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STRATEGIC FACTOR MARKETS: BARGAINING, SCARCITY, AND RESOURCE COMPLEMENTARITY

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Tunji Adegbesan*

Abstract

Strategic factor market theory suggests that without luck or asymmetric expectations firms cannot appropriate gains from acquired resources. Adopting the bargaining perspective on resource advantage, we hold that this is only true in the absence of resource complementarity. We extend factor market theory to account for resource complementarity, and we show that firms can profit when they exhibit superior complementarity to target resources, even in the absence of asymmetric expectations. Thus we provide an alternative interpretation of managers' recent emphasis on externally acquired resources.

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"Business processes – from making a mousetrap to hiring a CEO – are being analyzed, standardized, and quality checked. That work, as it progresses, will lead to commoditization ... on a massive scale" (Davenport, 2005: 101). "Gross savings of as much as 40% can be achieved from moving such functions to India from Europe and the U.S. ... according to a survey on information-technology outsourcing published in June by Boston Consulting Group" (Taylor, 2005).

"In a move that will save ABN Amro *hundreds of millions* of dollars a year, the Dutch bank said it had agreed to pay *$2.2 billion* [over five years] to outsource most of its technology work to five companies ... Tata Consultancy said it will get around $240 million, while Infosys says it will get at least $140 million from the contract. The respective deals are the biggest ever landed by the two, which are India's largest software companies..." (Bellman, 2005).[1] "A survey by Mercer in October showed Indian private sector salaries rising more rapidly than anywhere in the world, at a forecast rate of 7.3 per cent above inflation next year and 11.3 per cent year-on-year" (Johnson, 2005).

Why do we consistently observe managers trying to improve performance by means of strategies that depend on external resources whose value seems apparent to all and sundry? Shouldn't sellers' prices anticipate the gains widely bandied about by managers, analysts and journalists?

[1] Emphasis added.

Strategic factor market theory (Barney, 1986; Makadok and Barney, 2001) holds that firms cannot appropriate gains from the deployment of valuable resources unless they have superior expectations about their future value or are beneficiaries of luck. Yet we daily observe that, from mobile phone companies sourcing for value-added data services to investment banks jostling over "star" fund managers, organizations consistently seek to build superior performance around resources obtained from reasonably competitive markets, where it would be difficult to argue that they have much higher expectations than suppliers about the value of the resources in use.[2] In such situations, we would expect sellers' prices to approximate the gains to be realized from the deployment of the resources they supply.

Why then do managers often place great emphasis on the acquisition of such resources in the face of competition from industry rivals? Is it that they are too optimistic, just plain dumb, or that asymmetric expectations are not always a necessary condition for appropriating gains to trade from resources acquired in competitive factor markets?

In this paper we support the latter view, arguing that firms can competitively acquire resources for less than the surplus they create in combination with other firm resources and capabilities, when they exhibit superior complementarity to the target resources relative to competing firms.

Employing the recent "bargaining perspective on resource advantage" (Lippman and Rumelt, 2003a), we conceptualize the external acquisition of resources as taking place in factor markets with multiple sellers, and multiple potential users exhibiting varying degrees of complementarity to target resources. In such markets, appropriation results from bargaining over value that could be created by various combinations of resources and firms.

Cooperative game-theoretic analysis is used to show that the amount of value captured depends on the relative supply/demand of seller and buyer groups, the relative degree of complementarity between individual buyers and target resources, and the bargaining ability of individual buyers relative to individual resource suppliers. As such, firms can realize gains to trade when they exhibit superior complementarity to target resources, even in the absence of asymmetric expectations.

Thus instead of searching for resources whose value is unknown to all players, managers can search for resources whose value in combination with their firms' resources and capabilities can be matched by few players. In addition to being a more feasible challenge, this approach seems more in keeping with the efficiency-based spirit underlying the resource-based view (Peteraf and Barney, 2003). Finally, our theoretical approach for analyzing the components of bargaining power in the distribution of surplus further develops the integration of cooperative game theory into the resource-based view (Lippman and Rumelt, 2003a, b), demonstrating the great promise it holds for strategic management research.[3]

In the next section, we start off with a review of the existing knowledge on the profitability of trade in strategic factor markets, extending it to account for the possibility of resource complementarity. In the following section, we present a coalitional model of a strategic factor

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[2] Indeed the opposite is sometimes the case, for example in situations where firms depend on supplier capabilities for resource integration.

[3] Other uses of cooperative game theory in strategy include the work by Brandenburger and Stuart, 1996, 2004; MacDonald and Ryall, 2004; and Stuart, 2001.

market, we obtain its core, and use it to characterize the determinants of value appropriated by each player. In doing so, we show how value appropriation is determined by scarcity, bargaining ability, and complementarity. We then discuss the theoretical and practical implications, limitations, and extensions of our study, before concluding.

Making Money from Resources

The resource-based view (RBV) of the firm holds that superior performance is underpinned by the deployment of valuable resources that are rare, inimitable, and non-substitutable (Barney, 1991; Hoopes, Madsen and Walker, 2003; Peteraf, 1993; Peteraf and Barney, 2003). Therefore, a natural question to ask is where those resources come from, and how they can be acquired at a cost below the amount of value they create (Barney, 1986, 1989; Denrell, Fang and Winter, 2003; Dierickx and Cool, 1989a, b; Makadok and Barney, 2001).

Most of the academic discourse on this issue has revolved around Barney's (1986) theory of strategic factor markets (SFM). According to him, "the cost of acquiring strategic resources will approximately equal the economic value of those resources" unless "buyers are consistently better informed about their future value" (ibid: 1231, 1232) or are just plain lucky. He held that these two conditions were necessary for acquiring resources at a cost less than their value, and that all other seeming strategic factor market imperfections could ultimately be reduced to one or the other (Barney, 1986).

In response, Dierickx and Cool (1989a) pointed out the existence of an important set of "strategic resources" that are not freely tradable across any existing markets. Such resources are accumulated within firms through processes characterized by "time compression diseconomies, asset mass efficiencies, interconnectedness of asset stocks, asset erosion, and causal ambiguity" (ibid: 1507). (An illustration of this mechanism at work is provided by Miller's (2003) study of 22 companies which leveraged seemingly unimportant asset asymmetries, internally building them into sources of competitive advantage.) Thus in Dierickx and Cool's (1989a) view, SFM theory might not apply to this class of resources.

