scale used by Scott and Bruce (1994). From this scale, we took the 8-items that loaded into the factor '*support for innovation*' (alpha of 0.86).

Second, a number of studies have also demonstrated the importance of the supervisor/manager in providing a supportive work environment for creativity (Oldham & Cummings, 1996; Shalley, Gilson, & Blum, 2000). To control for this, we introduce a measure of *managerial support*, which consists of a 7-item scale, which we adapted from a scale developed by Greenhaus, Parasuraman and Wormley (1990). The original scale measured the perceived level of supervisory support for career advancement. We modified this scale to capture the perceived level of support that senior scientists or engineers received from their peer in the management career ladder (Cronbach's alpha 0.94).

Third, since research has shown that individuals with high intrinsic motivation are likely to be more creative (Amabile, 1996; Ryan & Deci, 2000), we introduce a measure of intrinsic motivation. *Intrinsic motivation* was assessed using an 8-item scale adapted from Rynes, Gerhart and Minette (2004). Respondents were asked to indicate on a scale ranging from 1 ('not at all important') to 5 ('crucial') how important were different features of their job such as intellectual challenge, degree of independence, salary, job security. The data was subjected to a principal factor analysis, which resulted into a two-factor solution corresponding to intrinsic and extrinsic motivation. The factor capturing intrinsic motivation had a Cronbach's alpha equal to 0.69.

Fourth, we include a measure of an individual's *grade*, as the level of seniority could also directly affect an individual's innovative performance, as senior members of the technical career ladder are more accomplished innovators (Amabile, 1996; Bailyn, 1985). Fifth, since *tenure* could also have an impact on an individual innovative performance as the accumulated work experience can enhance their ability to generate new ideas, we introduce a variable capturing the years of work experience the individual has in the organization. Sixth, building on research suggesting that creativity achievements by *female* workers are not always valued as highly as those of male co-workers (Evans, 1979), we include a dummy with men as reference category. Seventh, since the potential to develop an innovation may be shaped by the amount of slack resources an individual can gain access to, we control for the *size of the market* in which the division of Neptune is operating by including a dummy equal to 1 if the respondent is working in one of the divisions with the largest market. Eighth, we control for whether the individual is working at the *headquarters* of the company. Finally, we include dummy variables to control for differences in *division* and *job function* in all our regressions.

Finally, we include *past managerial rating* in our analysis since this measure might be a proxy for other individual features we have not been able to control for,. More specifically, we include managerial rating achieved two years prior to our survey (*Past Rating*).[3]

[3] Although introducing lagged values of the dependent variable does not completely rule out issues of endogeneity arising from omitted variables bias, it should, in the absence of valid instruments, substantially mitigate this problem (Wooldridge 2009).

RESULTS

We tested our hypotheses estimating logit models when we use the managerial rating as a dependent variable given its dichotomous nature and an ordinary least square model when we regressed radical innovation against bootlegging and our control variables. All equations were estimated clustering the errors by the grade of the respondent. Thus, we assume that individuals with the same level of seniority display a similar behavior.

Table 2 presents the descriptive statistics and bivariate correlations of the variables used in our econometric models. On average, the scientists and engineers in our sample spent almost 20 years working for Neptune. The levels of correlation are generally low among our keys variables and the maximum VIF is less than 2.5, indicating that multicollinearity is not present in our data.

--- INSERT TABLE 2 ABOUT HERE ----

In Table 3, we test the impact of bootlegging on managerial rating and radical innovation. After controlling for past managerial rating, Model 1 shows that bootlegging activities – both *bootlegging effort* and *time* – have a positive and significant effect on the likelihood of obtaining the highest managerial rating.[4] For bootlegging *effort*, a one standard deviation increase in bootlegging, increases an individual's chances of obtaining a top rating by four percent; whereas for bootlegging *time*, a one standard deviation increase is associated with a seven perfect higher chance of receiving a high managerial rating. This lends support to our Hypothesis 1. Model 4 shows the results for Hypothesis 2, which predicted that bootlegging activities – both *effort* and *time* - had a positive and significant effect on the ability of an individual to develop a radical innovation. We find that bootlegging efforts are positively and significantly associated with

