A RESOURCE NEED AND AVAILABILITY VIEW OF THE MAKE OR ALLY CHOICE:
EVIDENCE FROM THE WORLDWIDE AIRCRAFT INDUSTRY 1945-2000\(^1\)

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Abstract:

This paper investigates why firms choose to undertake product expansion through alliances with competitors rather than on their own. We argue that both firm and product heterogeneity influence this expansion mode choice. Building on and expanding Penrose’s theory of firm growth, we propose that resource conditions influence not only the decision to grow but also the choice of expansion mode: firms turn to horizontal alliances in order to implement product expansion projects that require greater resources than those available to them. More precisely, we hypothesize that a firm is more likely to launch a new product in a given business domain through a horizontal alliance rather than autonomously, when the resource requirements of the project are greater, when the resources available to the firm are more limited, when there is a mismatch between resource endowment and requirement, and when the firm’s collaborative competence allows it to better cope with the inter-organizational concerns that collaboration with competitors raises. We find support for our arguments on a sample of 310 new aircraft developments launched between 1945 and 2000, either by a single prime contractor or as a horizontal alliance in which prime contractorship is shared with another industry incumbent. This paper highlights the importance of developing an integrated perspective which combines production and exchange aspects of governance decisions.
This paper investigates why firms choose to grow through alliances with competitors rather than on their own. Despite the vast body of literature on alliance formation, there is no clear consensus on the resource conditions that drive a given firm to implement some projects alone while collaborating with competitors on others. The topic of horizontal alliance formation has been investigated primarily through a resource and competence lens (Doz, 1988; Contractor and Lorange, 1988; Hamel, Doz and Prahalad, 1989; Nohria and Garcia-Pont, 1991; Eisenhardt and Schoonhoven, 1996; Ahuja, 2000; Chung, Singh and Lee, 2000; Rothaermel and Boeker, 2008). This resource perspective has led to a focus on firm resource heterogeneity as the main determinant of horizontal collaboration and has primarily examined firms’ overall propensity to ally (Eisenhardt and Schoonhoven, 1996; Stuart, 1998; Ahuja, 2000; Rothaermel and Boeker, 2008). In doing so, past research has overlooked the fact that firms form alliances to carry out specific expansion projects and that the features of such projects may influence a firm’s decision to collaborate rather than to expand autonomously. In addition, extant research on firm-specific determinants of horizontal alliance formation has produced mixed results: while some studies found that poorly endowed firms are more likely to form alliances to compensate for their weaknesses (Shan, 1990), others observed that stronger incumbents are more likely to cooperate because their resource endowment makes them more attractive as potential partners (Mitchell and Singh, 1992; Stuart, 1998). More recent research has combined these two logics in a “need and attractiveness” view of alliances which argues that firms turn to horizontal alliances to fill a particular resource gap, but that they must also possess valuable resources in other areas in order to attract potential partners (Eisenhardt and Schoonhoven, 1996; Ahuja, 2000; Rothaermel and Boeker, 2008). We claim that the ambiguous findings on the impact of firm resource endowment on horizontal alliance formation result from the fact that most previous research has overlooked product heterogeneity as a driver of alliance formation. We argue that the impact of firms’ resource endowments on horizontal collaboration is contingent on the resource needs generated by the product expansion projects the firms are pursuing. In other words, what drives a firm to collaborate with competitors is not its
resource endowment in absolute terms but the mismatch between the resources required by the
envisioned product and the resources available to the firm.

Thus, this paper complements those approaches that have emphasized the influence of firm
heterogeneity on alliance formation by highlighting the impact of product heterogeneity. In
addition, we also take into consideration autonomous production as the alternative to horizontal
collaboration (Shan, 1990). Therefore, this paper extends prior research by examining firms’
decisions to collaborate with other industry incumbents or go it alone on a product by product basis.
Beyond firms’ overall propensity to collaborate, we examine factors that drive firms to form
horizontal alliances for some product expansion projects while undertaking other projects on their
own.