However, Barney (1989) argued in reply that asset accumulation is not costless, and this cost has to be factored into the evaluation of strategies relying on resources accumulated within firms. Consequently, whether tradable or not, firms would still require superior expectations or luck to engage in the path-dependent processes leading to the accumulation of resources, at a cost lower than their use-value. Nevertheless, he considered the emphasis on resource accumulation as an important extension of SFM theory.

In a more recent development, Denrell et al's (2003) analysis suggested that insufficient attention has been paid to the incidence of "luck" (Barney, 1986) in SFM. They held that due to pervasive market incompleteness, prices often fail to reflect the best-use value of resources, leading to the occurrence of "strategic opportunities" whose discovery is characterized by "serendipity."[4] As such, their "stance is that 'the good news, is that the bad news [about the possibility of outsmarting the resource market] is wrong' (or at least, the bad news is valid only

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[4] Serendipity is "not just luck, but effort and luck joined by alertness and flexibility ... where the effort was not initially directed to the specific end realized, alertness is required to recognize the lucky appearance of a new possibility and flexibility is displayed in redirecting the effort" (Denrell et al, 2003: 978, 985).

within its proper sphere)" (Denrell et al., 2003: 977). In laymen's terms, one might interpret their position to mean that "being lucky isn't as hard as it seems at first sight."

In summary therefore, the prevalent view is that firms cannot appropriate gains from the deployment of valuable resources unless they have superior expectations about their future value, or they are just lucky (Ahuja, Coff, and Lee, 2005; Makadok and Barney, 2001). A resource seller will not accept a payment less than a resource's marginal productivity when used in combination with a firm's stock of other resources and capabilities. Thus the only systematic way to appropriate gains to trade in SFM would be by "outsmarting" the resource seller; and this is impossible in the absence of asymmetric information. As such there can be no systematic gains to trade in SFM in the absence of asymmetric information.

Strategic Factor Markets and Resource Complementarity

Nevertheless, despite its broad acceptance, this conclusion *is true only when there are no complementarities* between resources (Barney, 1988; Conner, 1991; Lippman and Rumelt, 2003a). The resource-based view assumes that productive factors in use have intrinsically differential levels of "efficiency" (Barney, 1991; Peteraf, 1993; Peteraf and Barney, 2003), and therefore a lot of attention has been paid to how firms endowed with such individual resources are able to produce more economically and/or better satisfy customer wants. However, much less attention has been paid to the nature and impact of various resource *combinations.*

When firms are characterized by heterogeneous resource endowments, different bundles of resources vary in their relatedness or complementarity to one another (Thomke and Kuemmerle, 2002). Several authors have alluded to resources that are more valuable in combination than in juxtaposition (e.g. Conner, 1991; Denrell et al., 2003; Dierickx and Cool, 1989a; Peteraf, 1993), but in practice most studies consider only the extremes of zero complementarity or "idiosyncratic bilateral synergy" (Mahoney and Pandian, 1992: 368; Barney, 1988; Chi, 1994; Makadok, 2001). In reality however, there is a more diverse variation in resource complementarity than this bipolar situation. Indeed, recent developments in economic theory (Makowski and Ostroy, 1995, 2001; Ostroy, 1984) account for factor complementarity at the very heart of their revision of neoclassical economics.

When there are no complementarities between resources, if the value of a resource R_1 on its own is $v(R_1)$ and the value of another resource R_2 is $v(R_2)$, then in combination their value is at most $v(R_1 \cup R_2) = v(R_1) + v(R_2)$. Thus $v(R_1)$ would be the marginal productivity of R_1 in the combination, and Barney's logic holds: unless the supplier of R_1 doesn't know what it is worth (asymmetric information), the owner of R_2 cannot pay less than $v(R_1)$ for the services of R_1. As such, a resource buyer cannot get more than she pays for.

However, when there is some degree of co-specialization (complementarity) between the resources, their combination is "superadditive" and $v(R_1 \cup R_2) = v(R_1) + v(R_2) + \Delta V$ where $\Delta V > 0$. The magnitude of the surplus created (ΔV) is proportional to the degree of complementarity between the resources. It does not "belong" to either resource but *results from their combination,* and the way it is *split between them is therefore indeterminate ex ante.* Consequently if the owner of R_2 is able to appropriate a positive share of the surplus ΔV, she can realize gains to trade from the SFM even if she had to pay $v(R_1)$ for the services of R_1.

In a world of zero complementarity the critical issue is how to acquire resources at a price less than the amount of value they contribute, or if you like, at a price less than what is really "due"

to them. However, with varying degrees of complementarity, an important issue becomes how to maximize the share of the surplus appropriated from resource combination. While asymmetric information can still allow a given resource to be acquired for less than its outside value, it will no longer be a *necessary* condition for gains to trade to exist. Indeed, beyond a focus on the value of individual resources, the value created by resource combination takes center stage (Lippman and Rumelt, 2003a), leading to a more intriguing question: What determines the distribution of the surplus created by the combination of complementary resources?

A Bargaining Perspective on Resource Advantage

The resource-based view of the firm has been developed upon the micro-foundations of standard neoclassical economics (Lippman and Rumelt, 2003a). Nevertheless, with complementarities in SFM, the relative demand and supply of sellers and buyers and the various combinatorial possibilities create a complex situation that standard neoclassical economics-based approaches cannot handle (Denrell et al., 2003; Lippman and Rumelt, 2003a, b; Makowski and Ostroy, 2001).

According to Lippman and Rumelt, standard neoclassical theory runs into problems when resources exhibit some degree of co-specialization, and there do not exist large numbers of buyers and sellers for each product and input (2003b). They hold that these and other issues can be adequately addressed by integrating cooperative game theory into the micro-foundations[5] of the RBV (Lippman and Rumelt, 2003a, b). Thus they espouse a "bargaining perspective on resource advantage" (Lippman and Rumelt, 2003a), built on the foundations of a "payments perspective" (Lippman and Rumelt, 2003b).