[4] We explored the possibility of a curvilinear relationship between bootlegging and innovative performance by including a squared term for bootlegging efforts and past bootlegging time. The squared term of bootlegging efforts was positive and significant, indicating that the relationship between innovative performance and level of engagement in bootlegging is predominantly positive. The squared term of past bootlegging time is negative but not significant, suggesting that a curvilinear relationship is not supported by our data.

radical innovation. The marginal effect shows that a one standard deviation increase in the level of an individual's bootlegging efforts results in a 15.6% increase in the degree of radicalness of their innovative outputs. However, we do not find that past bootlegging time is significantly associated with radical innovation. This result is inconsistent with Hypothesis 2.

--- INSERT TABLE 3 ABOUT HERE ----

In Models 3 and 6, we test our Hypotheses 3a and 3b by including the growth in bootlegging time after the formalization of the front end of the innovation process and controlling for past levels of bootlegging. In line with our Hypothesis 3a, estimates of Model 3 suggest that those individuals who have increased the time they invested in bootlegging activities are less likely to achieve a high managerial rating. In particular, a one-percent increase in bootlegging time lowers the likelihood of obtaining a top rating by 1%. On the contrary, Model 6 shows that individuals, who have increased the time spent in bootlegging activities, are better able to develop radical innovations, which supports our Hypothesis 3b. Estimates of Model 6 indicate that a one-percent increase in bootlegging is associated with a 9% increase in level of radicalness of an individual's innovative output.

Testing for reverse causality

As suggested above, due to the cross-sectional nature of our data, there is the possibility that our results are affected by endogeneity bias. Using past values of managerial rating helps to address the problem of omitted variables bias, but it does not rule out another source of endogeneity, which is reverse causality. It might be possible that innovative performance determines bootlegging instead of the other way round, because more successful individuals might be granted more autonomy and resources to engage in bootlegging activities. To address this issue, we carried out a Granger causality test (Granger, 1969) exploiting the information on

the time individuals declared they spent on bootlegging activity at the time of the survey (*Bootlegging time*$_t$) and three years prior to that (*Bootlegging time*$_{t-3}$) together with information on managerial rating at the time of the questionnaire (*Managerial rating*$_t$) and past managerial rating (*Managerial rating*$_{t-1}$ *; Managerial rating*$_{t-2}$).

$$Bootlegging\ time_t = \alpha_1 Bootlegging\ time_{t-3} + \alpha_2 Managerial\ Rating_{t-1} + \alpha_3 Managerial\ Rating_{t-2} + controls + \varepsilon$$

$$Managerial\ Rating_t = \beta_1 Bootlegging\ time_{t-3} + \beta_3 Managerial\ Rating_{t-1} + \beta_3 Managerial\ Rating_{t-2} + controls + \vartheta$$

Since the coefficient of bootlegging time at *t-3* is significant in equation 2 (β_1=0.099**), but managerial rating at time *t-1* and at time *t-2* are not significant in equation 1 (α_2= - 0.397; α_3=0.148), we can conclude that bootlegging time, and thus bootlegging activity, drives innovative performance and not vice versa. Unfortunately, we cannot rule out such issues of reverse causality in the other models because we lack valid instruments for bootlegging activity in the radical innovation regression. Given there is strong conceptual and empirical affinity between innovation and radical innovation with the latter being a subset of the former, there is no obvious reason to assume reverse causality should be present in the relationship between bootlegging and radical innovation when it is not in the relationship between bootlegging and innovation.

