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Abstract

We analyse the hitherto unexplored relationship between intra-firm conflict between the research and development (R&D) department and central management, conflict alleviation and the choice of 'open' versus 'closed' innovation, in the context of a simple formal model. We find that in the presence of (intentional or unintentional) divergence of preferred (R&D) output between the R&D department and central management, the decision by central management to adopt an 'open' (versus 'closed') innovation approach, may help serve the twin purpose of shifting constraints to growth and increasing firm profitability, by alleviating intra-firm conflict.

Keywords: intra-firm conflict, management, open innovation, firm growth.

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1 Introduction

One of the central tenets of the currently dominating resource based view (RBV) and/or dynamic capabilities (DCs) – based theories of the firm is the firms' presumed superior capability in engendering, leveraging and upgrading intra-firm knowledge and innovations (Penrose, 1959; Helfat et al. 2007; Teece, 2007; Katkalo eet al., 2010). Such knowledge/dynamic capability may help effect endogenous firm growth and sustainable competitive advantages, when they satisfy conditions such as difficulty for rivals to imitate.

A well known theme in the RBV tradition concerns the Penrosean view of managerial constraints to growth - the idea that the non-availability of appropriate management capabilities in the open market can serve as a constraint to the rate of endogenous firm growth. Little recognized in this literature, however, are the following; First, the potential existence of intra-firm conflict; Second, is the potential for central management/entrepreneurial decisions to help remove constraints to growth by effecting intra-firm conflict resolution. Third, is the idea that one way for this to be achieved is through the choice of "open" (versus "closed") innovation. The aim of our paper is to address these interrelated exciting possibilities/gaps in the literature, both conceptually and in the context of a simple formal model.

Structure-wise, the next section identifies the issues to be addressed; immediately after that a formal model is presented that captures the main aspects or the issues under consideration. The final section has concluding remarks and discusses implications for managerial practice and future research.

2 Intra-firm conflict alleviation, innovation and growth

Intra-firm conflict is a time-honored theme both in economics and in management scholarship, which however has been all but overlooked in more recent literature, which seems to be fixated to inter-firm rivalry, as in Porter (1980). The idea of divergent objectives between intra-firm groups, like for example, owners and managers is at the heart of managerial theories of the firm (see Marris, 1996), and of a thriving 'agency' literature (Alchian and Demsetz, 1972; Jensen and Meckling, 1976; Mahoney, 2005; Pitelis and Teece, 2009). Cyert and March (1963) have taken the idea a step further in positing a potential divergence of interests between different departments in the firm, for example the central office (that seeks maximum profit) and the sales department (which is likely to be more interested in growth and market share). Such intra-firm divergence of objectives alongside bounded rationality, led Cyert and March to conclude that firms were more likely to pursue satisficing rather than profit maximizing levels of output (*Organization Science*, 2007). Empirically, the presence of intra-organisational political behaviour is both common and perceived to be so, see Buchanan (2008) for a critical account and evidence.

In recent years, the resource, knowledge and/or dynamic capabilities-based views are dominating management scholarship on the theory of firm growth. Based on Penrose (1959), these views suggest that firms are superior to markets and/or other organizations in engendering knowledge, innovation and (dynamic) capabilities for value creation and value capture, which in their turn can lead to endogenous growth, and also help shift the various existing constraints to growth, such as Penrose's well known 'managerial constraint'. From the now large available literature on these issues, one can look at Penrose (1959), Wernerfelt (1984), Barney (1991), Peteraf (1993), Peteraf and Barney (2003), Teece et al. (1997), Teece (2007), Helfat et al. (2007)

and Katkalo et al. (2010). AMR (2007) discusses value creation and value capture in general and in the context of the RBV in particular while Coad (2007) provides an extensive survey on firm growth, including theories and constraints. Greve (2008) provides a behavioural perspective on firm growth that proposes a sequential approach to size and performance objectives. Becker and Huselid (2006) assess the state of the art in strategic human resource management (SHRM) and call for research on the mediating factors between HR and firm performance.