Our framing of this make or ally decision draws on both the resource based view (Penrose,
1959; Rumelt, 1984) and the transaction cost logic (Williamson, 1991), and thus responds to
Winter’s (1988) call for considering both production and exchange concerns to explain governance
choices. More specifically, we posit that, when contemplating product expansion, managers gauge
the project’s resource requirements against the firm’s resource endowment, thus assessing the
firm’s ability to undertake the activity on its own. When the firm’s resources do not match the
project requirements, managers can opt for a horizontal alliance as an alternative. When considering
the alliance option, they also take into account the firm’s collaborative competence, i.e. its ability to
address potential collaboration hazards and costs which include both rent and resource
appropriation concerns (Williamson, 1975; 1991; Kogut, 1988; 1989; Hamel, 1991; Gulati and

We define autonomous product expansion as a firm’s independent decision to launch a new
product and to bear the risks and rewards associated with such a decision. Product expansion
through horizontal alliances, in contrast, involves sharing product definition, risks and returns with
firms competing in the same business domain. In our definition, both autonomous product
expansion and horizontal alliances can co-exist with outsourcing activities to suppliers and subcontractors or even with vertical collaboration with such partners.

The empirical setting of our study is the global aircraft industry. We test our model of product expansion mode choice on a sample of 310 new aircraft projects undertaken by all the major aircraft manufacturers in the world (excluding those from former Warsaw pact countries) from 1945 until 2000, either as single prime contractors (autonomous production) or joint prime contractors (horizontal alliance). We find support for all our hypotheses: we observe that aircraft manufacturers are more likely to undertake a new project through horizontal collaboration rather than autonomously when the resource requirements of the project are greater, when the firm’s resource endowment is more limited and when the firm has substantial collaborative competence. Further, consistent with our main argument, we find a significant impact of the interaction between project resource requirements and firm resource endowment on the choice between collaborative and autonomous production. It is interesting to note that, when we do not take into account varying levels of product resource requirements in different product categories, the impact of firm resource availability is no longer significant. This supports our view according to which the effect of available firm resources is contingent on product resource requirements. This might account for the somewhat inconclusive prior findings on the impact of firm resource endowment on alliance formation.

LITERATURE REVIEW

Both the governance and the firm growth literatures are relevant to our study of alternative product expansion modes. The governance literature has tended to focus on vertical relations (Walker and Weber, 1984; Martin, Mitchell and Swaminathan, 1995; Dyer, 1996; Poppo and Zenger, 1998; Leiblein and Miller, 2003; David and Han, 2004; Geyskens, Steenkamp and Kumar, 2006). This is due to the fact that Transaction Cost Economics (TCE), the main theory which has inspired governance research, focuses on vertical integration as a substitute to market relations, hence the emphasis on factors leading to market failure (Williamson, 1975; 1991). In contrast, we
focus on product expansion and the choice between expanding autonomously or through a horizontal alliance with other industry incumbents (Jarillo, 1988; Kogut, 1988; Hennart, 1988; Shan, 1990). As Penrose (1959) suggested, opportunities to expand arise from the experience and underlying learning that managers have developed about potential uses for the firm’s resources. In Penrose’s approach, the baseline option is therefore to grow organically, while in TCE, the default governance arrangement is the market. Whereas TCE views inter-organizational collaboration as an option when the market fails (Williamson, 1991), we extend Penrose’s theory and consider horizontal alliances as an option when internal resources are insufficient to grow organically (Kay, 2002).

Penrose’s (1959) theory of firm growth emphasizes internal inducements to expand over external factors. More precisely, although Penrose recognized the role of external factors, such as demand, she argued that growth primarily stems from managers’ perceptions of opportunities to put under-leveraged resources to new uses. Penrose also observed that firms can make acquisitions to obtain additional managerial resources. This view therefore suggests that resource conditions influence not only the decision to expand but also expansion mode choice. By focusing on the internal determinants of growth, Penrose has highlighted the heterogeneity of resources among firms. Further, in arguing that such firm heterogeneity leads different firms to pursue different expansion opportunities, Penrose (1959, p.67) suggested that undertaking different projects requires different amounts and types of resources. However, while firm resource heterogeneity has been the cornerstone of strategy research in general (Andrews, 1971), and the resource-based view in particular (Rumelt, 1984; Wernerfelt, 1984; Barney, 1986; Peteraf, 1993), product heterogeneity in terms of resource requirement has been under-researched (see Poppo and Zenger, 1998, for an exception).