DISCUSSION

The desire of organizations to encourage their staff to be creative and proactive in their work requires the willingness of these organizations to tolerate failure, variety and even a degree of chaos. Such a desire must also be balanced against the need to ensure that the corporate efforts to innovate are not too fragmented, disorganized and misdirected (Burgelman, 1983; Burgelman &

Grove, 2007). Using managerial processes to structure and allocate resources in R&D is a critical element in ensuring that these investments are put to proper use, aligned to the strategy and skills of the organization. Yet, the use of such methods may act as a significant brake on individual initiative. In this sense, developing innovations inside large, mature organizations is subject to a curious paradox: unstructured, chaotic and discordant efforts might be a precursor to innovation and strategic renewal, yet such efforts generate many failed efforts and little coordination, leading to few implemented ideas.

This study advances our understanding of these questions by exploring the effects of the bootlegging efforts of individuals on their ability to contribute to their organization's innovative performance. Our study provides important evidence for the value of these unofficial efforts at R&D for individuals and for their organizations. Our study clearly demonstrates that bootlegging activity by individuals is associated with a higher chance of that individual being awarded a high managerial rating even when we controlled for past innovative performance. Moreover, this finding is robust for both bootlegging effort and time. This suggests that individuals who create some space for 'slack search' in their R&D efforts, nurturing new ideas outside the formal system and keeping alive rejected ideas, have a greater potential to be recognized by their organization for innovative contributions. As a necessary corollary, it indicates that individuals, who adhere to the formal system, undertaking little or no underground R&D efforts, are limiting their ability to generate innovations. Thus, working outside formal processes for part of one's R&D time may sustain and enhance individual creative efforts.

The results for radical innovation provide richer contextual detail on the bootleg-innovation relationship. As we expected, bootleg activity appears to allow individuals to generate more radical innovative outcomes, a finding that is consistent with our argument that bootlegging

effort is associated with more explorative search efforts. However, we found that bootleg *time* was not correlated with radical innovation, suggesting only partial support for Hypothesis 2. One explanation for the weak results for bootlegging time for radical innovation may be that breakthrough ideas often require significant upfront investment, and the modest amount of time invested by bootleggers does not provide sufficient resources to achieve this goal (Augsdorfer, 1996; Sharma, 1999).

Using a major organizational change toward greater formalization in the early stages of the R&D process as a context, we examined how changes in bootlegging by individuals shape their innovative outcomes. Consistent with our expectations, we found that for those individuals who increased their bootlegging time during a period of increased formalization, the returns to such increased efforts were negative. We argued that these negative returns were caused by the organizations adverse reaction to the bootleg efforts during a period of increased scrutiny. In effect, raising one's deviant behavior during a period of increasing organizational formalization may heighten the chances of sanction and disapproval. However, we also found that increased bootlegging efforts during a period of formalization may increase the likelihood of an individual generating a radical innovation. This suggests that individuals' efforts to develop radical innovations – ideas that break away from existing conventions, routines and categories – may be further enhanced by deviance during such periods of formalization.[5]

CONCLUSIONS

By examining bootlegging efforts and changes in the levels of these efforts, we have attempted to enrich our understanding of the source of individual-level innovativeness in large,

[5] These differences in the value of increasing bootlegging may also arise from the nature of our measures of innovation. Our measure of innovative performance was based on managerial ratings, whereas our measure of radical innovation was based on self-assessment. Since the rating system is based on managers' judgments about an individual's performance, it is likely to be focused on an individual's fidelity to their formal work requirements. Self-assessed radical innovation may partly reflect an individual's attitude to the nature and direction of their R&D efforts.

mature organizations. In doing so, we have brought to the surface one of the frequently commented upon yet rarely systematically observed practices in R&D – bootlegging – and demonstrated its importance to the generation of new products, processes and services.

Our study has important implications for our understanding of creativity. First, by explicating the ways in which bootlegging allows individuals to overcome the barriers to innovation in mature organizations, we have extended our appreciation of the sources of individual-level innovation. In the literature on the individual-level determinants of innovation (Zhou & Shalley, 2008), relatively little attention has been paid to the working practices of R&D professionals and how such working practices may unlock opportunities for innovation. By invoking and directly measuring the concept of bootlegging, we are able to open up the black box of individual's working practices in R&D, providing insights into how individuals overcome the illegitimacy of innovation by operating below the formal surface of the organization's managerial processes. This approach provides tangible evidence about the role of proactive behavior and creative deviance in shaping innovation outcomes in organizations (Crant, 2000; Mainemelis, 2010).