The RBV all but ignores the issue of intra-firm conflict! This is likely to be a limitation, not least because conflict and conflict management may themselves be determinants of innovation, knowledge and capability creation-leveraging and (thus) firm growth. It is arguable for example, that the nature of intra-firm conflict may be an important determinant of the type of innovation selected by central management, in order to alleviate such conflict (Pitelis, 2007). Indicatively, the co-existence of intra-firm conflict, for example between different departments in a firm, and intense intra-firm rivalry, may tend to motivate exploitation versus exploration type innovations (March, 1991, 2008).

Despite progress on the conceptual front, and some empirical, case examples-based support, the embryonic research of intra-firm conflict, knowledge-innovation and growth, remains rather impressionistic. This is even more the case for intra-firm conflict management. Our aim in this paper is to shed some light on aspects of this issue, notably on intra-firm conflict management, the choice between 'open' and 'closed' innovation and on how these impact on (constraints to) firm growth.

"Open" innovation has recently assumed interest, in large part due to the path breaking work of Chesbrough (2003, 2006, 2007), von Hippel (2005) and others [see for example West and Gallagher (2006a, 2006b) for recent contributions]. At a general level, the issue of 'open' (versus 'closed') innovation is a variant of the internalization/externalization debate, or the 'make

or buy' (in this case sell, make or license) decision of firms, applied to the case of innovation or one of its possible sources, the R&D department. The 'closure' of innovation or the internalization of the forces of creative destruction, as aptly put by Penrose (1959), has been well documented by Alfred Chandler (1962). In contrast, the 'open' innovation model observes that firms can either buy and/or sell (their 'surplus') innovations, in the open market. 'Open innovation' is pursued by companies in sectors such as computers, IT and pharmaceutical, but also firms like Apple and Procter and Gamble. For example, the recent success of iPod can be explained in terms of the ability of Apple to use its internal portfolio of innovations, alongside externally sourced ones, as well as its complementary skills and capabilities for design and future demand appreciation and/or creation (Pitelis and Teece, 2010).

The reasons behind the emerging move from closed to open innovation are hotly debated (see West and Gallagher, 2006a; von Hippel, 2005). Important considerations relate to firm size and the type of activity. For example, large firms may be in a better position to capture value from their innovation (and/or that of others), if they possess complementary capabilities and assets (Teece, 1986, 2006). Smaller firms may need to sell, cooperate or compete with larger players. The choice may depend on the sector. For example, Gans and Stern (2003) suggest that in sectors such as biotechnology, where there exist 'markets for ideas' and where patents are relatively effective, intra-firm cooperation is more common than in sectors such as electronics, where such conditions are absent, which in turn leads to head-on competition between large firms and innovative start-ups.

We suggest that one potentially important consideration in the choice of open versus closed innovation (or more accurately perhaps, the 'optimal' mix of the two), is the need by firms to address issues of intra-firm divergence of interests and/or objectives. Such a need is proposed here to be one of the mediating factors that help articulate the relationship between SHRM and

firm performance, called for by Becker and Huselid (2006). Here we focus on intra-firm objective divergence between the R&D department and central management. Conflict between these two departments can arise because of different objectives (Cyert and March, 1963) and/or because the very operation of firms engenders knowledge and innovation in areas which central management perceives as (un)profitable to enter. For example, in the case of the British music company Electric and Musical Industries (EMI), the invention of the computerised tomography (CT) scanner resulted from a prolific R&D department that was given a mandate to pursue R&D of potential applicability to EMI's main line of business. As it happened the CT scanner's most obvious applicability was in the medical sector. That led to EMI's choice – to internalize or sell/license the new technology. As it turned out, the decision of EMI to try and internalize the potential benefits from this invention through greenfield foreign investment in a new (US) market might have been misconceived (Teece, 1986). Central management could have chosen to sell/license the technology instead, to other companies with complementary assets (Teece, 1986). In cases such as this even if different groups (in this case the R&D department and central management) happen to share the same objective (let us say maximum profit from the innovation), different perceptions of how best to profit from the innovation, may well engender intra-firm conflict that can hinder growth. Such conflict is more likely to emerge if the two groups have different objectives. In such cases it is the prerogative of central management to take a strategic decision. We propose to show that in the presence of intra-firm conflict, the choice of open innovation (in this case sell or license the technology) may help effect conflict alleviation and shift constraints to growth.

