# Implementable Mechanisms to Coordinate Horizontal Alliances

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Unprecedented changes in the economics of interaction, mainly as a result of advances in information and telecommunication technologies such as the Internet, are causing a shift toward more networked forms of organizations such as horizontal alliances—that is, alliances among firms in similar businesses that have positive externalities between them. Because the success of such horizontal alliances depends crucially on aligning individual alliance-member incentives with those of the alliance as a whole, it is important to find coordination mechanisms that achieve this alignment and are simple-to-implement. In this paper, we examine two simple coordination mechanisms for a horizontal alliance characterized by the following features: (i) firms in the alliance can exert effort only in their "local" markets to increase customer demand for the alliance; (ii) customers are mobile and a customer living in a given alliance member's local area may have a need to buy from some other alliance member; and (iii) the coordination rules followed by the alliance determine which firms from a large pool of potential member-firms join the alliance, and how much effort each firm joining the alliance exerts in its local market. In this horizontal alliance setup, we consider the use of two coordination mechanisms: (i) a linear transfer of fees between members if demand from one member's local customer is served by another member, and (ii) ownership of an equal share of the alliance profits generated from a royalty on each member's sales. We derive conditions on the distribution of demand externalities among alliance members to determine when each coordination mechanism should be used separately, and when the mechanisms should be used together.
(*Economics of Interaction; Horizontal Alliances; Externalities; Incentive Mechanisms*)

## 1. Introduction

Unprecedented changes in the economics of interaction, mainly as a result of advances in information and telecommunication technologies such as the Internet, are causing a shift toward more networked forms of business configurations such as horizontal alliances, that is, alliances between firms in similar businesses that have positive externalities between them. For example, a recent *McKinsey* study (Butler et al. 1997) suggests that the reduction in the cost of interaction will make horizontal alliances and other types of horizontal organizational structures more attractive and prevalent than traditional centralized organization structures. In light of this rising importance of horizontal alliances as an organizational form, it is important for organizational design research to examine such fundamental economic aspects as the appropriate incentive structure for alliance members. For example, it is well recognized that the goals of individual alliance members may not be aligned with those of the whole alliance. With positive investment externalities between mem-

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bers, such as the benefits from investments by one member in attracting customers spilling over to other members, self-interest results in underinvestment by individual members from the perspective of the alliance. Thus, it is important that research examines the design and performance of appropriate coordination and incentive mechanisms such that individual alliance members have the incentive to exert effort that is optimal from the alliance's perspective.

In this paper, we examine this important issue of coordination in a particular type of horizontal alliance. The structural features of this horizontal alliance are motivated by the features of a real horizontal alliance in the commercial real estate industry, specifically that of Colliers International Property Consultants, Inc. (Knoop and Applegate 1997). Our goal is to examine how two simple-to-implement coordinating mechanisms perform in this type of horizontal alliance. Although Colliers motivates features of the horizontal alliance used in this paper, these features are also found in other industries. For example, horizontal investment externalities are present in many alliances organized as franchises and in professional service firms (e.g., accounting, law, engineering, etc.). Indeed, variants of the coordination mechanisms we model are used by several firms in the commercial fueling industry.

The main features of the horizontal alliance in our model are as follows. Each firm in the alliance is in charge of a particular geographical area. Firms in the alliance can exert effort only in their "local" markets to increase customer demand for the alliance. Customers are mobile and a customer living in a given alliance member's local area may have a need to use the services of the alliance in some other alliance member's area. The alliance coordination rules determine how alliance members are rewarded for cross-member activities. This reward structure, in turn, determines which firms from a large pool of potential member-firms join the alliance, and how much effort each firm joining the alliance exerts in its local market.

Colliers is an alliance of independent local commercial real estate brokers in which the brokers invest in customer attraction and retention in their own local areas. The customers of a local broker may sometimes have a need to buy in some other geographical area where, without the alliance, the local broker would have no expertise and no ability to provide service to its client. This problem is mitigated for brokers joining the Colliers alliance because the alliance allows a member broker with a client in one territory to obtain information and services from member brokers in other territories when the client requires it. In this way, the alliance allows the brokers to take advantage of the positive externalities of serving clients from one territory with property consultation needs in another, and therefore use their local knowledge to compete better in the national and global market.

Of particular interest to us is the incentive structure at Colliers. On a transaction that requires the involvement of more than one broker, profits are divided between the brokers and Colliers. In addition, each member broker upon joining Colliers purchases a share of stock in Colliers. As a result, member brokers own Colliers and each member broker has an equal share in Colliers' profits. These components of the incentive structure at Colliers are the coordination mechanisms we explore in this paper. The first is a linear transfer (of fees) between members for demand from one member's customer served by another member. The second is ownership of an equal share of the alliance profits generated through a royalty on these cross-member sales.

We show that transfer and share ownership have opposite effects on the following two main drivers of alliance profitability: (i) the investment that alliance members make in their local market to increase demand for the alliance as a whole, and (ii) the alliance size, i.e., how many members find it in their interest to join the alliance. We then derive and explain conditions on the distribution of demand externalities among alliance members that determine when each mechanism should be used alone to increase total alliance profits, and when the two mechanisms should be used together.

**Relationship to Existing Literature.** The horizontal alliance examined in this paper satisfies many of the usual criteria used in the literature to define an organization. For example, Carley and Gasser (1998) suggest the criteria include whether there are multiple agents and multiple tasks, whether there are large-scale technologies, whether the organization has legal standing, etc. They also posit that the rationale for the existence of organizations is that they exist to overcome the limitations of individual agency. Indeed, the organization form we consider, together with the coordination mechanisms, is designed specifically to account for spillovers that are ignored by members acting in their own self-interest. The horizontal alliance form should incur a minimum loss of information as members are incented to use their specialized information locally. The absence of a central authority, however, means that there may not be a group objective or performance criterion that transcends individual objectives in the way one might normally think of an organization with independent or managerial ownership (e.g., Van Zandt 1998). Moreover, because there is no hierarchy to buffer the remaining members against a change in members, turnover results in a total loss of local information (see Carley 1992).