In this approach, rents appear as the negotiated payments for the services of scarce, valuable resources. The bargaining perspective "separates the issues of opportunity cost, value, and the distribution of rents," providing "a formal system in which surplus is known, but its division is subject to negotiation" (Lippman and Rumelt, 2003a: 1070). Firms are seen as coalitions of resources and "no resource is 'firm specific.'" Instead "there are co-specialized resources that exist within the legal shell of the firm" such that "bargaining parties are not firms or products, but rather the individual resources that lie behind them" (ibid.). The division of surplus is formally indeterminate and will be determined by the relative values created by different use combinations of resources. Thus at the heart of this approach is bargaining over the sharing of surplus created by resource combination.

This synthesis is both elegant and effective because, while solution concepts from cooperative game theory provide an excellent approach for studying the division of surplus, the RBV's focus on resource advantage highlights the impact of resource endowments on this division. In this paper we use the bargaining perspective to analyze when firms can profit from resources acquired in strategic factor markets in the presence of resource complementarity. We seek to make the coalitional approach more accessible to scholars who do not specialize in game theory, while providing an alternative explanation for the strategic importance many managers

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[5] "The micro-foundations of a subject are the definitions of its basic elements and the allowable operations that can be performed using these elements" (Lippman and Rumelt, 2003b: 903).

place on the acquisition of resources whose future value seems obvious to both buyers and sellers *ex ante.*

The Appropriation of Gains to Trade in Strategic Factor Markets

As we have seen, the combination of complementary resources creates surpluses whose division is subject to bargaining among the parties contributing to their creation. Thus when resources are obtained from factor markets in the presence of complementarities, buyers and/or sellers can enjoy gains to trade if they are able to appropriate a significant portion of the surplus created. How then can parties in the SFM ensure they enjoy gains to trade? What determines the distribution of the value created by trading in the SFM? In this section, we present a coalitional model of the SFM in order to address these questions. Before going ahead however, it will be useful to highlight some important features of the branch of game theory we will be using.

Coalitional Analysis of Value Appropriation

An important distinction for this paper is that between two branches of game theory: the so-called *non-cooperative* and *cooperative* branches. Many informal users of game theory might mistakenly identify the field as a whole with its non-cooperative branch, which uses the familiar language of decision trees and game matrices. Non-cooperative games, in technical terms, are those whose "primitives" are the sets of possible actions of *individual* players and their preferences with regard to possible outcomes, where an outcome is a profile of actions taken by each individual player autonomously (Osborne and Rubinstein, 1994). Familiar concepts from non-cooperative game theory include Nash equilibria and the Prisoners' Dilemma.

Cooperative game theory, on the other hand, has been less studied in recent years. Although the notion of a cooperative (or coalitional) game goes back to von Neumann and Morgenstern's (1944) seminal book, coalitional games are not well known beyond scholars in the field of game theory. Unlike the non-cooperative case, the "primitives" in a coalitional game are the set of joint actions that each possible *coalition* can take independently of the remaining players; in addition to the players' preferences over all possible outcomes (Osborne and Rubinstein, 1994). This time, outcomes specify the coalition that forms and the action it takes.[6]

While non-cooperative games tend to have very detailed and meticulously structured interactions, "cooperative theory abstracts away from this level of detail, and describes only the outcomes that result when the players come together in different combinations" (Brandenburger, 2002: 1). This is considered a virtue because the results of non-cooperative games often "depend very strongly on the precise form of the procedures, on the order of making offers and counter-offers and so on" (Aumann, 1987: 467). "Solution concepts for

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[6] Actually, the terms "non-cooperative" and "cooperative" are something of a misnomer, as they do not refer to whether players in a game "cooperate" or not, but rather to whether the "primitives" of the game are possible actions of *individual players* or possible joint (not necessarily cooperative) actions of *groups of players.* Thus "non-cooperative theory might be better termed *procedural* game theory, [and] cooperative theory *combinatorial* game theory. This would indicate the real distinction between the two branches of the subject" (Brandenburger, 2002: 1).

coalitional games do not depend upon the details of bargaining" and "this is helpful given the kind of loose, hard-to-model interaction that appears to characterize many competitive situations" (MacDonald and Ryall, 2002: 2).

Cooperative models are "useful for addressing the basic question of how much power the different players – firms, suppliers, customers, etc. – have in a given setting, and therefore, for saying how much value each player will capture" (Brandenburger and Stuart, 2004: 2). Non-cooperative models, on the other hand, quickly lose tractability under situations of multi-party bargaining. Nevertheless this is obviously not to deny the importance of non-cooperative models "for analyzing strategic moves in business – say the decision whether to enter a market, where to position a product, how much capacity to build, how much money to devote to RandD, etc." (ibid.). Each type of model simply has different applications. As Brandenburger and Stuart (2004) explain, non-cooperative models are useful for analyzing strategic moves that determine the amount of value (the size of the "pie") created, and coalitional games are ideal for analyzing how that "pie" is split up amongst the players.[7]

Game structure and solution concepts. Coalitional analysis involves the specification of a game structure, and then the application of an appropriate solution concept. On the one hand, the game structure is a representation of the situation being modeled and describes the joint actions that each possible coalition can take, independently of the remaining players (Osborne and Rubinstein, 1994). As such, it is a representation of the value-creating options available to the different players. The solution concept on the other hand, assigns a set of outcomes (i.e. the coalition that forms and the action its members take) to the game, thus predicting the result of the multi-party bargaining process (ibid.).

"Once a representation in coalitional form has been specified, we can try to predict the outcome of bargaining among the players. Such an analysis is usually based on the assumption that the players will form a grand coalition and divide the worth among themselves after some bargaining process; but that the allocation resulting from a focal equilibrium of this bargaining process will depend on the power structure rather than on the details of how bargaining proceeds" (Myerson, 1991: 427). Thus instead of a detailed analysis of bargaining procedures, the various solution concepts used in cooperative game theory are based on different underlying mechanisms of cooperative equilibrium selection (Myerson, 1991), more or less amenable to varying competitive situations.

The assignment game. One important set of coalitional models is that of the so-called games with a "transferable payoff" or "transferable utility." In these, each possible non-empty subset of players is associated with a single number representing the amount of value the members of that coalition would be able to create on their own; with no restrictions on how this payoff could be divided among the members of the group. A game with transferable payoff (N, v) is thus completely specified by a finite set N of players and a *characteristic function v* mapping every nonempty subset $G \subseteq N$ to a real number ($v(G) \in \Re$). In effect therefore, the characteristic function describes the cooperative possibilities of a game (ibid.). Consequently one challenge in specifying the structure of a coalitional game is the choice of a characteristic function which,

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[7] See Osborne and Rubinstein (1994: 255-261) for a good, though somewhat technical, introduction to coalitional games.

while adequately representing the reality of possible combinations and outcomes, allows a tractable application of the solution concept.

