WHAT GOES ON BENEATH THE SURFACE OF RECONFIGURATION? THE IMPACT OF REDEPLOYMENT VIA ACTIVITY ADDITION AND SUBTRACTION ON FIRM SCOPE AND TURNOVER

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ABSTRACT

Strategy research has long understood that reconfiguration of the scope of the activities a firm engages in over time is critical to its long-run success, while under-emphasizing differences in redeployment strategy that underlie apparently similar scope and changes in scope. In this paper, we build on the idea that a firm's number of activities (scope) and change in activities (turnover) arise from two fundamental rates of redeployment: the rate at which activities are added and the rate at which activities are subtracted. In net, the turnover rate reflects how actively a firm reconfigures its resource base by redeploying resources via addition and subtraction of activities. We develop a model that links addition and

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subtraction with the composition of a firm's activities and then provide an empirical illustration using data from the U.S. Patents and Trademarks Office. As an example of one extension, the model can be generalized to incorporate elements of absorptive capacity. The analysis contributes to our understanding of how firms reconfigure their activities and provide managers with a clearer understanding of tools that guide redeployment of existing resources.

Keywords: Firm activity scope; firm activity turnover; activity redeployment; absorptive capacity; firm patent activity

INTRODUCTION

Strategy research has long been interested in understanding the activities that firms undertake, both in terms of how many activities that a firm engages in at a point in time and the degree to which it reconfigures itself by adding and subtracting activities over time (Collis & Montgomery, 1998). By activities, we mean the routines and other processes that a firm undertakes as it seeks to create goods and services (Cyert & March, 1963; Makadok, 2001; Nelson & Winter, 1982). Since at least Coase (1937) and Penrose (1959), the concept of the scope of the firm has been central to strategic management; scope reflects the number of activities that firms undertake (Barney, 1991; Chatain & Zemsky, 2007; Wernerfelt, 1984). In parallel, a large literature has examined strategies that firms use to turn over their activities (e.g., Burton, Obel, & DeSanctis, 2011; Galunic & Rodan, 1998; Helfat, 1997; Karim, 2006; Karim & Capron, 2015; Teece, Pisano, & Shuen, 1997); studies have considered adding via the redeployment of internal resources (Hambrick & Macmillan, 1985; Pacheco-de-Almeida & Zemsky, 2007; Sakhartov & Folta, 2014), business acquisitions (Capron, 1999), and alliances (Mahmood, Zhu, & Zajac, 2011), as well as subtracting via employee departures (Karim & Williams, 2012; Klepper, 2007), divestitures (Capron, Mitchell, & Swaminathan, 2001), and shut downs (Duhaime & Grant, 1984; Greve, 1995). This work on scope and turnover of activities has provided important insights into how firms reconfigure themselves through internal redeployment as well as the shedding of resources over time.

The literature is beginning to pay attention to the temporal patterns of reconfiguration (e.g., Helfat & Eisenhardt, 2004). Few studies, though, have integrated the themes of scope and turnover (see Karim & Capron, 2015), to investigate the joint evolution of a firm's scope of activities at one time, together with resource redeployment via the rate of adding and subtracting activities over time. As a result, there are substantial gaps in our understanding of the forces that shape the revealed scope of a firm's activities. Why are some firms involved in a limited set of activities in some period, while others engage in a multitude? How often do these activities change? And, in considering these questions, what might we learn about the external factors and internal managerial levers that shape a firm's portfolio of activities? A more complete understanding of the redeployment processes that underlie business reconfiguration will aid scholars and managers alike.

In this paper, we develop a model that seeks to explain firm scope at a point in time, together with the rate of turnover of a firm's activities that may occur from one period to the next. The model suggests that the addition of new activities and subtraction of existing activities generate two complementary characteristics of a firm. The net balance of addition and subtraction rates determines whether a firm's activity scope will increase (if addition dominates), decrease (if subtraction dominates), or be stable (if addition and subtraction balance). In parallel, the aggregate of addition and subtraction of activities from one period to the next, which we refer to as turnover, determines how actively a firm is reconfiguring its activities and redeploying existing resources. The presence of these complementary characteristics illustrates the idea that firms with identical scope at a given time can have dramatically different rates of activity turnover. A key contribution of the paper is to highlight the innate interconnection between firm activity scope and turnover and, in turn, help unpack the nature of resource redeployment.

Our model of activity scope and turnover contributes to redeployment research in four ways. First, we suggest that assessing both firm scope and activity turnover is necessary for a more general typology of redeployment. Second, we focus attention on two elemental redeployment rates that drive scope and turnover: firms' rates of activity addition and subtraction. Third, we outline external factors and internal managerial levers that can change the magnitudes of these rates and, as a consequence, aspects of the activities that are core to issues in resource redeployment. Fourth, we illustrate the flexibility of our model by incorporating the concept of absorptive capacity.

This paper unfolds as follows. In the next section, we present our conceptual framework, linking activity addition and subtraction rates to the firm characteristics of scope and turnover. We then provide a basic illustrative model of our conceptual framework. Next, we map the model implications onto firm-level patent data from the consumer electronics and pharmaceutical industries to demonstrate the salience of the model. We then extend the model to incorporate assumptions concerning absorptive capacity. We end with a broader discussion of the implications of the argument.

BACKGROUND: ADDITION, SUBTRACTION, TURNOVER, AND SCOPE

The goal of this conceptual framework is to outline our model of a firm's activity composition. As we noted earlier, by activities we mean the routines and other processes that a firm undertakes as it seeks to create goods and services. Examples of activities include processes involved in innovation, production, sales, and other business endeavors. Activities tend to become embodied in tangible outputs such as products and patents.

A natural point of entry in the consideration of a firm's activity composition is firm scope. We define firm scope as the number of discrete activities that a firm is undertaking. Given the importance of firm activities, firm scope is a foundational component for central theories in strategy such as transaction cost (Teece, 1986; Williamson, 1979), resource-based (Penrose, 1959; Wernerfelt, 1984), and dynamic capabilities (Teece et al., 1997) theories, as well as literatures as diverse as alliance and acquisition management (Villalonga & McGahan, 2005), resource allocation (Bower, 1986; Burgelman, 1991), and organizational ecology (Hannan & Freeman, 1977).

To explain firm scope, we focus on two forces that will shape the characteristics of a firm's activity composition: (a) the rate at which firms add new activities and (b) the rate at which firms subtract existing activities. Taken together, addition and subtraction rates determine whether firm scope will expand, contract, or be stable.

Net Addition and Subtraction Rates Determine the Change in Firm Scope

Adding and subtracting activities are key elements of firm strategy. A large body of research has focused on a firm's addition of new activities, whether by redeploying resources between internal efforts or redeploying resources from external agents into internal uses. For example, firms may seek new capabilities through mergers and acquisitions (e.g., Capron, Dussauge, & Mitchell, 1998; Mowery, Oxley, & Silverman, 1996), use location choices to capitalize upon knowledge spillovers and agglomeration (e.g., Alcacer & Chung, 2014; Baum & Mezias, 1992; Chakrabarti & Mitchell, 2013; Greve, 2009; Shaver & Flyer, 2000; Stuart & Podolny, 1996), or to develop absorptive capacity internally (Cohen & Levinthal, 1990; Lenox & King, 2004).