Individual members in our alliance are likely to be low on measures of their individual power, such as betweenness centrality (Freeman 1979), although these measures would be correlated with alliance member size. The power measure is low because in our horizontal alliance each member can be connected with every other member and there are no formal restrictions of information flow. In this way members in our horizontal alliance do not have the power that, for example, dedicated biotechnology firms have in commercial biotechnology alliances (Barley et al. 1992). Moreover, our horizontal alliance is unlike alliances formed as integrated crisis management units (Topper and Carley 1999).

The horizontal alliance we study also meets the organizational characterization of pooled interdependence advocated by Thompson (1967), in which each unit contributes to the whole and is supported by the whole. Thompson indicates that under these conditions the organization should use coordination by standardization—establish rules that apply to all—consistent with our simple-to-implement coordination mechanisms.

The horizontal alliance and coordination mechanisms we examine fit Dyer and Singh's (1998) descriptions of how alliances generate rents through complementary resource endowments and effective governance. As they indicate, if alliance members have complementary resources and capabilities (our horizontal investment externalities), then all members can earn rents that they would not be able to earn alone. In addition, self-enforcing safeguards (our coordination mechanisms) are better than third-part safeguards, such as contracts or courts for providing incentives for members to create value for the alliance. Our coordination mechanisms, based on individual transactions rather than on aggregates, are in the spirit of transaction costs economics that suggests transactions should be aligned with governance structures in a transaction cost economizing way (Williamson 1991).

The externality problem between members in our model is similar in part to the classic externality problem discussed by Rubin (1978) in the context of franchises, whereby one franchisee's underprovision of quality can damage the brand, and create a negative externality for the other franchisees. Essentially, agents ignore the effects that their actions have on other dealers (Katz 1989).[1] Rubin views the problem as an underprovision of policing on the part of the franchisor, implicitly assuming that franchisee actions are observable (and verifiable) to the franchisor. To address the underprovision of policing, Rubin's solution is for the franchisor to charge a unit royalty in addition to using lump-sum franchise fees to motivate the franchisor to police the franchises. Brickley and Dark (1987) share the perspective that some central control is likely to be beneficial in the presence of externalities among units, and thus incentives for the franchisor to restrict free riding by franchisees are important. Mathewson and Winter (1984) approach this externality problem differently. To account for spillovers, they find that combinations of two vertical restraints—for example, from resale price maintenance, franchise fees, and quantity forcing—are sufficient to achieve incentives that are first-best.

[1] Horizontal free riding occurs not only in the provision of quality, but in many other contexts, including informational spillovers (e.g., the setting of advertising levels) (Mathewson and Winter 1984), and investments in service (Lal 1990).

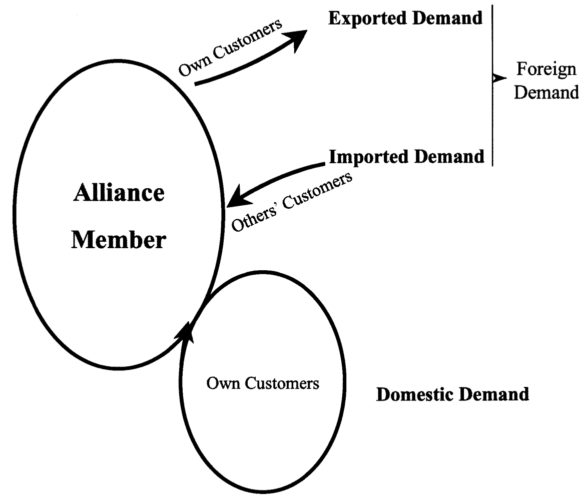
In general, this prior research is motivated by the fact that franchise systems can be efficient organization forms, because they minimize the *vertical* (franchisor-franchisee) agency costs, while allowing franchisees to employ their local knowledge.[2] In particular, that research is concerned with the agency problem involved in moving goods through the channel or the protection of brand equity. Thus, solving the vertical control problem between principal and agent has been the most important objective, with horizontal externalities being incidental. Our approach differs from these in that the critical problem is not the vertical agency problem, but rather the *horizontal* agency problem whereby the members do not account for the spillovers from their investments. Thus, we examine a related, but different, organization form and determine the properties of simple coordination mechanisms that can make it more efficient.

The remainder of the paper is organized as follows. The next section presents the model setup. In §3, we explain the members' decisions of how much to invest and whether to join the alliance under the two coordination mechanisms. Subsequently, we study the alliance's profits and derive our main results. We conclude the paper with a summary of our results and a discussion of how these coordination mechanisms may be applied using the Internet.

## 2. The Model Set-up

We use a model taken in part from Nault and Dexter (1994), who study the vertical and horizontal agency problems in a setting with a single upstream franchisor and many downstream franchisees. Specifically, here we consider a horizontal alliance of firms in which each member firm owns a well-defined exclusive location. The exclusivity means that the owning member is the only member that can serve customers in its location and is the only member that can invest in its location—for example, recruiting customers residing in its location to purchase from the alliance. Customers originating from any location are free to purchase across locations. As illustrated in Figure 1, a member in the alliance has three types of demands.

**Figure 1** **Types of Demand**




1. *Domestic demand*, $d_D$. The demand from its own customers in its own location.
2. *Exported demand*, $d_E$. The demand, from its own customers in others' locations.
3. *Imported demand*, $d_I$. The demand from others' customers in its own location.

Before moving on, we define the two coordination mechanisms used in our model. The first is a *transfer*. If a customer that resides in one territory makes a purchase in another territory, then the member in the home territory collects the proceeds from the sale and makes a transfer of fees to the member in whose territory the purchase was made.[3]

The second coordination mechanism is *share ownership*. For each purchase by a customer from one territory in another territory, the member that collects the proceeds of the sale pays a royalty fee to the alliance. This royalty fee is shared equally among the members by virtue of their ownership of a share of the alliance.

Members have locations of differing potential, and we refer to this potential as *member size*. We employ the real variable $x$ to represent member size, where $x$ is distributed with the density $f(x) > 0$ over the support $[\underline{x}, \bar{x}]$ and is zero elsewhere. More generally,

[2] Work in this area includes Coughlan (1985), Jeuland and Shugan (1983), Moorthy (1987, 1988), and Norton (1988).

[3] Which member collects payment from the customer and the direction of the transfer are not critical for our results.

if members differed along dimensions other than size, we would use $x$ to identify individual members.