A limitation of the now voluminous literature on open innovation is that its results are often based on specific case examples, limiting the scope for generalization. Using a simple formal model can help address this problem. Given recent calls for some degree of formalisation

in management scholarship (see AMR, 2009), we present here a simple formal model that aims to capture the main elements from our analysis above, and help explain how intra-firm conflict management through open innovation, may help firms reduce conflict, shift constraints to growth and profit from their innovations.

3 Conflict alleviation and firm growth through "open" innovation – a simple formal model

The basic tenets of our model are as follows. We assume a R&D active firm that pursues maximum possible profits, by pursuing investments financed mainly by retained profits (Penrose, 1959; Chandler, 1962).

In order to capture the possible conflict that may ensue between management and researchers and in order to simplify the analysis, we focus on firms whose structure is divided into two main different departments: a central management department, and an R&D department. An example that can best convey such a firm structure is Xerox, which Palo Alto Research Center has relative autonomy (from the management department) in decision making with respect to R&D. In what follows, we assume both departments to be fully informed about each other and consist of agents who are assumed to be homogenous for simplicity. In line with our discussion, it is also assumed that the central management department is ultimately responsible for strategic decision making.

We assume the firm to produce output y using two inputs of production: the number of innovations K produced by the firm's R&D department, and managerial capability A. In this setting K is similar to capital and A corresponds to managerial human resources. Since we concentrate on high-tech firms that focus on innovation and not on production we abstain from using labor as an input of production, limiting our discussion to K and A. Overall, production is

described by the following function, $y = A^{1-\alpha} K^{\alpha}$ $\alpha \in (0,1)$. In this context A is indicative of the firm's managerial capacity to capture value added from K, within a specific business model, and with adequate managerial ability.

Focusing our attention on K, our model endows innovations with effects akin to quasi-homogeneous inputs. This view contrasts with the fact that a firm's portfolio of innovations embraces many and sometimes diverse innovations, whose value seems independent from each other. Evidence to the contrary is amassed by Bessen and Meurer (2005), who observe decreasing returns to scale between the size of a software firm's patent portfolio and the probability of winning a patent litigation suit.[1] In addition, (patented) innovations as a group are understood to allow the firm to benefit from intra-firm knowledge spillovers (and/or learning by doing) and to act as a barrier to entry to potential entrants, while also proving beneficial as bargaining tool in case of inter-firm rivalry.[2]

This assumption of quasi-homogeneity is in line with Eaton and Schmitt (1994), and amounts to allowing the firm's innovations to be interlinked to an earlier innovation that acts as a common platform to most of the firm's innovations. In a nutshell, a firm's innovation portfolio K is made up of a set of technologies that advance a common platform (having a central idea as a backbone) to which they build on, or they elaborate upon. Therefore, innovations collectively describe a technological territory. This is akin to Penrose's (1959) concept of the "technological base" and much in line with her description of the case of Hercules Powder (Penrose, 1960), and with recent managerial practice concerning technological platforms, see Parker and Astyne (2007).

Denoting the average cost of innovation as c, and using output prices as a numeraire, the firm's profits are $\pi = A^{1-\alpha} K^{\alpha} - cK$, where c is small enough to allow $\dfrac{\partial \pi}{\partial K} > 0$. Considering that

the firm is a profit maximizing one, the above formulation suggests that the optimal number of innovations from the management's point of view (i.e. the one that maximizes profits) is

$K^* = \left(\dfrac{\alpha}{c}\right)^{\frac{1}{1-\alpha}} A$. This result indicates that, along their profit maximizing path, firms that have a

greater managerial ability are in need of a greater number of innovations.