In this paper, we represent a strategic factor market with the *assignment game* (Lippman and Rumelt, 2003a; Shapley and Shubik, 1972), a model of a two-sided matching market with transferable utility. Introduced by Shapley and Shubik in 1972, the player set of an assignment game consists of two finite disjointed sets of buyers and sellers, where the aim of each player on one side is to form a profitable coalition with a player on the other side (Núñez and Rafels, 2002a; Solymosi and Raghavan, 2001). The agents in our assignment game will be on the one hand the available units of the target resource (across one or more suppliers), and on the other hand the co-specialized bundles of resources and capabilities "existing within the legal shell" (Lippman and Rumelt, 2003a: 1070) of the bidding firms.

"In a bilateral assignment market a product that comes in indivisible units is exchanged for money, and each participant either supplies or demands exactly one unit. The units need not be alike and the same unit may have different values for different participants" (Núñez, 2004: 55). Thus the formality of the assignment game is an ideal framework for examining strategic factor markets in the presence of resource complementarity. One other advantage of using this approach is that assignment games have been studied extensively, and their characteristics are well known (see e.g. Núñez, 2004; Núñez and Rafels, 2002a, b; Shapley and Shubik, 1972; Solymosi and Raghavan, 2001; Sotomayor, 2003).

The core. Cooperative game theory has several solution concepts for predicting the end result of the process of coalitional bargaining. Each of these solution concepts corresponds to a different underlying bargaining mechanism, and thus they offer different perspectives on what to expect from the balance of power among all possible coalitions in a game. Some solution concepts such as the *core*, the *bargaining set*, and *stable sets* apply the criterion of averting coalitional objections and thus include payoff allocations that players would accept without forming coalitions to demand reallocation (Myerson, 1991). For this reason, Myerson calls them "unobjectionable solution concepts" (ibid: 455). On the other hand, "equitable solution concepts" like the *Shapley value*, the *nucleolus*, and the *kernel* are best interpreted as arbitration guidelines or determinants of focal equilibria (ibid.). From a different point of view, while "point" solution concepts like the -*value*, the Shapley value, and the nucleolus proffer unique values, "set" solution concepts like the core, bargaining sets, stable sets, and the kernel often predict a class of feasible solutions.

In this paper, we solve an assignment game using the core, "a very appealing solution concept" (ibid: 428) when coalitions can bargain effectively. "The idea behind the core is analogous to that behind the Nash equilibrium of a non-cooperative game: an outcome is stable if no deviation is profitable" (Osborne and Rubinstein, 1994: 258), and the core is "a solution concept that embodies competition among the players" (Brandenburger and Stuart, 2004: 4).

For a coalitional game with a transferable payoff (N, v), where a "payoff profile" is any vector $\mathbf{x} \in \mathfrak{R}^n$ that distributes the total value of the game among players 1,...,n such that $\sum_{i \in \mathbf{N}} x_i = v(\mathbf{N})$; the core (C($v$)) is the set of payoff profiles such that $\sum_{i \in \mathbf{G}} x_i \geq v(\mathbf{G})$, $\forall\, \mathbf{G} \subseteq \mathbf{N}$.

In other words, *the core is the set of payoff profiles that distribute the value available in a game in such a way that there is no subset of players that could create more value on their own, than the sum of their individual payoffs in the game*. Thus the core implies that in a stable situation players are guaranteed at least as much as their "outside" options, otherwise they have no

incentive to play the game. In this way, the core imposes minimum and maximum limits on value appropriated by individual players, with the exact payoff resolved by residual bargaining (Brandenburger and Stuart, 2004; Lippman and Rumelt, 2003a; MacDonald and Ryall, 2002).

The core is the solution concept most closely related to the standard competitive equilibrium of economic analysis (Shapley and Shubik, 1969), and in fact every competitive allocation in an exchange economy is contained within its core (Osborne and Rubinstein, 1994). The core "may also be regarded as an extension, to groups, of the individualistic principle that says that a man will not accept any redistribution of wealth that worsens his initial position, unless compelled to do so. Thus, the core is both Pareto optimal and individually rational" (Shapley and Shubik, 1969: 339). Although some games do not have any core, in the assignment game not only does the core always exist (Lippman and Rumelt, 2003; Shapley and Shubik, 1972), but most of the other solution concepts either coincide with it or lie within it. Thus for assignment games the bargaining set coincides with the core (Solymosi and Raghavan, 2001), the τ-value, the nucleolus, and the kernel are always within the core (Driessen, 1998; Núñez, 2004; Núñez and Rafels, 2002a), and the core is a subset of every stable set (Osborne and Rubinstein, 1994; Solymosi and Raghavan, 2001).

Finally, as mentioned earlier, since the core is a "set" solution concept it imposes restrictions on the maximum and minimum amount of value each player can appropriate. This is ideal for the purposes of this paper, because rather than "solving" for a unique value, we are interested in uncovering the *drivers* of value appropriation. By examining the drivers of variation in restrictions on core allocations, we seek to uncover the determinants of the amount of surplus that can be appropriated in the strategic factor market.

In the rest of this section, we conceptualize a strategic factor market as an assignment game, we derive its core, and then we determine the limits on core allocations of individual players and their drivers. We then conclude with a discussion of the impact of relative scarcity, relative complementarity, and bargaining ability on value appropriation in the SFM.

The Strategic Factor Market Assignment Game

We consider a strategic factor market where a number of firms compete for available units of a target resource. No unit of the resource can be sold to more than one firm, and no firm can purchase more than one unit of the target resource. We allow the supply of both firms and resources to vary such that when firms pair with units of the resource, either one or more firms, or one or more resources, remain unpaired.

The firms in our SFM are considered to be heterogeneous bundles of resources and capabilities exhibiting varying degrees of complementarity with the target resource (Lippman and Rumelt, 2003a; Thomke and Kuemmerle, 2002). Thus they vary in the amount of surplus that they would create in combination with the resource. The greater the complementarity exhibited by a firm, the greater the surplus it creates in combination with the resource, and the more "valuable" the firm is.