Juxtaposed against the literature on expansive forces of the firm is the notion that firm activities may be eliminated, whether by shutting down existing efforts or redeploying internal resources to external agents, resulting in a decrease in firm scope. The most prominent mechanism for the active reduction in firm scope is the divestiture of business activities (Capron et al., 2001; Duhaime & Grant, 1984). Firms may also actively abandon their strategies (Greve, 1995) or actively strive to forget (Bettis & Prahalad, 1995; de Holan & Phillips, 2004; Thompson, 2007). Complementing the active shedding of business activities, a firm's internal processes of resource redeployment may also affect the loss rate of incumbent activities. In the process of resource allocation within the firm, resource scarcity in some business lines, manifest through a shift in managerial attention or insufficient internal working capital, may induce employees to leave (Klepper, 2007). Because knowledge is commonly embodied in labor, employee departures often correlate with the exit of firm resources. Moreover, employees' individual stocks of knowledge tend to decay over time, which can reduce business activity (Jain, 2013). Hence, there are many ways by which firms add and subtract activities as they seek to provide profitable goods and services.

By definition, adding new activities increases firm scope and subtracting existing activities decreases firm scope. We define the addition rate as the rate at which firms acquire new activities in some period; the subtraction rate is the rate at which firms shut down or divest existing activities. In turn, the net value of these two rates determines the change in firm scope.

This intuitive basic idea underlies important differences in the observed scope of firms' activities. Consider a stylized example where a firm that desires to expand — whether to capitalize on underutilized economies of scope, seek new markets, or for other reasons — adds a new activity every month. If the firm's goal is to expand its scope, managers need to consider the monthly addition rate *relative* to the firm's subtraction rate. If the firm is subtracting many activities a month, even a torrid rate of arrival might result in contraction in firm scope. Hence, the relative rates of these two forces determine the change in firm scope.

Aggregate Addition and Subtraction Rates Determine the Turnover Rate

Just as the net *difference* in addition and subtraction rates determines a firm's scope of activities, the *sum* of these rates determines a second key characteristic of a firm's activities, which is its turnover rate. We define turnover rate as the sum of new activities added and existing activities subtracted from one period to the next. The concept of turnover is relevant in the literature on product renewal, which argues that firms often benefit by replacing older products over time (e.g., Burgelman, 1996; Danneels, 2002; Dougherty, 1992). Thus, we propose that a firm's activities have two complementary characteristics, scope and turnover, both of which are the result of the combined addition and subtraction rates.

Most generally, the turnover rate reflects how actively a firm reconfigures the scope of its resource base by redeploying resources via addition and subtraction of activities. If a firm does not add many new activities and subtracts few existing activities, the composition of its activities will change slowly. By contrast, a high rate of addition and/or a high rate of subtraction will induce significant change in the firm's activities as reflected in a high turnover rate.

This means that two firms with the same scope (i.e., same number of activities) can have very different turnover rates, reflecting intrinsically different resource redeployment strategies. At one extreme, an inertial firm may engage in the same activities year after year; at the other extreme, a dynamic firm with the same number of activities in any given period may have wholesale change over time. Fig. 1 illustrates the distinction between scope and turnover by mapping the characteristics of a firm's activity composition along addition and subtraction rate axes.

Begin by considering activity scope. If the firm's addition rate is greater than the subtraction rate, the firm will be situated in the bottom-right quadrangle of Fig. 1, where scope will increase. If subtraction rate dominates, the firm will be situated in the upper-left quadrangle, where scope will decrease. If the rates are relatively equal, the firm will be situated near the diagonal, with stable scope.

Now consider activity turnover. Because a firm's turnover rate depends on the summed magnitude of the addition and subtraction rates, the farther away the focal firm is from the origin in Fig. 1, the greater the rate at which a firm's activities are reconfigured. Thus, even if two firms have stable scope and hence lie on the diagonal, the two firms may vary dramatically in their turnover rates. By characterizing a firm's activity characteristics along addition and subtraction rate dimensions, this logic provides a

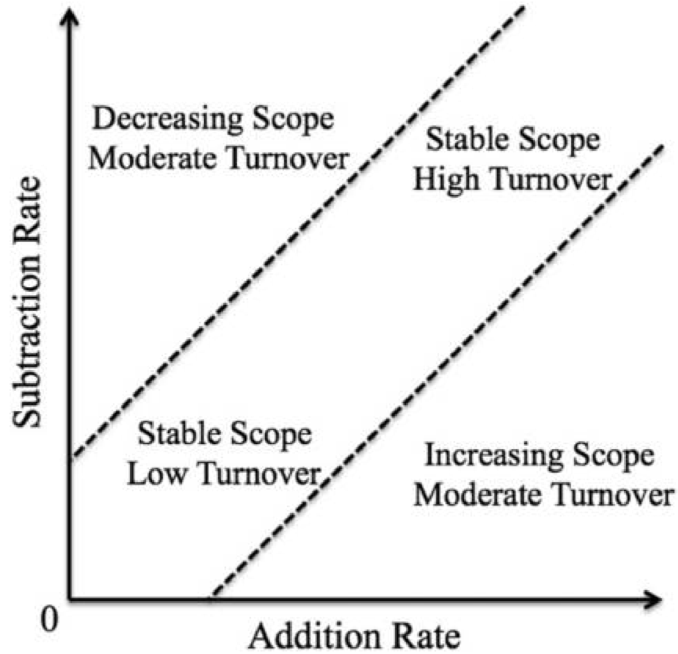

Fig. 1. The Mapping of Scope and Turnover onto Addition and Subtraction Axes. *Notes*: This figure illustrates the difference between firm scope and firm turnover by mapping the characteristics of a firm's activity composition along addition and subtraction rate axes. If the addition rate is greater than the subtraction rate, the firm will be situated to the bottom-right and firm scope will increase. If the addition rate is less than the subtraction rate, the firm will be situated to the upper-left and firm scope will decrease. For firms that have relatively equal addition and subtraction rates, the firm will have stable scope and lie along the diagonal. Firm turnover, which is the aggregate of addition and subtraction rates, will increase as firms are situated farther from the origin. Firms with high rates of turnover (i.e., reconfiguration) will be situated to the upper-right of the diagram.

more complete view of the potentially changing activities that comprise a firm's resource base.

What is not yet clear are the conditions that would lead to a steady-state equilibrium, where a firm has both stable scope and a constant turnover rate. The following model helps to illustrate this condition, as well as to derive comparative statics that demonstrate how changes in addition and subtraction rates affect scope and turnover. After introducing and discussing an equilibrium model, the subsequent section will turn to conditions that shift a firm toward new potential equilibria reflecting new scope and turnover rate.

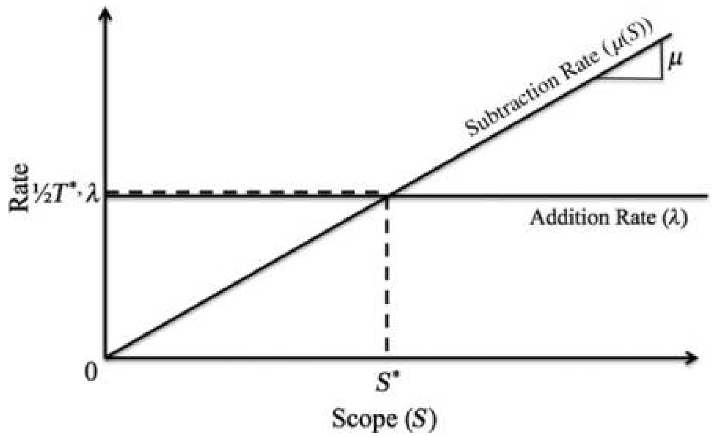

Fig. 2. A Firm's Steady State Equilibrium Point. *Notes*: This figure illustrates the model's derivations. Assumption A3 suggests that there is an unlimited number of potential activities, resulting in a constant addition rate. By contrast, the subtraction rate increases with firm scope (S), which is shown on the X-axis. The intersection of the addition and subtraction rate determines the steady state equilibrium point, which also defines S^* and T^*. Note that our model does not assume that firms are in steady state equilibrium but, rather, that without a change in the addition or subtraction rate, a firm's activity characteristics will move toward the equilibrium point. In this graph we depict $T^*/2$, to normalize it to λ (see Eq. (6)).