In contrast, TCE acknowledges product heterogeneity as a driver of economic organization. Indeed, TCE argues that rent appropriation concerns induced by transaction characteristics influence governance choices (Coase, 1937; Williamson, 1975; 1985; 1991). In turn, these
transaction characteristics vary across products: different products require more or less specific assets, entail different levels of uncertainty and are exchanged more or less frequently (Walker and Weber, 1984; Dyer, 1996; Oxley, 1997; Nickerson, Hamilton and Wada, 2001; Oxley and Sampson, 2004). Therefore, in TCE, product heterogeneity is limited to those factors that create rent appropriation hazards. Moreover, the original TCE perspective has downplayed firm specificities as drivers of governance choice. Building on the Resource Based View (RBV), several authors have complemented this position by pointing to the role of firms’ resource endowments in driving economic organization (Argyres, 1996; Madhok, 1996; Poppo and Zenger, 1998; Argyres and Liebeskind, 1999; Barney, 1999; Silverman, 1999; Leiblein and Miller, 2003). In response, expanding the original TCE approach, both Liebeskind (1996) and Williamson (1999) have recognized firm heterogeneity as a determinant of governance choice but they focus on differences in firms’ ability to transact. More precisely, they acknowledge that firms can learn to contract (see Mayer and Argyres, 2004 for empirical evidence) and that such contracting competence can reduce rent appropriation concerns.

In sum, TCE considers product heterogeneity and, to a lesser extent, firm heterogeneity, as determinants of governance choice, but only inasmuch as they influence rent appropriation. The RBV, in contrast, emphasizes firm heterogeneity but largely overlooks product heterogeneity as a determinant of governance choice. Neither of these approaches builds on Penrose’s fundamental intuition according to which different expansion opportunities require different types and amounts of resources which may or may not be available to different firms, thus suggesting that both firm and product heterogeneity influence governance decisions, irrespective of rent appropriation concerns.

Empirical studies that have examined horizontal alliance formation have primarily drawn on resource approaches and have emphasized firm heterogeneity over product heterogeneity (Hamel, Doz and Prahalad, 1989; Nohria and Garcia-Pont, 1991; Eisenhardt and Schoonhoven, 1996; Doz and Hamel, 1998, pp.45-55 and 61-66; Ahuja, 2000; Chung, Singh and Lee, 2000; Rothaermel and
Boeker, 2008). In this stream of research, only a few studies have considered horizontal alliances as an alternative to autonomous product expansion (Shan, 1990; Mitchell and Singh, 1992). Shan (1990) examined firm-level determinants that lead biotechnology start-ups to team up with pharmaceutical companies to manufacture and commercialize an innovation rather than to go to market alone. He found that smaller start-ups which have not yet been able to develop manufacturing and marketing capabilities on their own tend to form alliances with pharmaceutical companies which possess such complementary resources (Teece, 1986; Doz, 1988; Das and Teng, 2000; Rothaermel and Boeker, 2008). Mitchell and Singh (1992) focused on industry incumbents that choose to collaborate with innovators. Contrary to Shan (1990), their results demonstrate that stronger competitors are more prone than weaker players to form alliances. Indeed, those incumbents most likely to cooperate are those which are more resource attractive and thus in a position to cherry-pick the most promising partners (Stuart, 1998). By focusing on firms’ resource endowments, this stream of research implicitly assumes that product expansion creates similar resource requirements across an entire business domain: all firms undertaking product expansion within their industry are thus assumed to face the same resource challenge and will opt for collaborative or autonomous production on the basis of their own resource endowment. We argue instead that, even within the same business domain, varying levels of resource requirements across products, together with differences among firms’ resource endowments, influence the choice between horizontal collaboration and autonomous expansion.

Overall, prior studies on horizontal alliance formation offer little insights into why a given firm will choose to collaborate on some products and produce others autonomously. Our study aims at filling this gap by taking into account product resource requirements together with firm resource endowment, as well as the interaction between these two factors.