The SFM matches all the members of the scarcer group with an equal number of players from the more populated group, leaving the remaining members of this latter group unpaired. Thus it either matches all the available units of the resource with the most valuable firms, or it matches all the available firms with an equal number of units of the resource. In the core, the

unmatched players will not appropriate any value, but the matched players will bargain over a share of the surplus they help to create.

The limits of bargaining are constrained by the options available to players of each type, and thus the SFM exhibits two-sided competition to create and appropriate value between firms and target resources. However, in addition to this *inter-group* competition, the mechanism of bargaining has two other components. On the one hand, there is *intra-group* competition to pair with (the most valuable) members of the other group, and on the other hand there is also *intra-pair* competition for as large a slice as possible of the pie created in combination with a member of the other group. Thus value appropriation will be an outcome of multi-level competition and bargaining.

We will now formalize this discussion and mathematically derive the distinct components of each player's allocation in the core.

Definitions. Consider an SFM represented by an *n*-player coalitional game with transferable utility (N, *w*). The players in the game consist of *r* units of a target resource belonging to the set R and *f* bidding firms belonging to the set F, such that $N = R \cup F$; $R \cap F = \varnothing$; and $n = r + f$. Thus $r < f$ means the available units of the target resource are scarcer than available bidding firms, while $r > f$ means resources are more abundant than firms.

We denote the total surplus created in the game by $w(N) = \Delta V \geq 0$. Similarly we denote the surplus created by the combination of a resource $i \in R$ and a firm $j \in F$ as ΔV_{ij}. Thus the value of the coalition $\{i, j\}$ is given by $w(i, j) = \Delta V_{ij} \geq 0$. Since neither resources nor bidding firms can generate any surplus on their own, we can summarize the possible value-creating combinations in the game in terms of an $r \times f$ matrix $V = (\Delta V_{ij})_{(i,j) \in R \times F}$. Thus each cell of the matrix contains the amount of surplus that would be created by the combination of a specific pair of resources and firms.

An *assignment* (or *matching*) between R and F is a subset μ of $R \times F$ such that each player belongs at most to one pair in μ. In other words $\mu \subseteq R \times F$ and $\mu \in M_{(R, F)}$, where $M_{(R, F)}$ is the set of matchings between R and F. Thus μ matches an equal number of players from both groups, while leaving $|r - f|$ members of the abundant group unassigned. We say that a firm $j \in F$ is not assigned by μ if $(i, j) \notin \mu$ for all $i \in R$ (and similarly for resources).

Finally, as mentioned earlier, a game with transferable payoffs is typically associated with a payoff vector $x \in \mathfrak{R}^n$ that distributes the value of the game among all the players. However, for terminological convenience, we split the overall payoff vector into two vectors $u \in \mathfrak{R}^r$ and $v \in \mathfrak{R}^f$. Thus the outcome of the game for each resource $i \in R$ will be a payoff of $u_i \geq 0$, while each bidding firm $j \in F$ will get $v_j \geq 0$.

So how do assignment and bargaining over the possible value-creating combinations determine the structure of u and v? To answer this question, we now analyze the game's core.

The core of the SFM. To express the core of our assignment game, we first define an *optimal matching*. We say that a matching $\mu \in M_{(R, F)}$ is optimal if for all $\mu' \in M_{(R, F)}$, $\sum_{(i,j) \in \mu} \Delta V_{ij} \geq \sum_{(i,j) \in \mu'} \Delta V_{ij}$ (Núñez and Rafels, 2002a). Thus an optimal matching will preferentially assign the most valuable players.

Now, Shapley and Shubik (1972) prove that the core $\mathbf{C}(w)$ of the assignment game $(\mathbf{R} \cup \mathbf{F}, w)$ is non-empty and can be represented in terms of any optimal matching μ of $\mathbf{R} \cup \mathbf{F}$. Thus we express the core (Núñez and Rafels, 2002b) of the assignment game as:

$$
\mathbf{C}(w) \;=\; \left\{ (\mathbf{u},\mathbf{v}) \in \Re^{\mathbf{R}\times\mathbf{F}} \left|
\begin{array}{ll}
u_i \geq 0, \text{ for all } i \in \mathbf{R}; \; v_j \geq 0, \text{ for all } j \in \mathbf{F} & \text{(a)} \\
u_i + v_j = \Delta V_{ij} \text{ if } (i,j) \in \mu & \text{(b)} \\
u_i + v_j \geq \Delta V_{ij} \text{ if } (i,j) \notin \mu & \text{(c)} \\
u_i = 0, \text{ if } i \text{ is not assigned by } \mu & \text{(d)} \\
v_j = 0, \text{ if } j \text{ is not assigned by } \mu & \text{(e)}
\end{array}
\right. \right\} \qquad (1)
$$

Equation (1) tells us a number of things about the outcome of assignment in the core. Firstly, from lines (d) and (e), observe that unpaired players ($|r - f|$ members of the abundant group in this case), do not appropriate any value in the core. Secondly, the fact that μ is an optimal matching tells us that the members of the abundant group that do get assigned will be the most valuable ones. Thirdly, and importantly, while line (b) shows that each matched pair will split the surplus they create only between themselves; line (c) imposes limits on the amount each member of the pair can hope to appropriate. Thus the relative amount of value appropriated by partners within a pair depends, to some extent, on players that do not form part of that pair. If some assigned player were to appropriate "too much" or "too little," the inequality in line (c) would be violated, and there would exist some other player who could pair with a currently matched player for their mutual benefit. The fact that the core does not permit this imposes limits on the amount of value matched players can appropriate.

Consequently, the overall assignment game resolves to a series of residual bilateral bargaining games between i and j ($(i,j) \in \mu$) over ΔV_{ij}, where the scope of bargaining is constrained by each player's "outside options" as summarized in line (c) of equation (1). Now if we could characterize the component parts of ΔV_{ij}, the portion guaranteed to each player by competition and the portion dependent on each player's bargaining ability, we would be in a position to make general statements about the variation in value appropriation across player types and across individual members of each type. To this final task we now turn.

Core allocations in the SFM. As just mentioned, the split of ΔV_{ij} between members of the matched coalition $\{i, j\}$ is the joint effect of competitive assignment and free-form bargaining. Recall that if $(i, j) \in \mu$, then $u_i + v_j = \Delta V_{ij}$. Thus to analyze the constituent parts of ΔV_{ij}, and consequently the mechanics of allocation of u_i and v_j, we start by denoting the maximum and minimum amounts of surplus each player can appropriate in the core.