To be clear, our model does not assume or require that a firm ever reach equilibrium. Rather, the idea of a predicted equilibrium point is useful because it specifies tendencies in the direction and rate of change in a firm's turnover rate and scope (i.e., movement toward the equilibrium point in Fig. 2, which we introduce in the discussion of the model below). In turn, changes in the external environment and/or firm strategies may redirect the firm toward a new scope and a new turnover rate. The model provides a means to understand this process and to potentially help guide managers in their reconfiguration efforts.

MODEL

To make our arguments more concrete, we present a parsimonious formal model for a firm's activity scope and turnover. In the first iteration, the goal of this model is to outline several simplifying assumptions and then consider the implications of relaxing the assumptions in the basic model. This modeling lends precision to our theory: it highlights the conditions that are necessary and sufficient for our ideas to hold. In a later section, we use the scaffold of our model to introduce a possible refinement of the model that incorporates absorptive capacity. Thus, the second portion of our modeling exercise illustrates the myriad possibilities that our model enables.

Model Set Up

We define the instantaneous activity arrival rate λ (the rate at which the firm acquires activities) and the instantaneous activity loss rate μ (the rate at which the firm shuts down or divests a given existing activity). The rate at which the firm subtracts activities is then μ multiplied by the number of total activities in the firm. We define activity scope, $S(t)$, as the number of distinct activities present in the firm at time t.

The basic model makes three simplifying assumptions; in a later section, we discuss the implications of relaxing each of the three assumptions:

A1. All activities are equally likely by the firm to be added, while all existing activities have an identical subtraction rate μ.

A2. Activity addition is independent across activities (i.e., the addition of activity X does not affect the likelihood of activity Y being added); similarly, activity divestiture is independent across activities.

A3. An unlimited number of potential activities are available.

With an unlimited number of potential activities (A3), any single added activity is new from the point of view of the firm, and therefore the firm's activity addition rate is the same as the arrival rate. The law of motion for the scope of the firm is given by the difference between the firm's addition and subtraction rates:

$$\frac{dS}{dt} = \lambda - \mu S \quad (1)$$

This is a first-order linear differential equation with solution

$$S(t) = \frac{\lambda}{\mu} + Ce^{-\mu t} \quad (2)$$

where C is some constant that is determined by, for example, the initial scope of the firm; the effect of C vanishes as t increases. Equation (2) describes the evolution of S over time.

We define a firm's activity turnover, $T(t)$, as the aggregate number of distinct activities in a firm that are added and subtracted at time t (the sum of the addition and subtraction rates).

$$T(t) = (\lambda + \mu S) \tag{3}$$

Combining this equation with Eq. (2), we obtain an expression for turnover:

$$T(t) = 2\left(\lambda + C' e^{-\mu t}\right) \tag{4}$$

where C' is also some constant. Eq. (4) describes the evolution of T over time.

Steady State

Having derived expressions for $S(t)$ and $T(t)$, we can now compute the steady state equilibrium values S^* and T^*. For a given λ and μ, $S(t)$ and $T(t)$ will converge to

$$S^* = \frac{\lambda}{\mu} \tag{5}$$

and

$$T^* = 2\lambda \tag{6}$$

Fig. 2 depicts the steady state equilibrium point, in which both the number of activities (S^*) on the x-axis is stable and the turnover rate (T^*) on the y-axis is constant. In this figure, the equilibrium point is the intersection of the addition and subtraction rate curves. To the left of the equilibrium point, the addition rate ($\lambda(S) = \lambda$) exceeds the subtraction rate ($\mu(S) = \mu S$), so that scope will increase. By contrast, to the right of the equilibrium point, the subtraction rate exceeds the addition rate, so that scope will decrease.

What causes a firm to converge toward a potential equilibrium point? Consider a new firm with no initial activities (i.e., scope = 0). The firm experiences an arrival rate λ, which might be given by the characteristics of its founding location (e.g., the presence of sources of activities such as established firms and/or universities). Over time, as the addition rate (which under A3 is equal to the arrival rate λ) drives the expansion of scope, the firm accumulates activities to subtract; where the subtraction rate is given by factors such as locational characteristics. The key point is that the addition rate is constant for any scope, while the firm subtraction rate ($\mu * S$) increases proportionately with scope (see Eq. (1)). As a result, there will exist an intersection point where addition and subtraction rates are equal. This is the potential equilibrium point, denoted by S^* and T^* in Fig. 2, toward which the firm will converge.

By contrast, firms can find themselves to the right of a potential equilibrium point if the arrival rate (λ) declines and/or the loss rate (μ) increases. Such a drop in the arrival rate might arise through exogenous shocks such as the disappearance of potential sources of new activities due to the exit of established firms or closure of university labs. An increase in loss rates could be due to exogenous changes in market taste that lead to shedding of prior activities. A reduction in arrival and/or increase in loss might also arise through active managerial intent; for example, moving into a tax haven with more limited technical resources might reduce arrival rates, while moving into a desirable market with several competitors might increase loss rates if competitors hire away key employees.

Such cases, where there are changes in the arrival or loss rates, will result in a new potential equilibrium point. As a result, whether or not a firm was at equilibrium before the change, the trajectory of the firm's scope and turnover will change. As an example, when a firm's arrival rate declines, it will have a scope greater than the new S^*, subtraction rates exceed addition rates, and the firm's scope will decrease. As the firm's number of activities declines, subtraction rates will also decline, causing the firm to shift toward the new equilibrium point, S^*, to the left of the firm's position at the time of the change. In a similar manner, the turnover rate may shift toward a new T^* when the arrival rate changes.

Assessing Assumptions A1–A3 in the Basic Model

Before formally examining the effect of changes in arrival and loss rates, it is useful to consider the strictness of the simplifying assumptions, A1–A3, in deriving S^* and T^*. Relaxing assumption A1 – whether by allowing some activities to arrive more frequently than others or allowing existing activities to have different loss rates – leads to similar implications though with slightly different patterns. Those activities with the highest arrival rates are most likely to be added first, so that the addition rate curve in Fig. 2 will be concave rather than straight. If existing activities have different loss rates, the ones with the highest rate are most likely to be lost first, leaving more persistent activities. As a result, the subtraction rate curve in Fig. 2 will also be concave rather than a straight line.

A2, concerning the independence of arrival and loss rates, provides a stronger challenge. If we relax this assumption, individual activity arrival and loss rates may depend upon one another. For example, the arrival of activity X (e.g., smartphones) could lead to a propensity for activity Y (e.g., tablets) to arrive. Alternatively, the arrival of one activity (e.g., smartphone innovation) might inhibit a second activity (e.g., netbook innovation). Intuitively, interdependencies may result in the arrival and loss rate curves in Fig. 2 to be non-monotonic. If these non-monotonicities are large enough, there may be multiple equilibria and a firm may become "trapped" in a local minimum, S' and T'. Nonetheless, we would expect firm behavior around a local minimum point, such as S' and T', to be consistent with our predictions. Graphically, we would expect rate curves around the local minimum to be similar to those shown in Fig. 3.