Second, by bringing to the surface individuals' tactics for advancing innovations in mature organizations, we have contributed to our understanding of the sources of corporate entrepreneurship. Our research demonstrates that bottom-up personal initiatives, operating outside formal management systems, may provide a critical mechanism to allow mature organization to break away from established routines and categories (Burgelman, 1983).

Third, our work contributes to our understanding of how attempts to formalize R&D and organizational processes may shape innovative outcomes. Although the formalization of R&D can help ensure greater alignment and efficiency in the search process, it can also create

challenges and tensions for scientists and engineers. Our conceptual framework argued that during periods of formalization increased bootlegging could have negative effects for individuals. This is because increasing deviation from the formal work allocation system during a period of greater formalization provides infertile ground for realizing the potential of bootleg efforts. During periods of formalization, the products of underground efforts may be viewed as being highly illegitimate within the organization. Yet, the benefits of going underground during a period of formalization may increase the potency of bootlegging for radical innovation, because during such a period it may be even more imperative to experiment with ideas that break away from existing categories. In other words, individuals may gain in terms of radical innovation from behaving more 'foolishly' in the face of greater pressures for conformity (March, 2006).

Our study is subject to several limitations, which in turn open up a range of future research questions. First, since we have focused on the bootlegging efforts of individual R&D staff, we have not attempted to track bootleg projects through the organization. Future research could compare the innovation journey of bootleg versus non-bootleg projects inside organizations. Second, our study focuses on a single organization and therefore one needs to be cautious about generalizing our results for other organizations, which means we are unable to explore how differences in bootlegging. Third, since bootlegging is an activity that takes place secretly without organizational approval, there may be a tendency for individuals to under-report (or even over-report) their bootleg activities. Other methods, such as in-depth observation, time logs and detailed case studies, might help to evoke a richer picture of the nature of underground efforts inside organizations.

By theorizing and measuring the impact of underground efforts of individuals in R&D on innovation, this paper has sought to cast new light on a perennial managerial challenge – the

need to support creativity while at the same time ensuring that such efforts are well managed and aligned with the organization's goals and capabilities. In doing so, it opens a range of future research possibilities to better understand how creative and proactive individual behavior – some which may even be deviant – can support and sustain organizational renewal and development.

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TABLE 1. Principal factor analysis of bootlegging scale (α = 0.85)

Bootlegging scale items	Factor loading
I have the flexibility to work my way around my official work plan, digging into new potentially valuable business opportunities.	0.608
My work plan does not allow me the time to work on anything else than the projects I have been assigned to.	0.592
I enjoy tinkering around with ideas which are outside the main projects I work on.	0.349
I am running several pet projects that allow me to learn about new areas.	0.762
I proactively take time to work on unofficial projects to seed future official projects.	0.784

TABLE 2 Descriptive statistics and bivariate correlation (N=257)

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Managerial Rating	0.26	0.44	0	1													
2 Radical innovation	0.00	0.95	-2.84	1.37	0.22												
3 Bootlegging activity	0.00	1.02	-3.10	1.84	0.15	0.22											
4 Past Bootlegging time (t-3)	14.17	9.24	0	50	0.16	-0.03	0.10										
5 Growth in bootlegging time	-0.19	1.09	-3.26	3.05	-0.06	0.14	0.46	-0.53									
6 Support for innovation	0.05	0.92	-2.78	1.92	0.04	0.09	0.25	-0.11	0.25								
7 Managerial Support	0.03	0.97	-3.50	1.08	0.13	-0.01	0.17	-0.03	0.08	0.35							
8 Intrinsic Motivation	0.00	1.01	-3.08	1.64	0.16	0.32	0.17	0.04	0.07	-0.04	0.01						
9 Grade	1.24	0.46	1	3	0.03	0.15	0.22	0.09	0.06	0.05	0.01	0.11					
10 Tenure	19.85	7.81	0	44	0.00	0.03	0.02	-0.07	0.05	-0.02	0.00	0.00	0.30				
11 Gender	0.20	0.40	0	1	-0.07	-0.04	-0.07	-0.16	0.09	-0.04	-0.02	0.03	-0.07	0.06			
12 Large Market	0.59	0.49	0	1	0.04	-0.02	0.03	0.06	0.05	0.17	0.12	-0.03	0.04	-0.12	-0.16		
13 Headquarters	0.64	0.48	0	1	-0.02	-0.04	-0.02	0.06	-0.05	-0.17	-0.02	0.06	0.18	0.31	0.03	-0.07	
14 Past Managerial Rating (t-2)	0.30	0.46	0	1	0.27	0.09	0.06	-0.04	0.06	0.04	-0.03	0.04	-0.03	-0.13	-0.01	0.05	-0.09