Each member invests in activities that affect demands from its own customers, that is, customers from its own location. We make use of the vector $\mathbf{e}$ to represent the vector of member investments over the support of $x$, that is, $\mathbf{e} = (e_x, \mathbf{e}_{\backslash x})$ where the real variable $e_x$ is investment by member $x$ and $\mathbf{e}_{\backslash x}$ is a vector of investments made by other members. For convenience, we measure $e_x$ in monetary units (e.g., dollars), and without loss of generality we assume each $e_x$ is in the interval $[\underline{e}, \bar{e}]$. To simplify exposition, we assume that marginal investment costs are not member-specific and set them to unity.[4]

The *alliance size*, i.e., the number of members in the alliance, is denoted by $y$.

Each demand (domestic demand, imported demand, and the exported demand) is naturally a function of member size, alliance size, and the vector of member investment. Thus, for example, we can write domestic demand as $d_D(x, y, e)$.[5]

We add structure to this general framework by using the following set of reasonable assumptions. The first three assumptions are the direct and cross effects of member size, alliance size, and member investment on demands.

Assumption 1: Size. *Each member's demands from its own customers in its own location and in others' locations are increasing in own size. The demands from others' customers in its own location are not affected by own size. Demands from its own and others' customers are increasing in alliance size.*

Assumption 2: Investment. *Each member's demands from its own customers are increasing in its own investment at a diminishing rate, and demands from others' customers in its own location are not affected by its own investment. Each member's demands from its own customers are not affected by others' investment and its demands from others' customers in its own location are increasing in others' investment.*

Assumption 3: Cross-Effects. *Marginal returns to investment for each member's demands from its own customers are greater for larger members and in larger alliances.*

Assumption 4 rules out the members of the alliance writing binding contracts specifying each member's investment contingent on states of the world.

Assumption 4: Contractibility. *Each member's investment is not contractible.*

Typically this is true, as any contract would necessarily be incomplete for reasons of bounded rationality—the inability to enumerate all the possible states of the world—and the information asymmetry—constant changes in each member's local information. Given that investment is critical, and is not contractible (Assumption 4), our coordination mechanisms are designed to embody strong performance incentives.[6]

Assumptions 5 and 6 are technical assumptions required for the model.

Assumption 5. *The total effect on profits of being larger is positive for each member.*

Assumption 6. *For smaller members in the alliance, the demand from others' customers in its own location is greater than demand from its own customers in others' locations.*

We require that Assumptions 5 and 6 hold only for the smallest alliance member. However, because membership is endogenous in our model, we cannot identify the smallest member a priori.

The model setup can be interpreted in the context of our commercial real estate example as follows. Customers are allocated to territories based on the location of their head office. Customers from one territory may wish to purchase commercial property in that territory or in another territory. An illustration of the latter is when a customer wishes to open a new office in another city. Each member is assigned an exclusive

[4] There is no loss of generality from employing constant marginal costs of investment as compared to using convex investment costs. In addition, the focus of our analysis is not on costs.

[5] The functions we employ are continuously differentiable where necessary.

[6] Similar to Shepard's (1993) argument in gasoline retailing, contractual forms that have strong performance incentives are chosen when effort (investment) is important and not observable (for the purpose of contracting).

territory. The exclusivity has two aspects. The first is that a member from one territory cannot make a sale in another member's territory. The second is that a member from one territory cannot recruit customers from another territory.[7] Territories vary in the size of the potential of customers that reside in the territory, and each member makes investments in generating business from the customers residing in its territory.

Demands from resident customers in a territory with more head office residences are larger both inside and outside the territory, but more head offices do not affect demand inside the territory from organizations outside the territory. A member of a larger alliance is more attractive to customers because they have more resources to offer, and consequently a larger alliance has higher returns on investment. Investment in local head office visits increases demand from those head offices (at a diminishing rate, although less so in a larger alliance), but not demands from head offices outside the territory. Each member knows best how to recruit in its territory.

## 3. Member Behavior

As already explained, the two coordination mechanisms used in our setup are transfers and share ownership. We denote the transfer by $t$ and the royalty by $r$. Our interest is to determine when and why each one of the two coordinating mechanisms should be used alone, and when they should be used together.

Alliance profits are determined by (i) the effort alliance members put in their local market to recruit customers for the alliance, and (ii) the alliance size. We first examine how the choice of $t$ and $r$ determines these two factors.

### 3.1. Member Investment

Each member selects its level of investment to maximize its profit. The member's profit function is

$$\psi(x,y,\mathbf{e}) = pd_D(x,y,\mathbf{e}) + [p-r-t]d_E(x,y,\mathbf{e}) + td_I(x,y,\mathbf{e}) + \frac{r}{y}\int_{\hat{x}}^{\bar{x}} d_E(x,y,\mathbf{e})f(x)dx - e_x, \tag{1}$$

[7] In reality there are occasionally deviations from these exclusivities, however the model that Colliers wishes to follow is in accordance with this set-up.

where $p > 0$ is the premium for the good sold. In (1), the member receives the premium on domestic and exported demands, pays the transfer on exported demands, receives the transfer on imported demands, pays the royalty on exported demands, and receives a share of the royalty collected on all foreign demands. *Foreign demands* are represented by the integration term in (1), and could have been equivalently written using imported rather than exported demands. The smallest member in the alliance is represented by $\hat{x}$. We constrain our attention to cases where $p > t+r \geq 0$. If $t=0$, then there is no transfer, and the third term in (1) involving imported demand disappears. If $r=0$, then there is no share ownership, and the fourth term in (1) involving the redistribution of the royalty disappears.

Each member selects its level of investment $e_x$ to maximize its profit. The first-order condition for profit-maximizing using (1) is:

$$p\frac{\partial d_D(x,y,\mathbf{e})}{\partial e_x} + [p-r-t]\frac{\partial d_E(x,y,\mathbf{e})}{\partial e_x} + \frac{rf(x)}{y}\frac{\partial d_E(x,y,\mathbf{e})}{\partial e_x} - 1 = 0, \tag{2}$$

recognizing that own investment matters only for own customers. As a result, the imported demand term and all but the effect through $x$ of the integration in the last term of (1) do not contribute. Assumption 2 is sufficient for (1) to be concave, so that together with the definition of $\mathbf{e}$ and the continuity of demands, the solution to the set of equations (2) for all members constitutes a Nash equilibrium as a function of the transfer and the royalty, $\mathbf{e}(t,r)$.