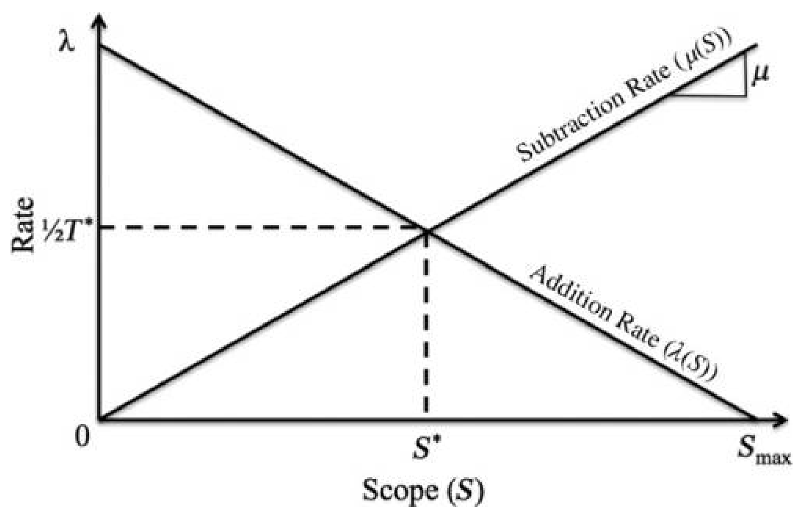

Fig. 3. A Firm's Steady State Equilibrium Point with Limited Activities. *Notes*: This figure illustrates the effect of relaxing assumption A3 and allowing only a limited number of activities. In this case, as firm scope (S) increases, fewer activities will be available to be added to the firm, resulting in a downward sloping addition rate. The implications are unchanged from our baseline model.

Lastly, consider assumption A3. Rather than an unlimited number of potential activities, what happens if we allow only a limited number? A limited number of potential activities could occur through either a limited pool of potential additions (e.g., if the firm is isolated from external sources of activities) or simply because there are a limited number of ways to accomplish a certain thing. In this case, when the firm has zero activities the rate of addition is still equal to the rate of arrival (λ), but as a firm's number of incumbent activities (S) increases, fewer of the arrivals are novel additions that expand S. As a result, the addition rate will be downward sloping, rather than flat, as shown in Fig. 3. With a declining addition rate, coupled with an increasing subtraction rate, the firm will still converge on a potential equilibrium point, again defined by S^* and T^*.

Comparative Statics

We next use comparative statics to demonstrate the implications of changes to the activity arrival and loss rates. In doing so, we examine how the steady state equilibrium activity scope (S^*) and turnover rate (T^*) vary with changes in the activity arrival rate λ and activity loss rate μ. Specifically, we take the partial derivatives of S^* and T^* with respect to λ and μ (from Eqs. (5) and (6)).

Change in activity arrival rate: Taking the partial derivatives with respect to λ, we have:

$$\partial S^*/\partial\lambda = 1/\mu > 0 \tag{7}$$

$$\partial T^*/\partial\lambda = 2 > 0 \tag{8}$$

This first set of comparative statistics (Eqs. (7) and (8)) implies that an increase in the arrival rate, λ, results in a new equilibrium point $S^{*\prime}$ that has greater firm scope as well as a higher turnover rate $T^{*\prime}$ than the previous equilibrium point. In Fig. 2, an increase in λ shifts the potential equilibrium point to the upper right.

Change in loss rate: Now taking the partial derivatives of S^* and T^* with respect to the loss rate, μ, we obtain:

$$\partial S^*/\partial\mu = -\lambda/\mu^2 < 0 \tag{9}$$

$$\partial T^*/\partial\mu = 0 \tag{10}$$

This second set of comparative statics (Eqs. (9) and (10)) implies that an increase in the loss rate results in a new equilibrium point that has decreased firm scope but the same turnover. The intuition for the latter finding is that as the activity loss rate (μ) increases, firm scope, S^*, will decrease in the same proportion, keeping the firm subtraction rate (μS^*) constant (we will still have that $\mu S^* = \lambda$). In Fig. 2, an increase in μ makes the subtraction curve steeper, shifting the potential equilibrium point to the left (smaller S^*) but leaving turnover unchanged.

Implications of the Model so Far

Up to this point, the model provides three initial insights for understanding resource redeployment: (1) the juxtaposition of firm scope and turnover at a point in time, (2) predictable trajectories of scope and turnover over time, and (3) the link between these redeployment dimensions and activity arrival and loss rates. We illustrate these implications using USPTO data on firm patenting (Lai, D'Amour, & Fleming, 2009).

Implication 1 – Scope and turnover at a point in time: The model draws attention to fundamental forces driving firm activity scope and turnover: resource redeployment via activity addition and subtraction rates, which are important both in their net effect (determining scope) and their aggregate effect (determining turnover). There are important differences in these effects: addition increases both scope and turnover, while subtraction decreases scope but increases turnover. Thus, addition and subtraction diminish each other in determining scope, but augment each other in shaping turnover, which reflects how actively the firm is reconfiguring its activities (Fig. 1). This duality of resource redeployment provides a more complete image of the firm's activity composition than simply focusing on scope at a point in time. Firms with similar scope may have very different underlying turnover rates. Quite simply, if one compares firms only in terms of scope, it is easy to overlook differences in underlying turnover and in their related reconfiguration strategies.

Until this point, we have spoken about firm activities in the general sense, as the routines and other processes that a firm undertakes. Although there are many scholarly perspectives on how specific firm activities are chosen, there is general acceptance that one of the duties of the strategic manager is to choose which activities the firm should and should not engage in. To provide one window into the internal activities of the firm, we turn to a firm's patenting activity, as recorded in the USPTO. We believe that examining a firm's patenting activities is highly relevant: (a) patenting is the embodiment of appropriable assets in the knowledge economy, (b) there is a rich taxonomy organizing patents into distinct classes and subclasses, and (c) shifting of patenting activity from one class to another may be a trace of the activity reconfiguration process within a firm. Hence, a rich body of research uses patent data to study business activity.

The following examples illustrate implication 1. We focus on firms from the pharmaceutical and consumer electronics industries, using the number of patent classes in which these firms patent as a measure of their number of activities. Patent classes are relevant indicators of activities – though certainly not fully encompassing – because they indicate where a firm applies effort in attempting to create goods and services. We define redeployment via additions as new patenting activity (patenting in a three-digit patent class that the firm did not patent in during the prior year). Conversely, we define redeployment via subtractions as the absence in a given year of patenting in patent classes in which the firm patented in the previous year. Table 1 provides more information on how we measure additions and subtractions, as well as scope and turnover.

Panel A in Table 1 reports patent class activity for five pharmaceutical firms – Takeda, Astra, Pfizer, Glaxo, and Sanofi – in 1995. We chose these five firms because they had similar scope that year, each reporting activity in 14–16 discrete patent classes. Despite the similar scope, the firms differed strikingly in their activity turnover.

Digging into the illustration, the firms differ in the patterns of additions and subtractions that generated the turnover. Both Takeda and Astra had high turnover, but Takeda's turnover was via high subtractions while Astra's turnover was via high additions. Pfizer and Glaxo also had high turnover but their additions and subtractions were more balanced. Sanofi, with similar scope to other firms in the sample, had low turnover due to limited additions and subtractions. Thus, simply examining the scope of activities of the five firms in 1995 would mask major differences in key aspects of their underlying reconfigurations.