THEORY DEVELOPMENT AND HYPOTHESES

The crux of our argument is that a firm’s decision to expand autonomously or through a horizontal alliance is determined by the fit between the resource requirements of the envisioned
product and the resources available to the firm. We argue that product resource heterogeneity explains why a given firm with a given resource endowment may undertake some new products on its own and others through horizontal alliances. Conversely, firm resource heterogeneity explains why different firms choose to undertake similar products with similar resource requirements either on their own or through alliances. We also acknowledge that the firm’s ability to reduce inter-organizational costs influences its decision to form a horizontal alliance or go it alone (Simonin, 1997; Williamson, 1999; Anand and Khanna, 2000). More specifically, we argue that, when launching a new product development, managers assess the product’s resource requirements, the firm’s resource endowment, and thus the firm’s ability to undertake product expansion on its own. When the firm’s resources are insufficient given the project requirements, managers can choose to pool the firm’s resources with those of competitors in a horizontal alliance. When contemplating this option, managers consider the firm’s ability to cope with potential collaboration hazards and costs (Kogut, 1989; Hamel, 1991; Williamson, 1991). We now turn to formulating specific hypotheses based on this theoretical framework (see Figure 1).

Insert Figure 1 about here

Product Heterogeneity and Resource Requirements

The decision to undertake product expansion alone or through a horizontal alliance is influenced by the scope and magnitude of the resources required to successfully implement such a move. We claim that product characteristics determine the scale and scope of resources needed to develop, produce and commercialize the envisioned product (Poppo and Zenger, 1998; Mayer and Salomon, 2006). Depending on their functional attributes, different products have different levels of complexity and create different resource requirements in terms of research, development, manufacturing and marketing assets and capabilities. Because of this product heterogeneity in terms

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2 We follow Barney (1991) in considering that resources include both tangible and intangible assets and the capabilities needed to exploit these assets.
of complexity and resource requirements, firms make governance choices on a project by project basis. However, not all resource requirements drive governance choice. Indeed, some resources (notably financial resources) can be obtained on the market and greater requirements of such resources need not drive alliance formation. We therefore limit our argument to those resources that are affected by some degree of market imperfection and incompleteness (Wernerfelt, 1984; Barney, 1986; Dierickx and Cool, 1989).

*Ceteris paribus*, firms will be more likely to form horizontal alliances for more complex projects requiring greater and broader sets of difficult-to-trade resources than for simpler projects which they are more likely to undertake independently. Indeed, through alliances, two or more incumbents can combine or pool their resources to collectively address the resource requirement of the envisioned product, which would otherwise be out of reach of any one partner (Harrigan, 1985; Doz, 1988; Contractor and Lorange, 1988; Hennart, 1988; Kogut, 1988). Hence the following hypothesis:

*Hypothesis 1. The greater the complexity of the envisioned product, the greater the likelihood a firm will undertake product expansion through a horizontal alliance rather than autonomously.*

**Firm Heterogeneity and Resource Endowment**

Holding a product’s desired characteristics constant, firms possessing most of the imperfectly tradable resources needed to undertake the product expansion project are more likely to do so on their own and are therefore less likely to collaborate with other industry incumbents (Shan, 1990). The more firms have, in the past, launched products in the same domain, the more likely they are to have built relevant production capabilities by developing and codifying activity-specific technological, operational and commercial know-how and by investing in assets redeployable to new products in the same domain (Yelle, 1979; Simon, 1991; Argote, 1999; Williamson, 1999; Zollo and Winter, 2002; Leiblein and Miller, 2003).
Further, building on the RBV, we claim that more competent firms have an incentive to opt for autonomous expansion in order to avoid knowledge leakage (Rumelt, 1984; Hamel, 1991; Barney, 1999) which is facilitated by the fact that partner firms in horizontal alliances have similar operational knowledge bases (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998).

In addition, stocks of resources tend to deplete over time and renewing an existing resource stock is less costly than building one up because of time compression diseconomies (Dierickx and Cool, 1989). Product expansion within a given domain is a privileged way through which firms practice, refine and extend their competences in a learning-by-doing process (Penrose, 1959; Nelson and Winter, 1982). As a consequence, more experienced firms are more likely to decide to carry out a new product expansion project on their own in order to sustain their competence accumulation path and, thereby, their competitive advantage (Conner and Prahalad, 1996; Leiblein and Miller, 2003).