For all $i \in \mathbf{R}$ we denote

$$\overline{u}_i = \max_{(\mathbf{u},\mathbf{v}) \in \mathbf{C}(w)} u_i \quad \text{and} \quad \underline{u}_i = \min_{(\mathbf{u},\mathbf{v}) \in \mathbf{C}(w)} u_i$$

Similarly for all $j \in \mathbf{F}$

$$\overline{v}_j = \max_{(\mathbf{u},\mathbf{v}) \in \mathbf{C}(w)} v_j \quad \text{and} \quad \underline{v}_j = \min_{(\mathbf{u},\mathbf{v}) \in \mathbf{C}(w)} v_j$$

(For matched firms or resources, i.e. $(i, j) \in \mu$, we use the notation $\overline{u}_{i\mu}$, $\underline{u}_{i\mu}$, $\overline{v}_{j\mu}$, or $\underline{v}_{j\mu}$ as applicable).

Now it has been severally shown (e.g. Brandenburger and Stuart, 1996; Demange, 1982; Leonard, 1983; MacDonald and Ryall, 2002) that the maximum payoff to a player in the core is the reduction in value created that would be caused by the player's exit from the game, i.e. the player's marginal contribution or "added value" (Brandenburger and Stuart, 1996). Thus

$$\bar{u}_i = w(N) - w(N\backslash\{i\}), \text{ for all } i \in R \tag{2}$$

and similarly[8],

$$\bar{v}_j = w(N) - w(N\backslash\{j\}), \text{ for all } j \in F \tag{3}$$

Players matched in the core appropriate such that $u_i + v_j = \Delta V_{ij}$. Therefore it is obvious that if $(i, j) \in \mu$, then $\Delta V_{ij} = \underline{u}_{i\mu} + \bar{v}_{j\mu}$. Note also that since matching in the core is optimal, then $w(N) - w(N\backslash\{i, j\}) = \Delta V_{ij}$. Thus $\underline{u}_{i\mu} + \bar{v}_{j\mu} = w(N) - w(N\backslash\{i, j\})$. Consequently, replacing $\bar{v}_{j\mu}$ in this last expression, we use equation (3) to derive the minimum appropriation as

$$\underline{u}_{i\mu} = w(N\backslash\{j\}) - w(N\backslash\{i, j\}) \tag{4}$$

Similarly,

$$\underline{v}_{j\mu} = w(N\backslash\{i\}) - w(N\backslash\{i, j\}) \tag{5}$$

Next, to apply these general formulae to our SFM we present some further notation. By δ_1, we denote the amount of surplus created by the combination of the target resource and the *matched* firm that displays the *least* complementarity to it. By definition therefore, δ_1 always exists and is given by $\min_{(i,j)\in\mu} \Delta V_{ij}$.

By δ_0, we denote the amount of surplus that *would be created* by the combination of the target resource and the *unmatched* firm that displays the *most* complementarity to it. Thus δ_0 exists when $r < f$, given by $\max_{\{j:(i,j)\notin\mu,\,\forall i\in R\}} \Delta V_{ij}$, but is zero when $r > f$ by definition.

We can now characterize the upper and lower limits of value appropriation for firms and resources in our SFM. Firstly, if a firm j currently matched to resource i were to leave the game, the core would assign the most valuable currently unmatched firm. Consequently the value of the game would reduce by $(\Delta V_{ij} - \delta_0)$. Applying equation (3) therefore, for $r < f$ the maximum a matched firm j can appropriate is given by

$$\bar{v}_{j\mu} = w(N) - w(N\backslash\{j\}) = \Delta V - (\Delta V - \Delta V_{ij} + \delta_0) = \Delta V_{ij} - \delta_0 \tag{6}$$

On the other hand if i were to leave the game, the core would no longer match the least valuable of the previously matched firms.[9] Thus with one value creating pair lost, ΔV would

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[8] X\Y denotes the intersection of X with the complement of Y. That is, X with all Y in X removed.

[9] This becomes clearer on considering that j could then offer a value-creation opportunity $\Delta V_{ij} \geq \delta_1$ to the resource previously matched with the least valuable firm; unless j itself was the least valuable matched firm, in which case $\Delta V_{ij} = \delta_1$.

reduce by δ_1. Applying equation (2) therefore, for $r < f$ the maximum a matched resource can appropriate is given by

$$\bar{u}_{i\mu} = w(\text{N}) - w(\text{N}\backslash\{i\}) = \Delta V - (\Delta V - \delta_1) = \delta_1 \tag{7}$$

Secondly, to obtain the minimum core allocations, note, trivially, that the elimination of *both i* and *j* from the game reduces ΔV by ΔV_{ij}. Thus applying the previous reasoning to equations (4) and (5), for $r < f$

$$\underline{v}_{j\mu} = w(\text{N}\backslash\{i\}) - w(\text{N}\backslash\{i, j\}) = (\Delta V - \delta_1) - (\Delta V - \Delta V_{ij}) = \Delta V_{ij} - \delta_1 \tag{8}$$

and

$$\underline{u}_{i\mu} = w(\text{N}\backslash\{j\}) - w(\text{N}\backslash\{i, j\}) = (\Delta V - (\Delta V_{ij} - \delta_0)) - (\Delta V - \Delta V_{ij}) = \delta_0 \tag{9}$$

Finally, it is obvious that since firms seek to acquire units of the same resource, if there is resource oversupply, firms will appropriate the entire surplus. In other words, for $r > f$, δ_0 disappears, δ_1 ceases to constrain, and we have

$$\underline{u}_{i\mu} = \bar{u}_{i\mu} = 0; \text{ and } \underline{v}_{j\mu} = \bar{v}_{j\mu} = \Delta V_{ij} \tag{10}$$

Scarcity, Complementarity and Bargaining Ability in the Strategic Factor Market

An analysis of the results presented above permits us to make at least three observations on the structure of payoffs in the core. Firstly, we see that each matched firm is guaranteed a minimum level of appropriation, proportional to its superior complementarity relative to the *least valuable matched firm* (equation (8)). Therefore regardless of the eventual bargaining outcome, each matched firm will appropriate at least $\Delta V_{ij} - \delta_1$, as a result of its superior complementarity. Secondly, and simultaneously, each member of whichever group is scarcer is assured of appropriating at least δ_0, (equations (9) and (10)) regardless of the eventual outcome. Thus relative scarcity is a second driver of surplus appropriation in the SFM. Finally, in the presence of resource scarcity, a portion $(\delta_1 - \delta_0)$ of the surplus ΔV_{ij} has an *ex ante* indeterminate split within each pair (equations (6) to (9)). Consequently this residual surplus is not assigned by competition, but split according to the relative bargaining ability of partners in a pair. Bargaining ability includes "all the means – apart from the threat of exercising their strategic alternatives... – that agents might employ to cajole one another into parting with value" (MacDonald and Ryall, 2004: 7).