Applying the implicit function rule to (2), it is straightforward to show that individual equilibrium investments are increasing in member size (from Assumption 3), and are decreasing in the transfer. As can be seen by combining the exported demand terms, equilibrium investments are also decreasing in the royalty because $f(x)/y < 1$. We state these last two results as our first lemma.

LEMMA 1.1. *An increase in the royalty or the transfer decreases the equilibrium investments.*

The following lemma indicates the *relative* magnitudes of the effects of the transfer and the royalty on equilibrium investment. We leave the proofs of all our lemmas and theorems for the Appendix.

Lemma 1.2. *The effect of a change in the transfer on equilibrium investment is larger than the effect of a change in the royalty on equilibrium investment.*

In Lemma 1.1 and 1.2, the transfer works against investment by transferring profits away from members based on the demands generated from their investment, that is, demand from own customers (exported demand). As a result, increases in the transfer act to reduce return on investment. In contrast, although the royalty removes profit from these same members based on their exported demands, it also redistributes a share of these removed profits back to the demand-generating members. Therefore, an increase in the royalty acts the same as the transfer in reducing return on investment, but it partially compensates for that reduction through redistribution. Thus, the investment-reducing effect is mitigated.

### 3.2. Alliance Size

To study the effects of the transfer and royalty on alliance size, we define the smallest member in the alliance as

$$\hat{x}(t, r, \mathbf{e}(t, r)) = \min\{x \mid \psi(x, y(x), \mathbf{e}(t, r)) = 0\}, \qquad (3)$$

where the member profit function, $\psi(x, y(x), \mathbf{e}(t, r))$, is given in (1). To economize on space, we represent $\hat{x}(t, r, \mathbf{e}(t, r))$ by $\hat{x}(\cdot)$. Assumption 5 is sufficient for all $x > \hat{x}(\cdot)$ to be in the alliance. Consequently, alliance size is defined as

$$y(\hat{x}(\cdot)) = \int_{\hat{x}(\cdot)}^{\bar{x}} f(x)dx.$$

We can now state our next lemma.

Lemma 2.1. *An increase in the royalty, transfer, or member investment increases alliance size.*

Alliance size works through the smallest member of the alliance, that is, the marginal member. An increase in the royalty, transfer, and investment by other members all decrease the size of the marginal member, thereby increasing the size of the alliance. The key to this result is that the effects of a change in alliance size on exported demand are not large relative to the difference between the average foreign demand and the exported demand of the marginal member. The next lemma shows the *relative* magnitudes of the effects of transfer and royalty on alliance size.

Lemma 2.2. *If the average foreign (e.g., imported or exported) demand is greater than imported demand for the smallest member of the alliance, then the royalty has a larger effect on membership than does the transfer, and vice-versa.*

The intuition for Lemma 2.2 is as follows. Smaller members in the alliance benefit from the transfer in proportion to the difference between their imported and exported demands. All members benefit from the royalty in proportion to the total number of members. Thus, when imported demands for smaller members are lower than the average imported demand, then smaller members benefit more from a redistribution that is proportional to membership (royalty) than they do from a redistribution that is proportional to imported demand (transfer). Because increasing the profitability of smaller potential members is critical for increasing alliance size, the royalty is a more effective instrument under the condition in the premise of the lemma, ceteris paribus, to increase alliance size. If imported demand for smaller members is higher than the average imported demand, then smaller members benefit more from redistribution proportional to imported demand, and therefore the transfer would be a more effective mechanism to increase alliance size.[8]

## 4. Alliance Profits

In the previous section, we found that, while an increase in the transfer or royalty increases the alliance size, that increase decreases the investment

[8] The qualitative properties of our results are not affected if the royalty is paid on all demand from owned customers. If the royalty is paid on imported, rather than exported, demands, then an additional assumption to determine the effect of the royalty on membership is required. This is because for smaller members the advantage of redistribution through share ownership is offset by having to pay a royalty on imported demand, which is their larger component of foreign demand.

that each alliance member makes in its local market. Because the total alliance profit depends on *both* alliance-member investments and alliance size, increases in the transfer or royalty can have an ambiguous affect on total alliance profit. In this section, we examine this issue further and find out the conditions under which alliance profit-maximization requires the use of both the transfer and the royalty (i.e., share ownership), and conditions under which alliance profit-maximization requires the use of only the transfer or royalty alone.

Because the premium that the alliance charges is fixed in our setup, maximizing total alliance profit is the same as maximizing the total alliance sales. Total alliance sales is

$$V(\mathbf{e}(t,r),\hat{x}(\cdot)) = \int_{\hat{x}(\cdot)}^{\bar{x}} [d_D(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r)) + d_E(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))] f(x)dx.$$

Maximizing alliance sales by choosing the transfer, $t$, and royalty, $r$, requires that the following two first-order conditions be satisfied:

$$\frac{dV(\mathbf{e}(t,r),\hat{x}(\cdot))}{dt} = \frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial \hat{x}}\left[\frac{\partial \hat{x}(\cdot)}{\partial t} + \frac{\partial \hat{x}(\cdot)}{\partial \mathbf{e}_{\setminus \hat{x}}}\frac{\partial \mathbf{e}_{\setminus \hat{x}}(t,r)}{\partial t}\right] + \frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial e_{\hat{x}}}\frac{\partial \mathbf{e}_{\hat{x}}(t,r)}{\partial t} + \frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial \mathbf{e}_{\setminus \hat{x}}}\frac{\partial \mathbf{e}_{\setminus \hat{x}}(t,r)}{\partial t} = 0, \quad (4)$$

$$\frac{dV(\mathbf{e}(t,r),\hat{x}(\cdot))}{dr} = \frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial \hat{x}}\left[\frac{\partial \hat{x}(\cdot)}{\partial r} + \frac{\partial \hat{x}(\cdot)}{\partial \mathbf{e}_{\setminus \hat{x}}}\frac{\partial \mathbf{e}_{\setminus \hat{x}}(t,r)}{\partial r}\right] + \frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial e_{\hat{x}}}\frac{\partial \mathbf{e}_{\hat{x}}(t,r)}{\partial r} + \frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial \mathbf{e}_{\setminus \hat{x}}}\frac{\partial \mathbf{e}_{\setminus \hat{x}}(t,r)}{\partial r} = 0, \quad (5)$$

where the $\partial \hat{x}(\cdot)/\partial e_{\hat{x}}$ term is zero and therefore disappears in (4) and (5). An interior solution to the transfer requires that (4) holds, and an interior solution to the royalty requires that (5) holds. In what follows, we assume that $V(\mathbf{e}(t,r),\hat{x}(\cdot))$ is quasi-concave over the nonnegative domains of the transfer and royalty. Consequently, (4) and (5) are necessary and sufficient for an interior solution to the problem of maximizing total alliance sales.