Now consider turnover rates and scope in the consumer electronics industry in 2004. The three firms in Panel B of Table 1 – Apple, RIM, and Nokia – had similar turnover patterns that year. However, they had very different scope of technological activities, as well as different patterns of additions and subtractions. Compared to its peers, Apple had lower scope, achieving high turnover via a mix of additions and subtractions. RIM had a somewhat higher scope of activities, with high additions driving high

Table 1. Scope and Turnover for Consumer Electronics and Biopharmaceuticals Firms.

Firm-Year	Scope	Turnover	Additions	Subtractions	Addition-Subtraction	Description
Panel A. Biopharmaceuticals						
Takeda (1995)	16	16	4	12	−8	High turnover, via high subtraction
Astra (1995)	16	13	11	2	9	High turnover, via high addition
Pfizer (1995)	15	12	4	8	−4	High turnover, via mix of addition and subtraction
Glaxo (1995)	14	13	7	6	1	High turnover, via mix of addition and subtraction
Sanofi (1995)	14	6	4	2	2	Low turnover (limited addition and subtraction
Panel B. Consumer electronics						
Apple (2004)	29	12	12	16	−4	High turnover, via mix of addition and subtraction
RIM (2004)	35	19	19	7	12	High turnover, via high addition
Nokia (2004)	52	9	9	18	−9	High turnover, via high subtraction

Notes: To illustrate the importance of considering both firm scope and firm turnover, we use data on the patenting activities of firms in the biopharmaceutical (Panel A) and consumer electronics (Panel B) industries. We define firm scope as the number of distinct (primary) patent classes in which a firm applied for a patent within a given year. Additions are new patent classes (i.e., present in year $t1$ but absent in year $t0$) and subtraction is the absence of prior patent classes (i.e., absent in year $t1$, but present in year $t0$). Turnover is the sum of additions and subtractions. Panel A illustrates that firms with similar scope can have very different turnover, additions, and subtractions. Moreover, high turnover can occur through high addition, high subtraction, or both. Panel B illustrates that firms with relatively similar levels of turnover can vary greatly in firm scope.

turnover. Nokia, meanwhile, had the highest scope of all three firms: it had activity in 54 discrete patent classes that year. In contrast to RIM, Nokia's high turnover reflected high subtractions. Again, then, the examples in Table 1 highlight the need to examine scope and turnover in conjunction, as well as underlying additions and subtractions, in order to gain a more complete understanding of the resource redeployment that underlies firm reconfiguration.

Implication 2 – Predictable trajectory under stable conditions: A second implication of the model is that, given a firm's arrival and loss rates, the firm's activity characteristics converge toward a predicted equilibrium point (Fig. 2). Thus, the disparity between a firm's *current* scope and turnover and the *predicted* scope and turnover will shape the rate and direction (i.e., increase or decrease) of change in the firm's activity composition. Scope and turnover will first quickly converge toward the equilibrium value and later converge more slowly. That is, as firms approach their predicted equilibrium point, their scope (S) and turnover rates (T) will stabilize. It is important to note that firms will converge arbitrarily close to their predicted equilibrium point but will never actually reach it in finite time. Moreover, any change in the arrival or loss rate will set them on a new trajectory, as the next implication addresses.

Implication 3 – Changes in arrival and loss rates lead to changes in scope and turnover: In the comparative statics section of our model development, we illustrate how changes in the arrival and/or loss rate shift the predicted equilibrium point of a firm. As a consequence, following on implication 2 above, these shifts can alter, or even reverse, the direction of a firm's scope and turnover rate (in the case of the arrival rate). In this manner, our model suggests that a firm's activity composition is woven by the warp and weft of arrival and loss rates; as these rates change, so do the activity composition characteristics of scope and turnover that the rates underpin.

Recognizing the intimate relationship between arrival and loss rates pushes one to consider factors that shape these rates. To list a few possible elements, one can parse factors into external drivers, firm characteristics, and managerial levers. Potential external drivers include regional knowledge spillovers and employee poaching by competitors. Potential firm characteristics include size and employee departure rates that arise from demographic characteristics. Potential managerial levers include R&D budgeting, alliances, acquisitions and divestitures, creation of knowledge repositories, and organizational design such as skunkworks or forums (Chown & Liu, 2015); in turn, managerial levers need to be tuned to relevant aspects of the environment and firm characteristics. Thus, our model offers a flexible framework of resource redeployment that accommodates both passive and active factors that can shape both convergence and change in firm scope and turnover rates.

To illustrate implications 2 and 3, we further develop the examples from the pharmaceutical and consumer electronics industries to consider turnover rates and scope over time. We first turn attention to Apple, RIM, and Nokia in the consumer electronics industry (Fig. 4a). For Apple, we observe reasonably stable turnover throughout the observation period, although this was dominated by addition in the early 1990s, subtraction in the late 1990s, and balance between the two thereafter. As a consequence, Apple's patent class scope has remained relatively stable through recent history. By contrast, Nokia had a significant number of additions, with its scope of activities tripling over the course of a decade, from 1990 through 2002. After 2002, although Nokia maintained stable turnover, subtractions dominated with a concomitant decrease in scope. For RIM, both scope and turnover increased steadily throughout our observation period. Hence, these three firms illustrate markedly different patterns, whether arising through planned or emergent strategy, for companies situated in the same consumer electronics space.

Fig. 4b depicts firm activity compositions in the pharmaceutical industry, reporting varied patterns of reconfiguration. For our observation period, Takeda, Sanofi, and Pfizer have relatively stable scope and turnover. By contrast, in the early 1990s, Glaxo increased its scope dramatically (largely via acquisitions) and has been stable ever since. Lastly, following a prolonged period of stability in the 1980s, Astra had a change in strategy in the mid-1990s. The company expanded the scope of its activities dramatically in the latter part of that decade through a strategic alliance with Merck, which increased access to external knowledge and therefore increased the addition of new activities.

MODEL EXTENSION: ABSORPTIVE CAPACITY

Model Extension

To illustrate the flexibility of the model, we develop an extension to address a firm's absorptive capacity. So far, the model has assumed that the arrival rate is independent of firm scope (Eq. (1)). However, Cohen and Levinthal's (1990) concept of absorptive capacity suggests that firms differ in their ability to receive and assimilate activities, based on the internal characteristics of their knowledge base (in our model an activity arrives if it is both received and assimilated). They argue that "diversity of knowledge plays an important role" (Cohen & Levinthal, 1990, p. 131) in the ability to recognize, assimilate, and apply new capabilities, where we use the term activity as