Thus as shown in Figure 1, we can neatly delimit ΔV_{ij} into three distinct components, the appropriation of which are determined by superior complementarity, a scarcity premium, and bargaining ability. When $r < f$, for example, each matched firm will be guaranteed $\Delta V_{ij} - \delta_1$, while each resource will be guaranteed δ_0. Their intra-pair split of $\delta_1 - \delta_0$, dependent on relative bargaining ability, will determine the exact sizes of u_i and v_j as illustrated by the arrows in Figure 1.

Figure 1

Competition and Bargaining in Value Appropriation
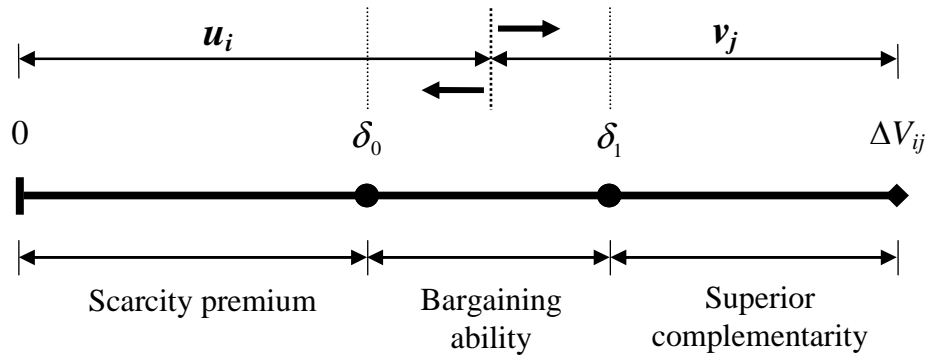
It is interesting to note that the dynamics of allocation of each component depend on a different competitive mechanism. Thus the scarcity premium reflects *inter-group* competition (the relative supply of each type of player); appropriation through superior complementarity is a result of *intra-group* competition (the relative value of the individual firms); and resolution of the residual bargaining situation is a result of *intra-pair* competition (the relative bargaining ability of each partner). Further, while the scarcity premium and the amount resolved by residual bargaining (δ_0 and $\delta_1 - \delta_0$ respectively) are constant across all pairs, the degree of superior complementarity ($\Delta V_{ij} - \delta_1$) can vary across pairs. Thus our model nicely captures multiple levels of competitive interaction.

Additional examination of Figure 1 also helps to shed light on other competitive possibilities. For example, if firms were to exhibit equal complementarity under resource scarcity, then δ_0 would coincide with ΔV_{ij} and the entire surplus would be appropriated by resources. This highlights the fact that the results are driven by *superior* complementarity, such that a firm would not benefit from even a very high degree of complementarity if it was equally exhibited by other firms. On the other hand, whenever resources are more abundant than firms, δ_0 disappears and the entire surplus is appropriated by acquiring firms.

Another extreme situation would be the existence of only one unit of the resource with only one potential buyer. In this case, our model would simply reduce to the familiar bilateral monopoly, as δ_0 would coincide with zero, and the entire surplus $\delta_1 - \delta_0$ would be split solely as a result of relative bargaining ability. In general, in situations where matched players are much more valuable than unmatched players, such that δ_1 is close to ΔV_{ij} and δ_0 is close to zero (perhaps in some forms of oligopoly or in some mature markets), we would expect relative bargaining ability to play a prominent role in determining the amount of value appropriated.

Finally, it is also interesting to note that while the marginal productivity (or "added value") of a matched firm j is $\Delta V_{ij} - \delta_0$, only the appropriation of $\Delta V_{ij} - \delta_1$ is assured. Thus although added value is a prerequisite for value appropriation, it is by no means guaranteed that a firm will appropriate *any* of its own added value, independently of the size of the added value of other firms. Once again therefore, the important driver here is superior complementarity.

In summary, when trading in SFM in the presence of resource complementarities, value appropriation will depend on the joint impact of scarcity, bargaining ability, and superior

complementarity. Thus for a firm acquiring in the face of competition, the gains to trade it can be guaranteed *ex ante* are those resulting from its superior complementarity relative to the least valuable acquiring firm.

Discussion

Our findings in this paper suggest that in the presence of superior complementarity to a resource, it can be competitively acquired for less than the amount of surplus it creates in combination with other firm resources and capabilities.

Building on the "bargaining perspective on resource advantage" (Lippman and Rumelt, 2003a), we draw attention to the fact that strategic factor markets are often characterized by the presence of multiple potential sellers and buyers of resources, with consequent competition for sellers *as well as for buyers.* Furthermore, in such markets, target resources display varying degrees of complementarity to buyers' existing bundles of resources and capabilities. Thus value appropriation is less about "hoodwinking" resource suppliers out of the marginal products of their resources, and more about bargaining over surpluses created by resource combinations within and across firms.

Our approach fits perfectly with the daily reality of modern management, where inter-firm collaboration and "coopetition" (Brandenburger and Nalebuff, 1996) have a pivotal impact on performance. In this environment, firms can strategically navigate resource markets, profitably outbidding rivals for resources to which they exhibit superior complementarity.

In addition, our study further elaborates a powerful methodology with great potential for theory development in strategic management. The integration of cooperative game theory into the RBV as presented in this paper shows great promise for at least four reasons. Firstly, the combination of competitive assignment and unstructured bargaining is quite realistic, since industry competition is typically neither entirely market-driven nor entirely free of competitive pressures. Secondly, our approach permits a simultaneous consideration of horizontal and vertical distribution of value created, capturing some of the multi-level nature of competition. Thus we were able to distinguish between inter-group, intra-group, and intra-pair cross-group components of competition to appropriate value.