In contrast, firms with less experience in a business domain may consider they lack some of the competences required to launch the envisioned product, have a more limited competence base to maintain through autonomous production and, therefore, are less likely to undertake product expansion on their own. Horizontal alliances can allow relatively inexperienced firms to pool their limited technological, operational and commercial know-how in order to pull the considered project through. Less competent firms are thus to gain more than more competent firms from forming a horizontal alliance (Ahuja, 2000). In addition, the risk of losing valuable knowledge is substantially lower for less experienced firms than for more competent incumbents.

Hypothesis 2. The greater a firm’s production experience in a product domain, the lower the likelihood it will undertake product expansion in this domain through a horizontal alliance rather than autonomously.

The Combined Effect of Product Resource Requirements and Firm Resource Endowment

The two prior hypotheses suggest that, when choosing product expansion mode, managers independently consider the resources required by the product and the resources available to the
firm. However, we argue that managers make these decisions based on the match between these two factors. More precisely, managers gauge the resources available to the firm against the resources required by the project. The greater the match between available and required resources, the more likely they are to undertake the project on their own. Conversely, the greater the mismatch, the more managers will turn to the alliance option as a means to pull through projects that are beyond their reach. In other words, we argue that, for less experienced firms, the influence of project resource requirements is greater than for more experienced firms. Similarly, for more complex products, differences in firm production experience become more critical: having little experience in the relevant product domain amplifies the need for forming a horizontal alliance to meet product resource requirements.

**Hypothesis 3.** *The greater the complexity of the envisioned product, the stronger the impact of firm production experience on the likelihood to undertake product expansion autonomously rather than through a horizontal alliance.*

**Firms’ Ability to Deal with Inter-Organizational Concerns**

Alliances are complex to set up and manage (Borys and Jemison, 1989; Simonin, 1997; Kale, Dyer and Singh, 2002) and generate inter-organizational costs which are the sum of transaction and coordination costs. Firms which engage in alliances incur transaction costs in searching for partners, negotiating, monitoring and enforcing the contract (Williamson, 1991; Parkhe, 1993; Zaheer, McEvily, and Perrone, 1998), as well as coordination costs in managing joint operations (Gulati and Singh, 1998; White and Lui, 2005). Coordination costs refer to those costs which “…arise from the task-related coordination needs and social integration that are necessary in order for partners to combine resources and integrate their activities in the course of undertaking a joint task” (White and Lui, 2005: page 914). Further, depending on its relative bargaining power and the extent of opportunistic behavior among the partners, a given firm might or might not obtain the expected share of the overall value created, potentially making collaboration less profitable than autonomous production for that firm. A firm’s collaborative competence can make collaboration
both more effective and efficient, by lowering coordination costs and reducing the potential rent appropriation and strategic risks of collaboration (Liebeskind, 1996; Simonin, 1997; Williamson, 1999; Gulati, 1999). Having collaborated in the past enables firms to assess the trustworthiness of potential partners, better select with whom to collaborate and thus reduce monitoring costs (Gulati, 1995). Further, thanks to their collaborative know-how, firms are capable of better managing day-to-day cooperation, that is, pooling resources and jointly leveraging operational knowledge, thus also incurring lower coordination costs. Past research has empirically shown that, through their experience, firms learn over time to contract in general (Mayer and Argyres, 2004) and more specifically to manage alliances, obtaining greater value from their subsequent alliance activity (Simonin, 1997; Anand and Khanna, 2000; Kale et al., 2002; Hoang and Rothaermel, 2005; Sampson, 2005). Therefore, past alliance experience leads to collaborative competence which creates an incentive to form alliances (Gulati, 1999), while a lack of such experience may deter from collaborating.