In the arguments of the demands we slightly modify the notation used in the proof of Lemma 2.1 and adopt the convention $(\hat{\cdot})$ for $(\hat{x}(\cdot), y(\hat{x}(\cdot)), e(t,r))$. Expanding (4), dropping the zero terms, substituting $y'(\hat{x}) = -f(\hat{x}(\cdot))$, and rearranging terms results in

$$\begin{aligned}
\frac{dV(\mathbf{e}(t,r),\hat{x}(\cdot))}{dt}
&= -\left[d_D(\hat{\cdot}) + d_E(\hat{\cdot})\right] f(\hat{x}(\cdot))\frac{\partial \hat{x}(\cdot)}{\partial t} \\
&\quad - \int_{\hat{x}(\cdot)}^{\bar{x}} \left[\frac{\partial d_D(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial y} + \frac{\partial d_E(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial y}\right] f(x)dx\, f(\hat{x}(\cdot))\frac{\partial \hat{x}(\cdot)}{\partial t} \\
&\quad - \left[d_D(\hat{\cdot}) + d_E(\hat{\cdot})\right] f(\hat{x}(\cdot))\frac{\partial \hat{x}(\cdot)}{\partial \mathbf{e}_{\setminus \hat{x}}}\frac{\partial \mathbf{e}_{\setminus \hat{x}}(t,r)}{\partial t} \\
&\quad - \int_{\hat{x}(\cdot)}^{\bar{x}} \left[\frac{\partial d_D(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial y} + \frac{\partial d_E(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial y}\right] f(x)dx\, f(\hat{x}(\cdot))\frac{\partial \hat{x}(\cdot)}{\partial \mathbf{e}_{\setminus \hat{x}}}\frac{\partial \mathbf{e}_{\setminus \hat{x}}(t,r)}{\partial t} \\
&\quad + \left[\frac{\partial d_D(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial e_{\hat{x}}} + \frac{\partial d_E(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial e_{\hat{x}}}\right] f(\hat{x}(\cdot))\frac{\partial e_{\hat{x}}(t,r)}{\partial t} \\
&\quad + \int_{\inf x > \hat{x}(\cdot)}^{\bar{x}} \left[\frac{\partial d_D(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial e_x} + \frac{\partial d_E(x, y(\hat{x}(\cdot)), \mathbf{e}(t,r))}{\partial e_x}\right] f(x)dx\frac{\partial \mathbf{e}_{\setminus \hat{x}(t,r)}}{\partial t} \\
&= 0,
\end{aligned}$$

noting that $\partial\hat{x}(\cdot)/\partial\mathbf{e}_{\backslash\hat{x}}$ is the derivative with respect to all the elements of $\mathbf{e}_{\backslash\hat{x}}$. Equation (6) illustrates the forces at work. The first two lines show the positive membership effect resulting from redistributing profits from larger members to smaller ones through increases in the transfer. The third and fourth lines show the indirect negative effect of investment on membership, as profit redistribution away from larger members is a disincentive for investment, and as the lesser investment by these members decreases the value of membership. The fifth and sixth lines show the direct negative effects on investment resulting from redistributing profits from larger members, who have greater investment incentive, to smaller members, who have a lesser investment incentive. Figure 2 shows these forces in diagrammatic form.

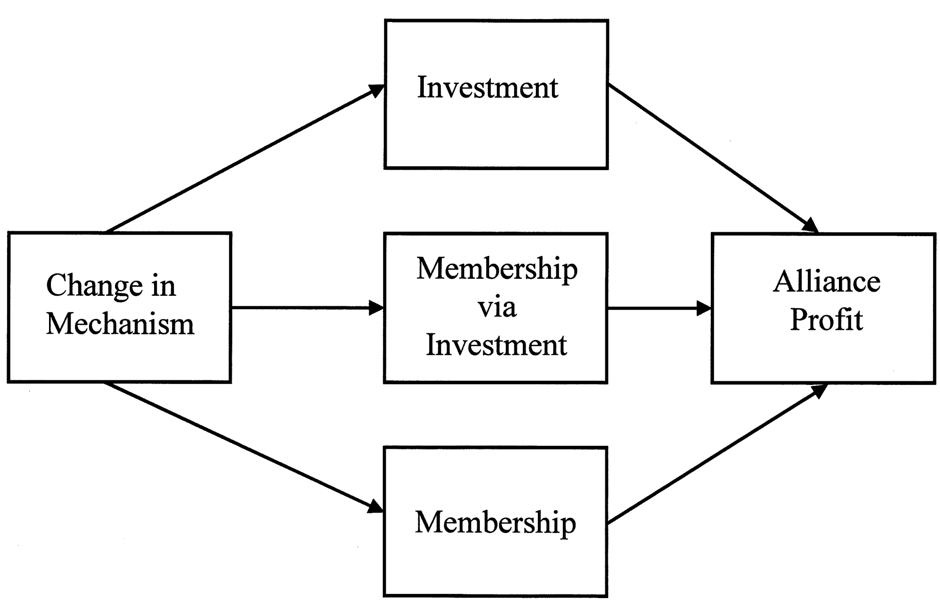
Before comparing the two coordination mechanisms, we show when the use of either of the mechanisms is beneficial. We first consider the effects on membership. If the direct positive effect of the transfer (royalty) on membership is greater than the indirect negative effect of the transfer (royalty) on membership through investment, then the membership effect of the transfer (share ownership) mechanism is beneficial. We explain this for the transfer coordination mechanism—the explanation for share ownership follows similar reasoning. Begin with $t = 0$. Consider the marginal return from an increase in the transfer, $dV(\mathbf{e}(t, r), \hat{x}(\cdot))/dt$ from (6), and therefore (4), as the transfer is increased from $t = 0$. For the transfer coordination mechanism to be beneficial requires $dV(\mathbf{e}(t, r), \hat{x}(\cdot))/dt > 0$ for some $t$. This in turn requires that $|\partial\hat{x}(\cdot)/\partial t| > |[\partial\hat{x}(\cdot)/\partial\mathbf{e}_{\backslash\hat{x}}][\partial\mathbf{e}_{\backslash\hat{x}}(t, r)/\partial t]|$, the relationship between the effects described above.