Thirdly, the distinctions between relative scarcity, relative complementarity, and bargaining ability help to further open up the black box of "bargaining power." Lastly, our methodology can be applied to other issues that could be represented in terms of value appropriation from complementary resources acquired in SFM, e.g. technology sourcing in particular and outsourcing in general, off-shoring, differential performance outcomes in inter-firm alliances, labor markets for knowledge workers, etc.

Another advantage of our theory is that it provides an efficiency-based explanation for differences in value appropriation, in keeping with the spirit of the RBV. According to Peteraf and Barney, the RBV gives "an efficiency-based explanation of performance differences, rather than one relying purely on market power, collusion, or "'strategic' behaviours" (2003: 311). As such, "performance differences are viewed as derived from rent differentials, attributable to resources having intrinsically different levels of efficiency" (ibid.). Our results support Conner (1991) who held that there could be gains to trade in perfectly tradable resources; and they are

also theoretically consistent with and/or supportive of work by Barney (1988), Capron and Pistre (2002), and Coff (1999).

One implication of our findings is that instead of searching for resources whose value is unknown to all other players, managers can search for resources whose value in combination with their firms' resources and capabilities can be matched by few other firms. While the difference may seem slight, it can considerably reduce the often heroic demands of environmental scanning and search made of managers. A focus on superior combinatory value underlines the fact that complementarity is not a binary variable, and returns attention to what is unique about each firm.

At the same time, however, our results warn against an excessively optimistic approach to external sources of advantage. In the absence of significant differences in use-value, competition for scarce resources (be they sponsored technologies, fresh PhDs, innovative startups, offshore locations, etc) will primarily benefit the resource suppliers. The very fact that firms exhibit superior complementarity to some resources means that they will exhibit average or even inferior complementarity to others.

Finally, our findings suggest that managers may sometimes have to make tradeoffs between value creation and value appropriation, as their drivers do not always converge. For instance, the alliance partner with which a firm could make the biggest "pie" might not be the alliance partner with which it could make the most unique "pie." A firm might thus have to choose between minimal appropriation of a large "pie," and maximum appropriation of a smaller "pie." Consequently in some cases maximizing value creation might not be the optimal firm strategy.

Our theoretical approach is limited by the standard assumption in coalitional analysis that the amount of value that can be created is known, and used by firms to bargain against each other. Though this might not be true in all cases, it should be noted that in this paper the results depend *not on knowledge of the exact amount of value created, but on knowledge of which firms are more valuable than which*, and to what extent. This is not so heroic an assumption, and allows us to show that common knowledge is not an impediment to asymmetric appropriation. In general though, knowledge characteristics are an underdeveloped area of cooperative game theory (see e.g. Brandenburger and Stuart, 2004: 23), requiring further work in the future.

Nevertheless our study raises several interesting questions, and thus avenues for further theory development. Perhaps the most intriguing of these is the question of the origins of differential resource complementarity. If superior complementarity permits the profitable acquisition of resources in the face of competition, then it is important to know whether and how complementarity can be developed. Can the configuration of complementarity be managed, or is resource complementarity solely dependent on "initial conditions?"

Recent work in the RBV suggests that managerial action occupies an important role in the configuration of resource complementarity. For example, Peteraf and Reed's (2005) study of 16 airlines over ten years highlights the importance of fit between managers' choice of operational variables and their choice of business model. In showing how this internal alignment was important in *both* regulated and deregulated eras, they suggest that managerial action was important in configuring this complementarity. Thus their findings "indicate that airline managers were surprisingly adaptive" suggesting "an adaptive capacity and degree of organizational resiliency during the regulatory era that may be insufficiently appreciated" (ibid: 4-5). The relationships between managerial action and resource configuration are thus ripe for further exploration.

The literature on "capability building" (Dierickx and Cool, 1989a; Makadok, 2001; Miller, 2003) suggests that instead of trying to "outsmart factor markets" ("resource picking"), firms can idiosyncratically develop valuable resources internally ("resource building"). On the other hand, our study suggests that heterogeneous firm endowments permit profitable factor market trading. Therefore rather than confronting "picking" with "building," we suggest that "building" *permits* "picking." But to what extent do managers build first and then pick as we suggest, or pick and then build as Miller suggests? How do we isolate these approaches empirically to explore their relative prevalence? These are questions that could be fruitfully addressed by future research.

Finally, further work on dynamic capabilities (Eisenhardt and Martin, 2000; Teece, Pisano and Shuen, 1997) has been advocated as one way to refute criticisms that the RBV is too static (Hoopes et al., 2003). Nevertheless, approaches taken by some scholars have led Winter (2003) to stress that "dynamic" is not a synonym of "valuable;" and in general it has been difficult to convincingly link dynamic capabilities to superior performance. Our theory suggests that a fruitful approach might involve conceptualizing dynamic capabilities as one mechanism for configuring complementarity. Eisenhardt and Martin (2000: 1107) see dynamic capabilities as helping to "integrate, reconfigure, gain and release resources," and we suggest that by modifying the resource endowment, they modify complementarity to external resources. Thus dynamic capabilities might enable firms to favorably configure their complementarity to external resources, allowing their profitable acquisition. Future work could examine if and how firms are able to modify their resource configuration in competing for and absorbing acquisition targets.

Conclusions

In this paper we have argued that the persistent importance managers place on resources whose use-values seem transparent *ex ante* might be explained by the fact that firms with heterogeneous resource endowments display varying degrees of complementarity to target resources. Thus firms exhibiting superior complementarity may be able to acquire resources at a cost below the amount of value they create in use, even in the absence of asymmetric information.

In developing our argument, we built on the "bargaining perspective on resource advantage" (Lippman and Rumelt, 2003a) which integrates cooperative game theory into the resource based-view. We conceptualized the external acquisition of resources as taking place in strategic factor markets with multiple sellers, and multiple potential users exhibiting varying degrees of complementarity to target resources. We then used coalitional analysis to show that the amount of value captured from the deployment of acquired resources depends on the relative supply/demand of seller and buyer groups, the relative degree of complementarity between individual buyers and target resources, and the bargaining ability of individual buyers relative to individual resource suppliers. Consequently, firms can realize gains to trade when they exhibit *superior* complementarity to target resources, and this has important implications for managerial practice, as well as for theory development in the resource-based view.

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