K^* constitutes management's preferred number of innovations and as such it cannot always coincide with the firm's actual K, because the latter depends on the R&D department's capacity to innovate. Focusing on this disparity, one can expect the following three cases: a) $K^* < K$, suggesting that the firm has a surplus of innovations, b) $K^* > K$, indicating that the optimal K is above current one leading to a deficit of innovations, and c) $K^* = K$, which is an equilibrium case. In what follows we take a closer look at $K^* < K$ and $K^* > K$. We do not consider $K^* = K$ any further because there is no rivalry in this case.

4 A surplus of innovations

A surplus of innovations is effectively a mismatch between K^* and K, which is equal to $K - K^*$. Contemporary examples (such as Xerox's Palo Alto Research Center) suggest that there exist cases where K can surpass K^*. Indeed, this case is in line with Penrose (1959) and the RBV, as it involves some "slack" and it raises the issue of its use (Cyert and March, 1963; Pitelis, 2007). In what follows, we endeavour to shed some light on the strategies that firms follow in such an occasion. Specifically, along its profit maximizing path (the path captured by K^*, which accords with the firm's managerial ability, business plan and expectations), the firm can follow two different strategies in order to remedy this surplus:

a.   a strategy that pursues strict profit maximization by forcing K down to K^*, thus risking

creating rivalry between the two departments, which can be costly as it may lead

researchers and ideas to exit the firm; this is a confrontational strategy. The firm's profits

from this strategy (excluding the cost of conflict) are $\pi = A^{1-\alpha}K^{*\alpha} - cK^*$.

b.   Alternatively, the firm can produce K, selling its surplus deriving profits that are equal to

$\pi = A^{1-\alpha}K^{*\alpha} - cK + c(K - K^*)$, where $c(K - K^*)$ captures the profits that the firm

derives by selling its $K - K^*$ surplus for a price c.

Strategy (b) is an open innovation strategy. It suffices to say that, even though the firm operates

in a competitive environment, the price for $K - K^*$ does not need to be c. However, to keep the

model tractable we abstain from shifting attention to c and how it is determined. After all, it is

intuitive that firms that can get a higher selling price for their innovations are more likely to

pursue such a strategy. Yet the issue here is not how c affects a firm's decision but the rivalry

ensuing from a discrepancy between managerial ability and innovativeness.

Needless to say that the firm may equally:

1 decide to stop its operation

2 function using K

3 continue producing K and use K^*, failing to maximize profits.

As all these strategies are outside the firm's profit maximizing path, we do not pursue them

further. In any case, a strategy of halting operation is always strictly dominated by strategies (a)

and (b). In addition a strategy of using K only (deriving profits $\pi = A^{1-\alpha}K^{*\alpha} - cK$) is always

strictly dominated by strategy (b). Moreover, if the firm continues producing K but uses K^*,

considering that its profits are $\pi = A^{1-\alpha}K^{*\alpha} - cK$, and bearing in mind that $K > K^*$), strategy a) always strictly dominates this strategy.

Shifting our attention to strategies (a) and (b), strategy (b) is dominant if $-cK + c(K - K^*)$ is greater than $-cK^*$. Rearranging terms we derive that strategy (b) is dominant if $K > K^*$), which is always true. It follows that in the presence of intra-firm conflict, "open innovation" can serve as a means to capture value from "excess innovation" avoiding the risk of intensifying intra-firm conflict.

5 A deficit of innovations

Shifting our attention to a deficit $K^* - K$ in the number of innovations, given that R&D department cannot deliver what management needs to maximize profits, the deficit in the number of innovations will tend to create some rivalry between management and the R&D department. Such rivalry is far from unknown in the business world, and even though it is frequently manifested in the delay of introducing novel products (as in the Airbus 380) such delays do not fully convey the problems faced by the firms and the solutions chosen. In what follows, we endeavour to shed some light on the strategies that firms follow in such an occasion. Specifically, in symmetry to the surplus case, along its profit maximizing path the firm can pursue two different strategies in order to remedy this deficit:

a. a confrontational strategy where, in the hope of achieving K^*, the R&D personnel must be replaced with one of higher quality (at a cost)

b. an open innovation strategy that promotes the acquisition of the $K^* - K$ innovations from external sources; at a cost c per innovation.[3]

Needless to say, that the firm may equally decide to stop its operation, or function using K only. As both of these strategies are outside the firm's profit maximizing path, we do not pursue them further. In addition, a strategy of halting operation is always strictly dominated by strategies (a) and (b). Furthermore, if the firm decides to function by using K only, comparisons between strategies and dominance must inevitably depend on the cost of acquiring the $K^* - K$ deficit, which is, in any case, the main theme of the analysis that follows.