Now consider membership and investment effects. From Lemma 1.1, increases in the transfer or the royalty decrease member investment, which decreases demands from Assumption 2, and therefore total alliance sales from (4). For either coordination mechanism to be beneficial, the overall effect of the mechanism on membership must be positive to offset the negative effect on investment.

Given that the mechanisms are beneficial, it remains to show when exclusive use of one of the mechanisms is optimal and when joint use of the two mechanisms is most profitable. The following theorem describes the condition under which exclusive use of the share ownership mechanism, that is, exclusive use of the royalty, is optimal.

Theorem 1 (Exclusive Use of Share Ownership). *If average foreign (e.g., imported or exported) demand is*

**Figure 2** **Effects of Coordinating Instruments**



*greater than imported demand for the smallest member of the alliance, then exclusive use of share ownership is optimal.*

The intuition for Theorem 1 follows closely from Lemmas 1.2 and 2.2. Both the transfer and the royalty work toward redistributing profits from larger members to smaller ones. From Lemma 2.2 (and consequently from the premise of Theorem l), at the margin an increase in the royalty increases membership more than an increase in the transfer, because smaller members benefit more from redistributions that are proportional to membership than from those that are proportional to demand. Thus, the royalty is the more effective instrument to use to increase membership. From Lemma 1.2, at the margin the transfer has a larger (negative) effect on investment than does the royalty. Hence, the royalty is a more effective (less damaging) instrument to use to increase investment. As a result, when imported demand is skewed towards smaller members, exclusive use of the royalty is more effective than the use of both instruments or of the transfer alone.

The next theorem describes the condition under which exclusive use of the transfer mechanism is optimal.

Theorem 2 (Exclusive Use of the Transfer). *If imported demand for the smallest member of the alliance is greater than average foreign (e.g., imported or exported) demand and demands are insensitive to investment, then exclusive use of the transfer is optimal.*

The condition in Theorem 2 is not the exact reverse of that in Theorem 1 because of the added condition on the sensitivity of demands to investment. Theorem 2 follows from the reasoning in Lemma 1.2, and the opposite to the condition in Lemma 2.2 (which is the first condition in the theorem). From Lemma 1.2, increases in the transfer are more damaging to investment than increases in the royalty. Thus, when demands are insensitive to investment, this negative aspect of the transfer relative to the royalty is mitigated. When the opposite to the condition in Lemma 2.2 holds, increases in the transfer have a greater positive effect on membership than do increases in the royalty. As a result, exclusive use of the transfer is optimal.

Theorem 3 (Both Mechanisms Optimal). *A necessary condition for the combination of the transfer and share ownership to result in higher alliance profits is that imported demand for the smallest member of the alliance is greater than the average foreign (e.g., imported or exported) demand.*

Theorem 3 requires an interior solution to both the royalty and the transfer. The interpretation of Theorem 3 is that when imported demand is skewed towards larger members, the transfer is more effective at increasing membership. At the same time, the royalty is less damaging to investment (Lemma 1.2). Then, so long as investment is still important, the transfer is used to increase membership and the royalty is used to mitigate the negative effects on investment.

The presence of both coordination mechanisms at Colliers suggests that imported demand for smaller members is large, relative to the average foreign (e.g., imported or exported) demand. This is consistent with the idea that growth in small commercial real estate markets is mostly fueled by demands for property from customers that reside outside those markets, whereas in larger markets, growth is generated for the most part by demands of local residents. It also suggests that Colliers believes that coordination must address a mixture of effects, balancing incentives for alliance growth through the transfer with incentives for local investment through the royalty.[9]

## 5. Concluding Remarks

In this research, we analyzed two simple-to-implement mechanisms, transfer and share ownership, that can improve intermember coordination in a horizontal alliance. We showed that both mechanisms increase membership and both decrease investment. In general, share ownership (through the royalty) is less damaging to investment than is the transfer. However, which coordination mechanism is more effective in encouraging membership depends on the distribution of imported demand across member size.

[9] As pointed out by the associate editor, there may be explanations outside of our model that also support the use of both coordination mechanisms by Colliers.

Thus, we provided conditions to determine when these different coordination mechanisms should be used. Future research in this area includes the development of additional coordination mechanisms that could be used in place of, or in conjunction with, the mechanisms presented here.

While not necessary for use of either of the coordination mechanisms we study, the Internet is a particularly good platform on which to implement these mechanisms. The Internet provides ubiquitous and easy access worldwide, is stable and has known standards and conventions, and provides a variety of common services. Thus, we believe that there are fruitful applications of the Internet to this type of channel coordination. For Colliers, the implementation of such coordination mechanisms over the Internet allows simple access to offices everywhere, and offers the promise of little compatibility or interoperability problems. In addition, previous research has raised the possibility of using software agents for coordination (e.g., Malone 1987). At the time, the work was speculative, because the infrastructure was not in place to accommodate industrial-strength applications. With the advent of the Internet, this situation has changed. In this research, we proposed and analyzed two coordination mechanisms that allow a horizontal alliance (e.g., franchises, branches, etc.) that have spillovers between them to act as an integrated firm and become more profitable without integrating. In principle, this coordination could be accomplished with a simple software agent encapsulating our coordination mechanisms residing on the Internet, possibly without the need for centralized ownership and control.