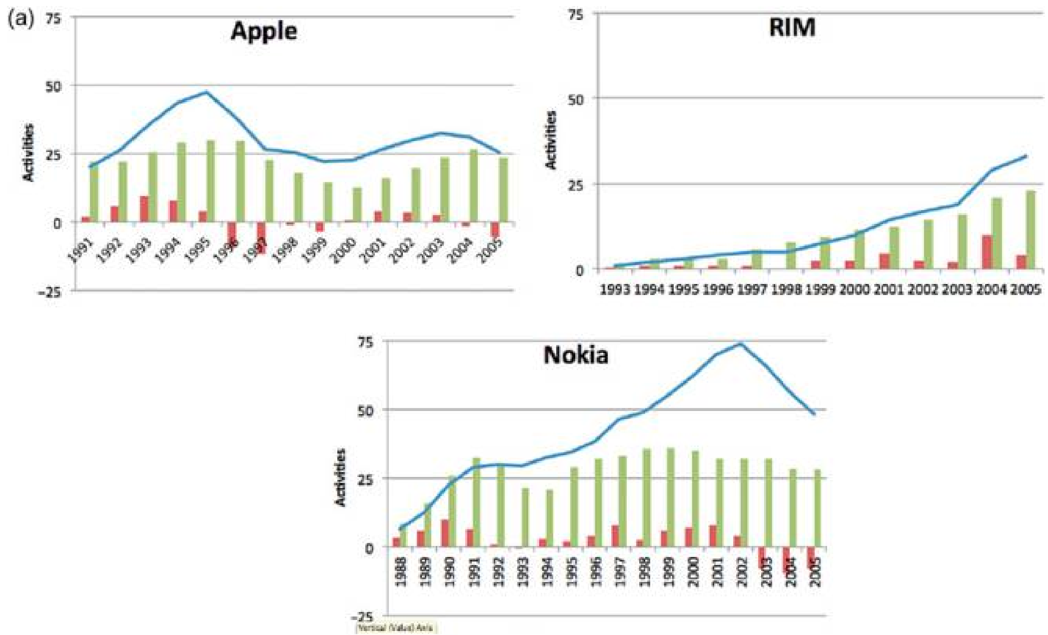

Fig. 4. Scope and Turnover Changes over Time. (a) Consumer Electronics Firms. (b) Pharmaceutical Firms. *Notes*: (a) To illustrate changes in firm scope and firm turnover over an extended period of time, we first focused on the patenting activities of three firms in the consumer electronics industry. Firm scope, the number of distinct (primary) patent classes in which a firm applied for a patent within a given year, is shown by the solid line. Firm turnover, the composite of additions (new patent classes not in prior year) and subtractions (absent patent classes present in prior year) is shown in light bars. The net of additions and subtractions, or the year-to-year change in firm scope, is shown in dark bars. (b) This figure illustrates changes in firm scope and firm turnover over an extended period of time for five biopharmaceutical firms. Firm scope, the number of distinct (primary) patent classes in which a firm applied for a patent within a given year, is shown by the solid line. Firm turnover, the composite of additions (new patent classes not in prior year) and subtractions (absent patent classes present in prior year) is shown in light bars. The net of additions and subtractions, or the year-to-year change in firm scope, is shown in dark bars.

analogous to their term capability. In turn, Cockburn and Henderson (1998) suggest that active engagement with some activities enables a firm to absorb others, and this may refract into the internal intensive structures of firms (Liu & Stuart, 2014). Conversely, scholars such as Levitt and March (1988) and Leonard-Barton (1992) have discussed cases in which current

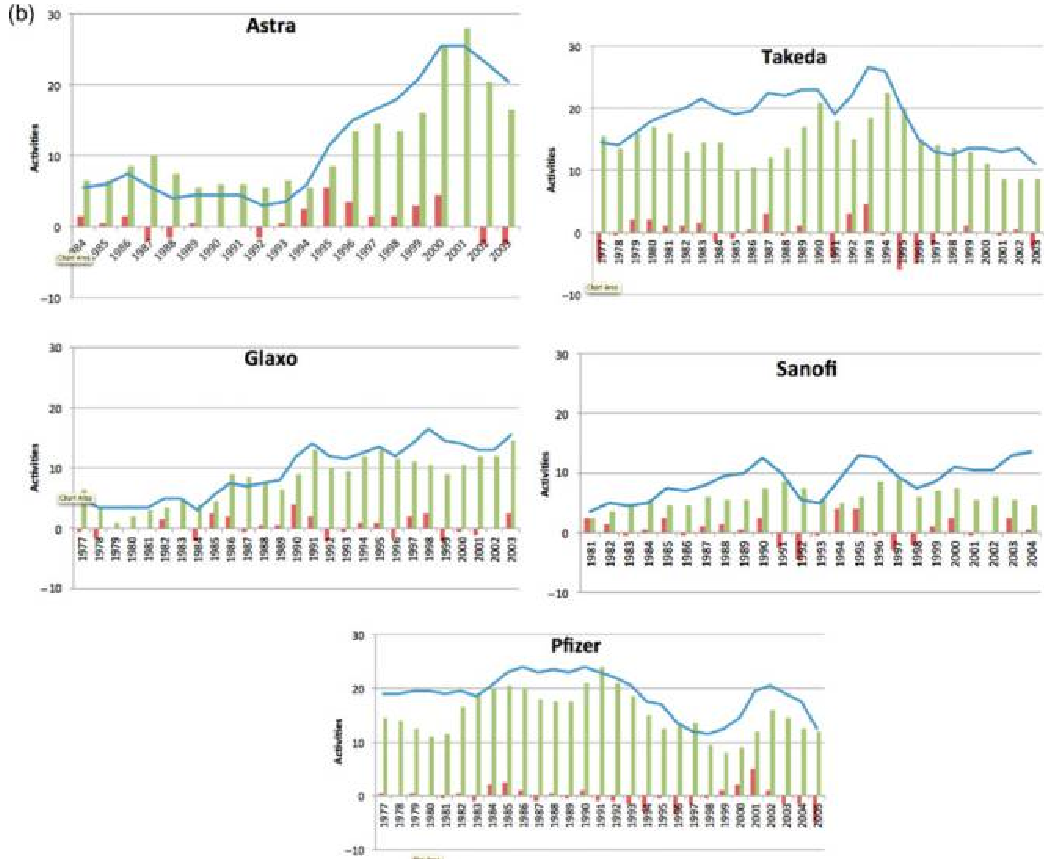

Fig. 4. (*Continued*)

activities constrain the ability of a firm to add new activities. The extension of the model accommodates either view, depending on whether the firm's arrival rate is a positive or negative function of the firm's existing number of activities (i.e., scope).

We model absorptive capacity (in the form of a firm's arrival rate) by adopting the following more general form for the addition rate of activities, which now, in addition to the firm's constant rate λ, is also affected by the firm's existing scope S:

$$Addition(S) = \lambda + \alpha S \tag{11}$$

where $\lambda \geq 0$ and α are constants. λ models the fact that the baseline (constant) arrival rate may differ across firms; α models whether scope positively or negatively impacts the arrival rate of activities as well as the degree to which it does. We can think of α as a modeling parameter, that is, the extent to which we want to model the fact that absorptive capacity depends on scope and in what direction. In parallel, we can think of α as a parameter that captures additional firm heterogeneity, namely the extent to which each firm's arrival rate depends on its scope; this might occur if a firm is organized in such a way that the arrival rate is more dependent on scope or if a firm is in a location where scope has a bigger impact. The expression derived in the previous section is then a special case where absorptive capacity is potentially different across firms, but constant (λ), rather than being affected by scope (S).

Under these conditions, the law of motion for the scope of the firm is then given by the difference between the addition rate ($\lambda + \alpha S$) and the subtraction rate (μS):

$$\frac{\mathrm{d}S}{\mathrm{d}t} = \lambda + \alpha S - \mu S \tag{12}$$

This is a first-order linear differential equation with solution:

$$S(t) = \frac{\lambda}{(\mu - \alpha)} + C\mathrm{e}^{-(\mu-\alpha)^{t}} \tag{13}$$

where C is a constant that is pinned down, for example, by the initial conditions of the firm.

Turnover is now

$$T(t) = \lambda + (\alpha + \mu)S \tag{14}$$

Combining this equation with Eq. (13), we obtain

$$T(t) = \frac{2\lambda\mu}{\mu - \alpha} + C'\mathrm{e}^{-(\mu-\alpha)t} \tag{15}$$

where C' is some constant.