In what follows, we elaborate on the conditions under which strategy (b) is dominant. Specifically, in terms of strategy (a), if the firm wants to equate K^* to K then it must hire new researchers at a cost which can be found (by equating K^* to K) as $\hat{c} = \alpha\left(\dfrac{A}{K}\right)^{(1-\alpha)}$; this is the cost of intra-firm conflict. This equation suggests that firms with a high managerial capacity A, as they require a greater K^*, need to pay a higher price $\hat{c}$. Such a need is ameliorated when, having a large K, the firm is capable of producing such innovations on its own, reducing $\hat{c}$. Subsequently, the price of intra-firm conflict must be higher for firms with a high A and a low K.

By contrast, if the firm follows strategy b) it must also account for the cost c of acquiring the $K^* - K$ deficit. Thus, in the latter case the firm's profits are $\pi = A^{1-\alpha} K^{*\alpha} - cK - c\left(K^* - K\right)$. In order to examine the issue of the dominant strategy, we need to compare the profits from strategy a) (i.e. $\pi = A^{1-\alpha} K^{*\alpha} - \hat{c}K^*$) to the above noted ones from strategy b). Simple algebra helps determine that strategy b) is dominant if $\hat{c} > c$. Noting that $\hat{c} = \alpha\left(\dfrac{A}{K}\right)^{(1-\alpha)}$, $\hat{c} > c$ can be re-expressed as,

$$(1) \qquad\qquad\qquad\qquad \alpha\left(\frac{A}{K}\right)^{(1-\alpha)} > c \,.$$

It would appear that the greater the firm's managerial capability A is, the greater its need for innovations K^*, a need that, as long as there exists an innovation deficit, can create intra-firm rivalry that is manifested through $\hat{c}$. Subsequently, as equation (1) suggests, we should expect $\hat{c} > c$ to be binding for firms with a high A. Intuitively, firms that have a small K are candidates for an open innovation strategy, because the smaller the K is the larger the left hand side of equation (1) leading to $\hat{c} > c$.

6 Open innovation and firm growth

In the preceding sub-sections we explained how and when rivalry can lead the firm to follow an open innovation strategy, by shifting constraints to firm growth. Here we focus specifically on firm growth by exploring the dynamic implications of open innovation between firms. Considering that open innovation is a generic term under whose aegis one frequently encounters firm acquisition, leveraged buyouts, startup innovations, stake-holding through venture capital financing, and many other forms of inter-firm cooperation that facilitate technology transfer, it may be best to elaborate on our use of the term and its implications.

Specifically, for our purpose (and in contrast to in-house technological development) open innovation is defined here as any activity that allows a firm to benefit from the technology of another firm, incorporating its skills, knowledge and technological capital, along with at least some of its managerial expertise. Firms have proved very innovative in devising such agreements. For example, pharmaceutical firms are well known to frequently buy innovative start-up firms. On the other hand, Intel finances (through venture capital) many innovative start-

up firms, whose technology may prove beneficial for Intel's uses. Through such financing Intel indirectly controls R&D planning and managerial practices.

The above definition implies that when a firm chooses to follow an open innovation strategy it also increases its managerial capability A. This increase does not take place if rivalry is remedied through a strategy of confrontation as in strategy a). To capture this increase we henceforth formalize A as a function of the overall size s of the firm's managerial department, and we denote it as $A(s)$, where $A'(s) > 0$, $A''(s) < 0$. The emerging concavity is the result of a managerial department, which is spread thin by the existence of many innovations stemming from many different sources that need to be managed and coordinated; namely Penrose's managerial constraint to growth.