Correlations greater than |0.12| are significant at 5

TABLE 3. Impact of bootlegging on innovation (N=257)

	Managerial Rating Logit estimates				Radical Innovation OLS estimates			
	1	2	3	4	5	6	7	8
Bootlegging activity		0.262				0.156		
		(0.084)***				(0.020)**		
Past Bootlegging time (t-3)			0.052	0.047			-0.005	0.000
			(0.018)***	(0.018)***			(0.004)	(0.003)
Growth in bootlegging time				-0.071				0.095
				(0.042)*				(0.017)**
Organizational Climate	-0.058	-0.114	0.021	0.036	0.088	0.053	0.081	0.062
	(0.019)***	(0.035)***	(0.055)	(0.058)	(0.028)*	(0.017)*	(0.030)	(0.032)
Managerial Support	0.379	0.344	0.403	0.405	-0.059	-0.077	-0.058	-0.058
	(0.163)**	(0.195)*	(0.195)**	(0.190)**	(0.030)	(0.037)	(0.030)	(0.034)
Intrinsic Motivation	0.407	0.369	0.396	0.401	0.292	0.263	0.292	0.282
	(0.148)***	(0.159)**	(0.141)***	(0.141)***	(0.016)***	(0.012)***	(0.015)***	(0.018)***
Grade	-0.486	-0.488	-0.289	-0.274	-0.077	-0.063	-0.099	-0.115
	(0.200)**	(0.175)***	(0.291)	(0.316)	(0.052)	(0.040)	(0.065)	(0.056)
Tenure	-0.144	-0.244	-0.274	-0.262	0.226	0.154	0.236	0.217
	(0.130)	(0.121)**	(0.204)	(0.199)	(0.188)	(0.189)	(0.187)	(0.182)
Gender	0.019	0.021	0.027	0.027	0.005	0.006	0.005	0.005
	(0.003)***	(0.005)***	(0.006)***	(0.006)***	(0.003)	(0.003)	(0.003)	(0.003)
Large market	0.054	0.082	-0.014	-0.013	-0.07	-0.057	-0.063	-0.068
	(0.112)	(0.119)	(0.125)	(0.138)	(0.079)	(0.076)	(0.081)	(0.063)
Headquarters	-0.154	-0.175	-0.26	-0.247	-0.14	-0.142	-0.132	-0.136
	(0.350)	(0.373)	(0.371)	(0.369)	(0.043)*	(0.059)	(0.034)*	(0.045)*
Past managerial rating (t-2)	1.47	1.453	1.567	1.575				
	(0.325)***	(0.372)***	(0.262)***	(0.252)***				
Constant	-1.151	-1.006	-1.816	-1.802	-0.279	-0.196	-0.21	-0.239
	(0.123)***	(0.169)***	(0.174)***	(0.182)***	(0.240)	(0.272)	(0.223)	(0.218)
R squared [a]	0.13	0.14	0.16	0.16	0.18	0.20	0.18	0.19

[a] McFadden Pseudo R^2 for logit estimates. Robust standard errors for two-tailed tests clustered by grade. Division and job function dummies included.

* significant at 10%; ** significant at 5%; *** significant at 1%