Having derived an expression for $S(t)$ and $T(t)$, we can now compute the steady state equilibrium values S^* and T^* when the model incorporates the more complex modeling of absorptive capacity. There are two qualitatively distinct cases:

Case 1. *Convergence:* $\mu > \alpha$

$S(t)$ and $T(t)$ will converge to

$$S^* = \frac{\lambda}{\mu - \alpha} \tag{16}$$

and

$$T^* = \frac{2\lambda\mu}{\mu - \alpha} \tag{17}$$

Case 2. *No distinct steady state:* $\mu \leq \alpha$

$S(t)$ and $T(t)$ will increase without bound over time because the addition rate will always be larger than the subtraction rate. Therefore, there is no steady state.

Fig. 5 illustrates the steady state for the two types of cases. When $\mu > \alpha$ (case 1), scope and turnover converge to a steady state (Fig. 5a); by contrast, there is no convergence when $\mu \leq \alpha$ (case 2). In Fig. 5b we have the case where $\mu = \alpha$; the addition and subtraction curves are parallel and meet only at infinity. In the case of $\mu < \alpha$, the dashed line in Fig. 5b highlights how the addition curve lies above the subtraction curve and has higher slope, so that the divergence between the two increases with S; again, the addition and subtraction curves do not intersect.

Thus far, we have focused on the case with $\alpha \geq 0$, but the case where $\alpha < 0$ also could arise. For instance, this would occur in firms that face a "not-invented-here" syndrome in the form of core rigidities (Leonard-Barton, 1992; Levitt & March, 1988). Rather than an addition curve with a positive slope (Fig. 5a), the addition curve will have a negative slope, with the steepness of the slope determined by α. This special case relaxes assumption 3 in Fig. 3 and, as with the earlier discussion of relaxing that assumption, having $\alpha < 0$ yields consistent implications with our baseline model.

Implications of Absorptive Capacity Extension

The extended model has two implications for redeployment research. First, whether α is positive or negative, the larger the absolute magnitude of α (i.e., the more the firm's addition rate is affected by S), the steeper the

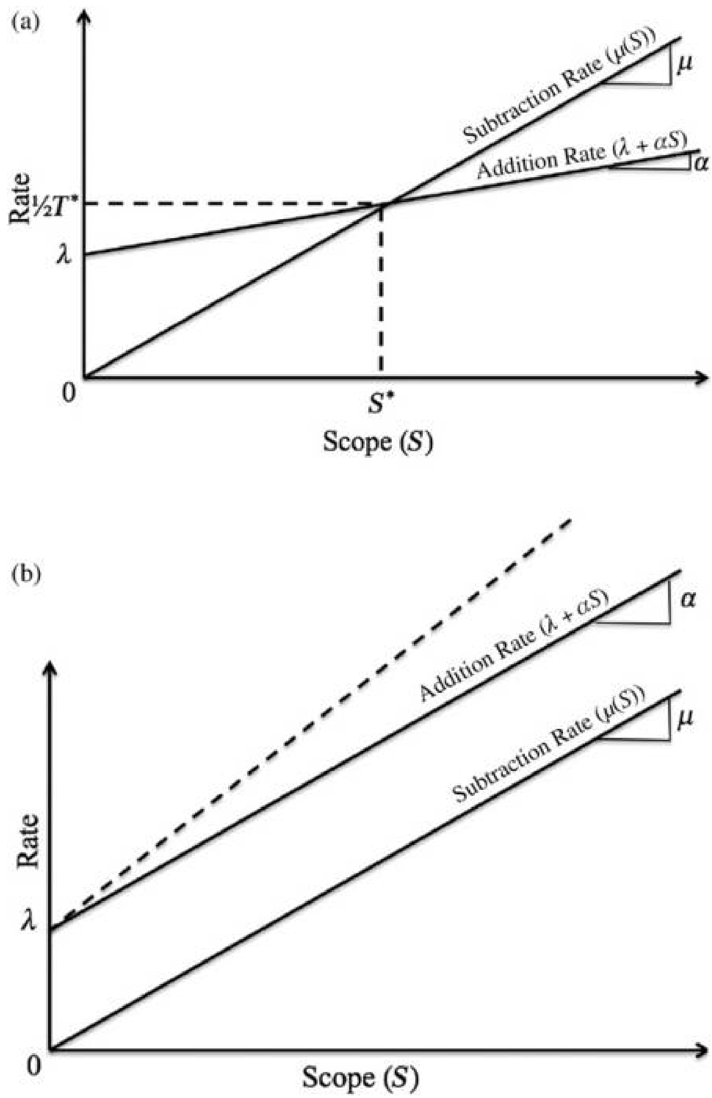

Fig. 5. Convergence and Non-Convergence in Model with Absorptive Capacity. (a) Steady State S^* and T^* when $\mu > \alpha$ (Case 1). (b) No Steady State when $\mu = \alpha$ (Case 2a). *Notes*: (a) This figure illustrates the model extension, incorporating elements of absorptive capacity. If the arrival rate depends upon scope, but $\mu > \alpha$, then a potential equilibrium point will be reached and our model implications are largely unchanged. (b) This figure graphically illustrates the results if $\mu = \alpha$, where no potential equilibrium point is possible. The condition where $\alpha > \mu$, which also yields no equilibrium point, is shown in the dashed line.

addition rate. In practice, this means that a firm with greater positive α (greater sensitivity to scope) will ratchet up to a higher level of scope and turnover, reaching a potential equilibrium point defining S^* and T^* farther from the origin (e.g., Fig. 5a). By contrast, a firm with a greater negative α will ratchet down to lower S^* and T^*, lying closer to the origin.

Second, the model lays out the necessary conditions for stability in a firm's scope and turnover rate and, in turn, suggests points of emphasis for redeployment strategy in practice. The model illustrates two ways in which firms may be unstable. If α is particularly large, greater than or equal to the subtraction rate, the firm might never reach an equilibrium point (e.g., Fig. 5b); similarly, if activity loss rates (μ) are particularly low, the firm's scope and turnover rate also may increase without limit. To the extent that managers desire stability in a firm's activity composition, they can adjust these two parameters. They can attempt to adjust α by seeking ways to link a firm's existing activities (S) to potential new activities, possibly through organizational changes that emphasize opportunities for addition. In parallel, they can seek to affect the activity loss rate μ, such as by adjusting incentives to retain diverse people and information. Hence, the parameter α links firm scope to addition rates with an upper limit ($\alpha < \mu$) for the firm to achieve stable activity composition.

DISCUSSION

This paper has put forward a framework to explain the reconfiguration of firms' activities. We suggest that a firm's activity composition lies at the intersection of redeploying resources as reflected in activity addition and subtraction rates. As a consequence, we highlight two complementary characteristics of a firm's activity composition: its scope (the net of addition and subtraction rates) and its turnover (the sum of addition and subtraction rates). We then illustrated an empirical operationalization of our theory using USPTO patent filings by firms in the consumer electronics and biopharmaceuticals industry. Lastly, a model extension allowed the arrival rate to vary with firm scope. In so doing, we demonstrated the flexibility of our model to incorporate aspects of the literature on absorptive capacity and the not-invented-here syndrome.

Importantly, our model offers a more complete view of a firm's redeployment activity than simply comparing firms' scope at a point in time or even over time; it is possible for firms with identical scope to have drastically different rates of underlying activity redeployment. Fig. 1 illustrates this masking. Two firms may have identical, stable scope over time; that is, the same number of activities year after year. However, it is possible that one of them has very high addition and subtraction rates and is situated in the upper-right sector of the graph. By contrast, a seemingly identical firm, if one looks only at the dimension of scope, could be situated in the lower-left sector of the graph with low addition and subtraction rates, and hence low turnover. This representation is reinforced by our empirical illustration in the consumer electronics industry (Fig. 4). If a researcher were to simply examine firm scope and net turnover, she would miss dynamics of activity redeployment that drive the reconfiguration of the firm's resources.