The simplicity of our coordination mechanisms makes it possible for groups of small firms to make individual investments as integrated units. Coordination in investment may lead to coordination in other functions, for example, in price setting. Our model has taken price as exogenous to member investment and its resulting affects. Because exclusivity over location and investments that affect residing customers mitigates competition between members, price is not a strategic variable, thus prices are likely to be higher than they would be in absence of the alliance. But price coordination across the alliance may make the alliance more attractive to customers by reducing price uncertainty. Relaxing exclusivity over investments that affect residing customers changes the levels of individual member investments, and may result in price competition within the alliance, which is an interesting direction for future research.

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## Appendix

Proof of Lemma 1.2. Using (2) and the implicit function rule to obtain the effects of changes in the transfer and the royalty on equilibrium investments yields the following relation:

$$\frac{\partial e_x(t,r)}{\partial r} = \left[1 - \frac{f(x)}{y}\right]\frac{\partial e_x(t,r)}{\partial t} \quad \forall x,$$

where from the definition of $y$, $0 < f(x)/y < 1$. Q.E.D.

Proof of Lemma 2.1. From (3), $\hat{x}(\cdot)$ satisfies the condition,

$$\begin{aligned}\beta(t,r,\mathbf{e}(t,r),\hat{x}) = {} & p\, d_D(\hat{x}, y(\hat{x}), \mathbf{e}(t,r)) \\ & + [p-r-t]d_E(\hat{x}, y(\hat{x}), \mathbf{e}(t,r)) \\ & + t\, d_I(\hat{x}, y(\hat{x}), \mathbf{e}(t,r)) - e_{\hat{x}}(t,r) \\ & + \frac{r}{y(\hat{x})}\int_{\hat{x}}^{\bar{x}} d_E(x, y(\hat{x}), \mathbf{e}(t,r)) f(x)dx = 0,\end{aligned}$$

at $\mathbf{e}(t,r)$, the equilibrium levels of investment. We simplify our notation so that the demand arguments for the smallest member in the alliance, $(\hat{x}, y(\hat{x}), \mathbf{e}(t,r))$, are represented by $(\hat{\cdot})$. Treating the equilibrium investments as fixed,

$$\frac{\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})}{\partial r} = -d_E(\hat{\cdot}) + \frac{1}{y(\hat{x})}\int_{\hat{x}}^{\bar{x}} d_E(x, y(\hat{x}), \mathbf{e}(t,r)) f(x)dx.$$

Consistent with Assumption 6, if larger members have greater demands from own customers, then $\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})/\partial r > 0$. In addition, from Assumption 6

$$\frac{\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})}{\partial t} = -d_E(\hat{\cdot}) + d_I(\hat{\cdot}) > 0.$$

Moreover, $\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})/\partial e_x > 0$ for members other than $\hat{x}$, although the value of $\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})/\partial e_x$ differs depending on whether the change is in the investment of the smallest member in the alliance. Finally,

$$\begin{aligned}\frac{\partial \beta(t,r,\mathbf{e}(t,r),\hat{x})}{\partial \hat{x}}\\ &= p\left[\frac{\partial d_D(\hat{\cdot})}{\partial \hat{x}}+\frac{\partial d_D(\hat{\cdot})}{\partial y}y'(\hat{x})\right]+[p-r-t]\left[\frac{\partial d_E(\hat{\cdot})}{\partial \hat{x}}+\frac{\partial d_E(\hat{\cdot})}{\partial y}y'(\hat{x})\right]\\ &\quad +t\left[\frac{\partial d_I(\hat{\cdot})}{\partial \hat{x}}+\frac{\partial d_I(\hat{\cdot})}{\partial y}y'(\hat{x})\right]\\ &\quad +\frac{-ry'(\hat{x})}{y(\hat{x})^2}\int_{\hat{x}}^{\bar{x}} d_E(x,y(\hat{x}),\mathbf{e}(t,r))f(x)dx+\frac{r}{y(\hat{x})}\left[-d_E(\hat{\cdot})f(\hat{x})\right]\\ &\quad +\frac{r}{y(\hat{x})}\int_{\hat{x}}^{\bar{x}}\frac{\partial d_E(x,y(\hat{x}),\mathbf{e}(t,r))}{\partial y}y'(\hat{x})f(x)dx.\end{aligned}$$

In each of the terms in the first two lines the direct effect of member size is (weakly) positive and the indirect effects through alliance size are negative from Assumption 1. Recognizing that $y'(\hat{x})=-f(\hat{x})$, the last two lines simplify to

$$\frac{rf(\hat{x})}{y(\hat{x})^2}\int_{\hat{x}}^{\bar{x}} d_E(x,y(\hat{x}),\mathbf{e}(t,r))f(x)dx-\frac{rf(\hat{x})}{y(\hat{x})}d_E(\hat{\cdot})-\frac{rf(\hat{x})}{y(\hat{x})}\int_{\hat{x}}^{\bar{x}}\frac{\partial d_E(x,y(\hat{x}),\mathbf{e}(t,r))}{\partial y}f(x)dx,$$

and rearranging gives

$$\frac{rf(\hat{x})}{y(\hat{x})}\left[\frac{1}{y(\hat{x})}\int_{\hat{x}}^{\bar{x}} d_E(x,y(\hat{x}),\mathbf{e}(t,r))f(x)dx-d_E(\hat{\cdot})-\int_{\hat{x}}^{\bar{x}}\frac{\partial d_E(x,y(\hat{x}),\mathbf{e}(t,r))}{\partial y}f(x)dx\right].$$

The sum of the first two terms in square brackets represents the direct effect of member size through share ownership and is positive from Assumption 6. The third term representing the indirect effect through size is negative from Assumption 1. Assumption 5 implies the direct effect outweighs the indirect effect. Thus, $\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})/\partial\hat{x}>0$. Hence, from the implicit function rule we have the following relationships:

$$\frac{\partial \hat{x}(\cdot)}{\partial r}<0,\qquad \frac{\partial \hat{x}(\cdot)}{\partial t}<0,\qquad \frac{\partial \hat{x}(\cdot)}{\partial e_{\backslash\hat{x}}}<0,$$

where $\partial e_{\backslash\hat{x}}$ is the partial derivative with respect to any or all the elements of $\mathbf{e}_{\backslash\hat{x}}$, and recognizing that $\partial\hat{x}(\cdot)/\partial e_{\hat{x}}=0$. Q.E.D.