While generic collaborative experience can provide negotiating and enforcing skills applicable to any alliance, we claim that alliance experience in the same domain as the envisioned product gives greater advantages, particularly in the case of horizontal alliances. Indeed, in horizontal alliances, partners are incumbents in the same business and have access to similar types of assets and capabilities. Therefore, in most cases, there is no obvious pre-determined scheme for allocating tasks between the partners. Each new endeavor thus requires working out an adequate organization for which fine grained alliance competence in the particular technical domain might prove valuable. To the extent that competence based on past experience is applicable to new projects (Haleblian and Finkelstein, 1999), firms with greater horizontal alliance experience in the same product domain will be better able to select the best possible partner for a new project in this domain, establish contractual agreements that permit a fair distribution of revenues, costs and rents among partners, appropriately break down the project into separable activities, efficiently allocate tasks among partners and effectively manage the technical and commercial interfaces.
In addition, we acknowledge that alliance experience might also increase the attractiveness of the focal firm as a partner, to the extent that its alliancing competence is known. Higher reputation for being a competent partner might facilitate the emergence of opportunities for cooperation (Eisenhardt and Schoonhoven, 1996; Gulati, 1999; Chung, Singh and Lee, 2000).

_Hypothesis 4. The greater a firm’s horizontal alliance experience in a product domain, the greater the likelihood it will undertake product expansion in this domain through a horizontal alliance rather than autonomously._

**METHODS**

**Empirical Setting**

The empirical setting for our study is the worldwide aircraft industry from 1945 to 2000, excluding former Warsaw Pact countries in which firms did not exist as such during most of the period. We focus on airframe manufacturers, excluding other firms participating in the aircraft industry that are suppliers or subcontractors to airframe manufacturers, such as engine makers, electronic equipment providers, etc. Unlike in most other industries, airframe manufacturers have been forming horizontal alliances with each other for many years to develop, manufacture and commercialize new products.

In this industry, products incorporate highly sophisticated and diverse technologies and thus, launching new products requires broad skill sets and substantial specialized assets. These resources are characterized by a high degree of market imperfection. Because of national defense considerations, the mobility and transfer of skilled employees and proprietary technologies are highly limited (Gansler, 1990, 1995).

Airframe development costs are extremely high: it was estimated that, between 1980 and 2000, R&D costs accounted for 13% of the US aerospace industry revenues on average. These costs have been increasing significantly over time (Augustine, 1975); average development time for

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3 Aerospace Industries Association website, [http://www.aia-aerospace.org](http://www.aia-aerospace.org)
a fighter aircraft, for example, went from a couple of months during World War II to over six years
by the end of the millennium (Jane’s All the World Aircraft, 1945-2003). Moreover, there are
significant differences in resource requirements across airframe projects (Hartley, 1983). While
fighter aircraft or large airliners are highly complex and costly, most propeller aircraft incorporate
much simpler technologies and require significantly lower development efforts. Within a given
aircraft category, variations in resource requirements are also significant. For example, producing a
combat helicopter requires a larger and more sophisticated set of resources than developing a small
VIP transport helicopter. These differences in resource requirements are reflected in pricing: several
hundred million dollars for the most sophisticated aircraft compared to a few tens of thousands of
dollars for the simplest models.

Because of increasing resource requirements and costs, the aircraft industry has undergone
major consolidation over the years (Anand and Singh, 1997). However, national security concerns –
which primarily prevail in the case of military aircraft but also affect commercial aircraft because
both are produced by the same firms and share technology extensively – have limited the potential
for international consolidation as well as for licensing. This has led airframe manufacturers to turn
extensively to collaboration to jointly produce aircraft. Most of these collaborations associate
industry incumbents that undertake a project jointly by sharing the prime-contractorship. Joint
prime-contractorship entails jointly defining product features, sharing investments, risks and
benefits. In such arrangements, the partners split the development work among themselves and then
each assumes responsibility for manufacturing (sometimes turning to subcontracting) those
elements and modules it has developed. Marketing and sales are either split among the partners on a
geographic basis or entrusted to an ad hoc joint sales organization controlled and staffed by all
partners (Dussauge and Garrette, 1995). Such joint prime-contractorship arrangements, which have
accounted for close to 20 % of all new aircraft developed since WWII (Jane’s All the World’s
Aircraft, 1945 – 2003), are horizontal alliances between incumbents, formed to jointly launch new
products. As such, they are a vehicle for all partners to implement product expansion.
We acknowledge that joint prime-contractorship is only one of the multiple forms that inter-firm collaboration can take on in the aircraft industry. Airframe manufacturers routinely collaborate with complementors such as engine makers or electronic equipment providers. They also collaborate with first tier suppliers on entire modules and subsystems (Masten, 1984). These arrangements, however, cannot be considered as horizontal alliances because the involved partners are not incumbents competing in the same sector. In addition, these collaborations are not substitutes to single prime contractorship: the role of a prime contractor is precisely to organize the entire network of such inter-organizational ties in a consistent way.