Managerial Implications

Our logic provides implications for strategic managers. First, the model suggests that changes in the fundamental, underlying addition or subtraction rates are essential if the manager is to enact lasting changes in the activity composition of the firm. For example, consider a manager who desires to increase the scope of the firm. This manager may bring in a new set of activities into the focal firm, thus increasing the firm's scope. In Fig. 2, this shifts the firm's scope (S) and turnover rate (T) to the right. However, without a change in the addition and subtraction rate curves (neither λ nor μ has changed), the firm is now in disequilibrium: the loss rate is now higher and, over time, the firm's breadth of activities will revert back to S^*. Within the model, shifts in a firm's activity composition, without changes to the underlying forces, (ultimately) result in reversion to the equilibrium state. While this point may appear arithmetically intuitive, the separation of control over different activities that is common in firms of any complexity can lead to such unanticipated results.

Second, a central contribution of the model is to segregate addition and subtraction rates. As suggested above, changes in the addition and subtraction rates correspond to changes in the activity composition of the firm. Thus, the model provides two complementary levers for the strategic manager to enact these changes. What might drive redeployment via addition and subtraction rates? We suggest that the rates may be driven by a mix of environmental factors, endogenous structuring processes, and managerial actions.

Third, any discussion of the managerial implications of scope and turnover needs to touch upon potential links to firm performance. For example, a firm's reconfiguration activity has been linked to its innovative capabilities (Henderson & Cockburn, 1994), learning (Khanna, Gulati, & Nohria, 1998), and ongoing performance (Galunic & Rodan, 1998; Helfat & Eisenhardt, 2004; Levinthal & Wu, 2010; Rumelt, 1974, 1982; Sakhartov & Folta, 2014). While we emphasize that the goal of our model is descriptive, not normative, we highlight two potential implications for performance.

First, firms in different environments might benefit from different scope and turnover rates, while such firm-environment fits are likely to change over time. Consider the case of Polaroid (Tripsas & Gavetti, 2000). After reaping profits for decades in an environment that rewarded the stable allocation of resources with low scope and turnover, a dramatic change in the external technical and competitive environment found the firm unable to adapt its capabilities. When the external environment is stable, a narrow, focused set of activities (i.e., small S and T) may tend to be beneficial. However, when environments change sharply, a diversified activity portfolio (e.g., Intel's pivot from memory to microprocessors), as well as rapid activity turnover, may be desirable (Brown & Eisenhardt, 1998; Sull, Tedlow, & Rosenbloom, 1997).

Although speculative, it is possible that some element of stability in firm scope, whether such scope is broad or narrow, is beneficial. Consider the counterfactual: a firm that swings wildly between a large number of activities and a narrow number of activities, year-over-year. It is unlikely that benefits of renewed activities would fully counter-act inefficiencies that arise through constantly hiring, reallocating, and shedding employees. Although drawing conclusions from a small number of firms requires caution, the notion that stable scope is beneficial is supported by our analysis of consumer electronics firms in Fig. 4, particularly with respect to the recent declining performance of both RIM and Nokia.

A second perspective would suggest that moderate levels of both scope and turnover might be beneficial. Continuing with the earlier example, Polaroid may have benefited from partitioning the firm into different subsections. Rather than a focus on its "cash cow," Polaroid might well have benefited by dedicating a limited set of resources to a secondary unit as a hedge against future volatility. For this second set of activities, an ongoing stream of redeployment and turnover, allowing entrepreneurial managers to constantly seek new ventures, may have facilitated a more favorable outcome for the company.

Most generally, we believe that a strength of this paper is to provide both clarity and levers to enable managers to tune the firms' scope and turnover characteristics to current needs for resource redeployment and business reconfiguration. Strengthening this linkage between firm activity characteristics and firm performance is an exciting opportunity for future research.

Limits and Directions for Future Research

This paper has limits that suggest directions for future research. First is an issue of boundary conditions. A central goal of this paper has been to develop a model to explain how redeployment of activities shapes a firm's knowledge base; addressing this goal has required a trade-off between parsimony and verisimilitude. Our model is a starting point for more complex iterations. We have shown that our model is largely robust to a relaxation of our core assumptions. Moreover, the model is flexible enough to allow several alternative specifications, such as assuming that absorptive capacity causes the arrival rate to depend on scope.

Second, our model has only considered a single firm, in isolation from the influence of others. Nonetheless, although largely outside the scope of this paper, we believe that our model also speaks to interrelationships between firms. It is logical to consider entities beyond the focal firm as sources of activities, leading to a higher addition rate. Alternatively, external firms may also act as competitors, serving to lure away the focal firm's strategic human capital and accelerating the firm's subtraction rate. Moreover, if the unit of analysis shifts from a firm to the business unit, one could apply a similar logic inside the firm, with activities from one unit cross-fertilizing another (e.g., corporate strategy) or crowding out (e.g., the exploitation/exploration paradox). We believe that this image of a firm as an archipelago of business units, situated in the greater constellation of entities may be a useful future avenue of study.

Third, we have defined activity scope, $S(t)$, as the number of distinct activities present in the firm at time t and have treated firm size as independent of turnover. Our implicit assumption concerning this definition of scope is that any one added activity has the potential to seed future growth, while any one subtracted activity has the potential to eliminate future trajectories of activities. Nonetheless, an alternative definition of firm scope would take into account the distribution of resources allocated to each activity in the firm. For example, for a firm that is engaged in multiple different activities, one could envision a Herfindahl-type measure that captures how evenly or unevenly sales are distributed between the activities.

In parallel, large firms with plentiful resource may dedicate more resources to each type of activity. This issue, the magnitude of resources allocated to each activity, will likely affect the subtraction rate of that activity. With greater redundancy in knowledge, departures of key employees are less likely to cause gaps in the firm's knowledge stocks. Moreover, larger firms may move more slowly to reallocate resources away from unattractive product lines. For these reasons, we suspect that the subtraction rate for larger firms will be lower than smaller firms. However speculative this line of reasoning is, linking different firm characteristics (e.g., industry, size, age) to the focal firm's addition and subtraction rates is an interesting future line of research.

Fourth, the focus of this paper has been on conceptual development rather than empirical testing. Our examples serve only to illustrate how aspects of our model might map onto characteristics of firm activities and perhaps to suggest a setting where one might empirically explore the model. In theory, a causal test is straightforward. One would require exogenous shocks to either a firm's arrival or loss rate, with the pre- and post-shock examinations of firm scope and turnover. Although identifying a set of exogenous shocks to either the arrival or loss rate without an effect on its complement will be challenging, we believe that these studies would be a useful addition to the current avenue of inquiry.

Several other issues merit attention. It would be useful to address the causes of addition and subtraction of activities in more detail, including factors that influence discrete additions and subtractions, as well as the degree to which addition and subtraction may arise from a firm's goals for overall scope. It would be useful to assess profitability, both in terms of how different patterns of addition and subtraction affect profitability and how profitability might affect addition and subtraction choices. One could also extend the investigation of interdependencies among arrival and loss beyond the discussion that we outlined above and in Table 2.

We hope that this paper highlights the importance of looking not just at firm scope, but also at the firm's rate of turnover for a more complete view of how resource redeployment shapes the composition of a firm's activities. In highlighting the role of redeployment via addition and subtraction rates of a firm's set of activities, we provide a richer perspective on the fundamental levers that drive reconfiguration of a firm's resource base.

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