Proof of Lemma 2.2. By definition, average foreign demand is the same as average imported demand and average exported demand. Using the implicit function rule, the difference between $\partial\hat{x}(\cdot)/\partial r$ and $\partial\hat{x}(\cdot)/\partial t$ depends on the relative magnitudes of $\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})/\partial r$ and $\partial\beta(t,r,\mathbf{e}(t,r),\hat{x})/\partial t$. The condition in the premise of the lemma results in the former being larger than the latter. Reversing the condition in the premise reverses this relation. Q.E.D.

Proof of Theorem 1. Increased alliance profits is equivalent to increased alliance sales. To prove the theorem, it is sufficient to show that only the royalty is used. Continuing with the notation $(\hat{\cdot})$ for $(\hat{x}(\cdot),y(\hat{x}(\cdot)),\mathbf{e}(t,r))$ in the arguments of the demands and referring to (6), recognizing that the first-order condition for the royalty has the same structure, we observe that:

$$\begin{aligned}\frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial \hat{x}} &= \left[-\left[d_D(\hat{\cdot})+d_E(\hat{\cdot})\right]-\int_{\hat{x}(\cdot)}^{\bar{x}}\left[\frac{\partial d_D(x,\hat{\cdot})}{\partial y}+\frac{\partial d_E(x,\hat{\cdot})}{\partial y}\right]f(x)dx\right]f(\hat{x}(\cdot))<0,\\ \frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial e_{\hat{x}}} &= \left[\frac{\partial d_D(x,\hat{\cdot})}{\partial e_{\hat{x}}}+\frac{\partial d_E(x,\hat{\cdot})}{\partial e_{\hat{x}}}\right]f(\hat{x}(\cdot))>0,\end{aligned}$$

and

$$\frac{\partial V(\mathbf{e}(t,r),\hat{x}(\cdot))}{\partial e_{\backslash\hat{x}}} = \int_{\inf x>\hat{x}(\cdot)}^{\bar{x}}\left[\frac{\partial d_D(\hat{x},\hat{\cdot})}{\partial e_x}+\frac{\partial d_E(x,\hat{\cdot})}{\partial e_x}\right]f(x)dx>0.$$

As a constrained optimization, the problem can be formulated as

$$\max_{t,r} V(\mathbf{e}(t,r),\hat{x}(\cdot))\quad \text{subject to } t\geq 0,\quad r\geq 0.$$

Letting $\hat{t}^*$ and $\hat{r}^*$ represent the optimal transfer and royalty, the necessary conditions for alliance sales maximization is

$$\left[\frac{dV(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{d\hat{t}^*}\right]\hat{t}^*=0,\qquad \left[\frac{dV(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{d\hat{r}^*}\right]\hat{r}^*=0 \tag{6}$$

$$\frac{dV(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{d\hat{t}^*}\leq 0,\qquad \frac{dV(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{d\hat{r}^*}\leq 0 \tag{7}$$

$$\hat{t}^*\geq 0,\qquad \hat{r}^*\geq 0, \tag{8}$$

where

$$\begin{aligned}\frac{dV(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{d\hat{t}^*} &= \frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial \hat{x}}\frac{\partial \hat{x}(\cdot)}{\partial \hat{t}^*}\\ &\quad +\frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial \hat{x}}\frac{\partial \hat{x}(\cdot)}{\partial e_{\backslash\hat{x}}}\frac{\partial \mathbf{e}_{\backslash\hat{x}}(\hat{t}^*,\hat{r}^*)}{\partial \hat{t}^*}\\ &\quad +\frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial e_{\hat{x}}}\frac{\partial e_{\hat{x}}(\hat{t}^*,\hat{r}^*)}{\partial \hat{t}^*}\\ &\quad +\frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial e_{\backslash\hat{x}}}\frac{\partial \mathbf{e}_{\backslash\hat{x}}(\hat{t}^*,\hat{r}^*)}{\partial \hat{t}^*},\end{aligned} \tag{9}$$

and

$$\begin{aligned}\frac{dV(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{d\hat{r}^*} &= \frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial \hat{x}}\frac{\partial \hat{x}(\cdot)}{\partial \hat{r}^*}\\ &\quad +\frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial \hat{x}}\frac{\partial \hat{x}(\cdot)}{\partial e_{\backslash\hat{x}}}\frac{\partial \mathbf{e}_{\backslash\hat{x}}(\hat{t}^*,\hat{r}^*)}{\partial \hat{r}^*}\\ &\quad +\frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial e_{\hat{x}}}\frac{\partial e_{\hat{x}}(\hat{t}^*,\hat{r}^*)}{\partial \hat{r}^*}\\ &\quad +\frac{\partial V(\mathbf{e}(\hat{t}^*,\hat{r}^*),\hat{x}(\cdot))}{\partial e_{\backslash\hat{x}}}\frac{\partial \mathbf{e}_{\backslash\hat{x}}(\hat{t}^*,\hat{r}^*)}{\partial \hat{r}^*}.\end{aligned} \tag{10}$$

The first term in each of Equations (10) and (11) is positive and the last three terms are negative. From Lemma 1.2, $|\partial e_x(t,r)/\partial r|<|\partial e_x(t,r)/\partial t|\ \ \forall x$. From Lemma 2.2, $|\partial\hat{x}(\cdot)/\partial r|>|\partial\hat{x}(\cdot)/\partial t|$. Thus, only one of the constraints in (9) can be binding at the optimum, and

$dV(\mathbf{e}(t,r),\hat{x}(\cdot))/dr > dV(\mathbf{e}(t,r),\hat{x}(\cdot))/dt$. Hence, the constraint on $\hat{t}^*$ in (9) must be binding. Q.E.D.

Proof of Theorem 2. From the proof of Theorem 1, using (10) and (11), the conditions in premise imply that $dV(\mathbf{e}(t,r),\hat{x}(\cdot))/dr < dV(\mathbf{e}(t,r),\hat{x}(\cdot))/dt$ and the second constraint in (9) is binding. Q.E.D.

Proof of Theorem 3. From the alternative direction of Lemma 2.2 this implies $|\partial\hat{x}(\cdot)/\partial r| < |\partial\hat{x}(\cdot)/\partial t|$. This relation is necessary for the conditions in (7) to be both satisfied with an interior solution. Q.E.D.

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