**Population and Sample**

To collect our data, we considered the population of civil and military airframe projects launched from 1945 to 2000, i.e. projects for which the prototype first flight took place during this time span. The population includes four types of aircraft: fighter aircraft, jet transport aircraft, propeller aircraft, and helicopters. We gathered data from two sources: *Jane’s All the World Aircraft* annual reports and *DMS Forecast* databases which list all aircraft models in production during a given year. *Jane’s All the World Aircraft*, published since 1909, is the major reference source on aircraft programs, covering the entire worldwide production. The *Jane* reports classify aircraft by country of origin and, within each country, by prime-contractor (e.g. the Dassault Rafale fighter is listed in the “France” section under the “Dassault” heading). Multiple prime-contractor programs are listed under the headings of all prime-contractors (e.g. the V22-Osprey tilt-rotor aircraft is in the US section and listed twice under both the Bell Textron and Boeing headings). Programs undertaken by multiple prime-contractors from different countries are listed in an “International Programmes” section under a heading identifying all prime-contractors. We classified all aircraft projects included in our sample as either alliances or autonomous projects based on whether they were listed under one or more prime-contractors in *Jane’s* reports.

We did not include production under license. In licensed production, the licensee takes on none of the responsibilities of a prime contractor: in particular, licensees do not participate in the
definition of essential product features or in technology development and limit their contribution to manufacturing a pre-existing product and commercializing it in a specific market area. Licensed production is therefore neither autonomous production (single prime-contractorship) nor a horizontal alliance (joint prime-contractorship). Licensed production can be viewed instead as a market transaction on technology and product design.

The unit of analysis in our study is an airframe manufacturer launching a new aircraft, either on its own or through a horizontal alliance. We therefore considered each firm-product combination a different observation. Each single-firm product resulted in one observation while each alliance resulted in as many observations as there were co-prime contractors involved in the project. This process led us to identify 412 firm-product observations with prototype first flights taking place between 1945 and 2000. These 412 observations corresponded to only 117 different firms, as several firms had launched more than one product in the considered period. Due to missing data on some of the independent variables, only 310 cases (75 % of the population) were available for use in the analysis. We found no bias in the resulting sample compared to the initial population based on expansion mode choice (alliance vs. autonomous production), nationality, age and product category. The 310 sample cases consisted of 84 collaborative firm-product observations and 226 single-firm products. These new product launches involved a total of 79 different firms.

**Dependent Variable**

Our dependent variable, **Alliance**, is a dummy indicating whether a given firm launching a new aircraft is doing so as the single prime contractor (Alliance =0) or by sharing the prime contractorship with one or several other industry incumbents (Alliance =1).

**Independent Variables**

We estimated **Product Complexity** based on product functional attributes, and measured it with the logarithm of the aircraft’s maximum speed (in km/h) multiplied by its range (in km) and takeoff weight (in kg), as reported by *Jane’s* and *DMS Forecast*. Such indicators have been frequently used in other studies on the aircraft industry (Frenken and Leydesdorff, 2000). Higher
scores on the Product Complexity measure are associated with higher upfront investments, higher development costs, the use of more sophisticated technologies, longer development times as well as with higher prices for the resulting products.

We captured a firm’s Production Experience with the number of different products that the firm had previously developed as a prime contractor in the same product domain as the focal project (fighter aircraft, jet transport aircraft, propeller aircraft, or helicopters). We gathered this data from Jane’s annual reports. We confirmed this information by consulting historical descriptions available on company or other specialized industry websites. While a more direct measure of firm resources would have been desirable, recent research has shown that assessing firm resources through product or project experience is as effective as finer-grained indicators (Rothaermel and Boeker, 2008).

Finally, we measured firms’ Alliance Experience in the considered product domain by the number of past horizontal alliances, i.e. products undertaken in collaboration with other prime contractors in the same product domain, prior to the focal prototype first flight.

In order to test H3, we created a multiplicative interaction term by multiplying Product Complexity and Production Experience after centering the measures for the main terms.