Consequently, the incorporation, through open innovation, of additional technology and managerial skills leads $A(s)$ to grow by Δs to $A(s + \Delta s)$. Hence, considering that K^* is a function of managerial capacity it must also increase from $K^*(s) = \left(\dfrac{\alpha}{c}\right)^{\frac{1}{1-\alpha}} A(s)$ to

$K^*(s + \Delta s) = \left(\dfrac{\alpha}{c}\right)^{\frac{1}{1-\alpha}} A(s + \Delta s)$, while the firm's stock of innovations is steady at

$K(s) = \left(\dfrac{\alpha}{c}\right)^{\frac{1}{1-\alpha}} A(s)$, creating a deficit of innovations (because $K^*(s + \Delta s) > K(s)$), and intra-firm rivalry. In a fashion similar to our previous analysis, this rivalry can be remedied through a confrontational strategy, or an open innovation strategy, where an open innovation strategy is dominant so long as equation (1) holds, i.e. $\alpha\left(\dfrac{A(s + \Delta s)}{K(s)}\right)^{(1-\alpha)} > c$. Substituting

$K(s) = \left(\dfrac{\alpha}{c} \right)^{\frac{1}{1-\alpha}} A(s)$ into the latter equation, after some rearranging, we derive that open

innovation is optimal if $A(s + \Delta s) > A(s)$.

It follows from the above, intra-firm rivalry does not only help firms grow, by shifting constraints to growth through open innovation, but it can also have a direct positive effect on firm growth. This growth will stop when $A(s + \Delta s) = A(s)$. Considering that $A'(s) > 0$, $A''(s) < 0$, indicating that $A(s)$ must converge (as s increases) to an upper barrier, this growth is not unlimited but it will stop when $A(s + \Delta s) \rightarrow A(s)$. We capture this firm growth in Figure 1, where, through equiproportional increases of Δs, the firm grows until it converges to an upper barrier.

Figure 1. Converging firm growth

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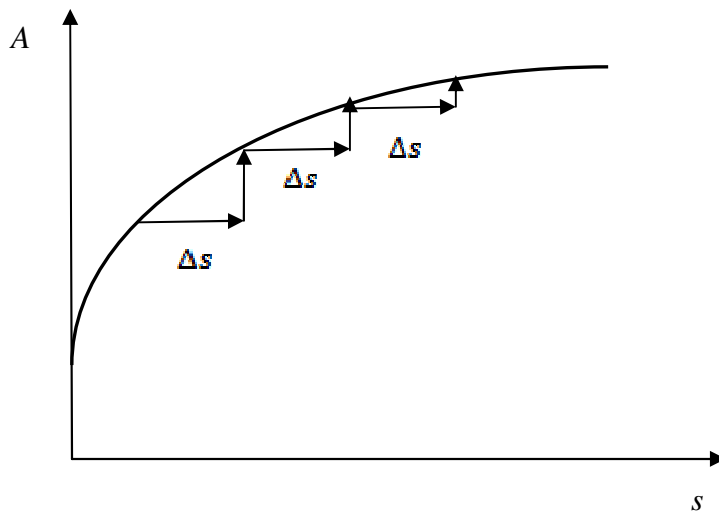
There follows from the above that in the presence of intra-firm conflict, "open innovation" can serve the dual purpose of helping firms to profit from "innovation" as well as to avoid the risk of intensifying intra-firm conflict. It also allows firms to continue growing and keep profiting from their innovations.

7 Limitations, sense-making, managerial practice and future research

The idea that intra-firm conflict can serve as a constraint to firm growth and that strategic decisions by entrepreneurs/central management on the choice of "open" versus "closed" innovation can help effect both conflict resolution, remove constraints to growth and directly facilitates firm growth, is both novel and unexplored in the literature, conceptually, analytically and empirically. In this paper we attempted a first move in the direction of addressing this important limitation.

Our results have the usual advantages and disadvantages of formal modeling. On the positive side, they specify exact conditions under which strategic decisions, as applied to the case of intra-firm conflict between departments, can motivate the adoption of a strategy ('open innovation') that helps mitigate conflict and remove constraints to growth. In this sense, our results shed light on an important issue that combines the concerns of leading classic scholars such as Penrose and Cyert and March with the innovative works and findings of Chesbrough (2007). On the other hand conflict resolution and the choice of 'open' versus closed innovation are likely to be affected by a multiplicity of factors, not allowed for by our model. Considering current calls for a degree of formal theorizing in management scholarship (see AMR, 2009), we hope our contribution makes a small step in the right direction.

A second limitation of the model is that it describes what happens if there is a 'deficit' or a 'surplus' of innovation. However, it does not explain which is more likely, and it fails to

provide a plausible story. We feel that there exists a story that is in line with our results and also with the contribution of Penrose (1959) and Cyert and March (1963). According to this, at the early stages of their development, start-ups, especially high-tech entrepreneurial firms, are likely to have more management talent than sources of funding for their intra-firm R&D. This could result to a search for innovation, from wherever this may be available, favouring an 'open innovation' approach. As firms grow, and an R&D department emerges, the gap will tend to close. However, due to indivisibilities and intra-firm learning, as described by Penrose (1959), it is unlikely that actual R will coincide with profit maximizing, R, most probably surpassing it in cases and leading to 'surplus' innovations. In such cases central management have the choice to cut down on R, or to pursue an 'open innovation' approach, selling, licensing and/or leveraging internally 'surplus' innovation.

Whether to 'sell or make' depends on a host of other considerations, not discussed here, see for example Teece (1986; 2006), Williamson (1991) and Wolter and Veloso (2008). Our claim is that *ceteris paribus* the choice of 'open innovation' compares well with the choice of cutting down on R, as it helps ameliorate intra-firm conflict and remove constraints to growth. In conclusion, this strategic choice of open versus closed innovation can be seen as a partial response to intra-firm conflict reduction by central management, or as a form of strategic decision that helps remove constraints to growth, by allowing the continuation of innovation-knowledge generation. Despite extensive interest on constraints to firm growth, intra-firm conflict and knowledge/innovation, and the role of management and entrepreneurial decisions on growth, this particular aspect of the issue has not been previously explored. We therefore hope to have made a contribution in this direction, while responding at least partly to calls to identify mediating factors between SHRM and firm performance (Becker and Huselid, 2006).

Our results have quite straightforward and rather powerful implications for managerial practice. They suggest that an 'open innovation' approach is *ceteris paribus* preferable to closed innovation, as it can help alleviate intra-firm conflict, shift constraints to growth and increase firm growth and profitability. It is precisely the simplicity and strength of such results that suggests caution. In particular further research is needed that analyses the sensitivity of these results to moderating factors not accounted for in our analysis and discussed below.

Concerning further research, it remains crucial to explore the choice of 'open' versus 'closed' innovation and types of intra-firm conflict resolution, by taking into accounts other factors. For the former case, these include the type of activity, (and inter-firm rivalry), 'appropriability regime', markets for technology, (Arora et al., 2008), different ways of intra-firm incentive alignment (Simon, 1995), the role of complementary assets (Teece, 1986; 2006), the role of new entry, see Research Policy (2006), and open innovation between firms and other organisations. We hope that our results help shed some light on some important issues that have been hitherto unexplored and that we will motivate others too to research further the exciting issue of intra-firm conflict, "open-innovation" and firm growth.

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Notes

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[1] As they argue, "...the idea of diminishing returns to patent portfolio size may seem counterintuitive. After all, if two firms merge, pooling their patent portfolios, why should this affect the role of litigation per patent? But such a merger would affect the probability of winning a suit against a third firm" (p. 3).

[2] See Hall and Ziedonis (2001).

[3] An alternative option for the firm, as firms frequently combine open innovation with a restructuring of their R&D department, would be to use mixed strategies. Nevertheless, our prime objective in this paper is to analyze the raison d'être behind each strategy.