Controls

We controlled for nine factors that might also impact the choice of horizontal alliances over autonomous production.

First, we controlled for the four previously mentioned product domains by creating three dummies (Helicopter, Fighter and Jet, propeller aircraft being the excluded category) because resource requirements might vary systematically across these domains, and therefore the likelihood of alliance vs. autonomous expansion, might vary across them. For example, helicopters incorporate a broader set of technologies than other aircraft categories and thus, we might expect firms undertaking a helicopter project to be more likely to form a horizontal alliance rather than to produce on their own, when compared to other product categories.
Second, we controlled for **Firm Size** because larger firms might have easier access to a broad range of resources such as capital and labor thanks to their greater reputation and market presence. Penrose (1959) explicitly argued that, though financial resources are easily accessible and thus are usually not a constraint for firm growth, small firms may face specific difficulties in raising funds. We assessed Firm Size on the basis of the firm’s revenues in the aircraft industry one year prior to prototype first flight. To do so, we constructed an aircraft revenue proxy by considering all of the firm’s different aircraft in production in the four product domains a year prior to the focal prototype first flight. We estimated the annual volume of production for a given model by dividing the total volume produced in its entire life cycle by the number of years during which the model was manufactured, assuming a yearly constant production volume. These data came from both Jane’s annual reports and DMS Forecast database. Then, we determined the annual revenues each model generated by multiplying its annual volume by the mean of its DMS Forecast estimated price range in 1999 dollars. We replaced missing prices by price estimates that we obtained by regressing prices on products’ technical characteristics: maximum speed, range and takeoff weight. Summing the annual revenues for all aircraft in production that year, we obtained an estimate of each year’s firm aircraft revenues. We used the logarithm of this estimate to generate the Firm Size variable. We were forced to turn to such an estimate because our data spans a fifty year period and covers 22 countries, making it impossible to collect comprehensive data on aircraft sales for each considered company (many of which have long disappeared). Also, isolating aircraft sales in the total revenues of large diversified groups is almost impossible for periods of time or in countries where reporting business line figures was not mandatory.

Third, we controlled for product launch year by using the product’s prototype first flight year (**Year**) in order to eliminate any trend effect, as the overall propensity to form alliances in aerospace appears to have increased over time, like in many other industries (Hagedoorn, 1993). Similar to other studies (Gulati, 1999), we used this quantitative measure rather than a dummy for

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4 We conducted a price regression for each of the four different product types (propellers, jets, helicopters, and fighters) and obtained significant models with a $R^2$ ranging from .76 to .94.
each year (49 dummies) in order to economize on the number of predictors. Furthermore, prior research has found the same results whether quantitative or dummy variables are employed (Gulati, 1999).

Fourth, we controlled for changes in the level of technology over time within each product domain by creating a variable that denotes the average development time of products in the considered category during the five years before the year of the focal project launch (Level of Technology). Indeed, aerospace in general has been characterized by drastic technology change over the years, which, as mentioned earlier, has resulted in a significant increase in average development times. However, the rate of technological evolution may vary from one product domain to the other as well as from one period to the other, thus resulting in varying incidences of alliance formation.

Fifth, we controlled for the military, civilian or dual nature of aircraft by creating two dummies, Military which takes on the value 1 for products developed for military purposes only and Civil which takes on the value 1 for products developed for commercial purposes only, dual purpose aircraft being the excluded category. Relative to commercial aircraft, military aircraft might benefit from greater government support in the form of financial subsidies or direct access to advanced technology. Military aircraft might therefore be more likely to be autonomously produced. Also, political and national security reasons might lead to more autonomous product development while, on the other hand, diplomatic considerations might favor international alliances for military aircraft. In addition, governments may force military aircraft makers to collaborate with each other in order for a broader set of potential providers to remain active in the industry. Dual use aircraft may entail greater resources requirements in order to satisfy both customer categories, thus leading to more alliances; on the other hand, greater sales opportunities might create an incentive to produce alone in order to capture all profits related to both market segments.

Sixth, we included a variable to control for government support of the aerospace industry. Indeed, through the funding of military projects, governments subsidize local producers and
guarantee outlets for the resulting products. While military aircraft are funded directly, commercial aircraft greatly benefit from technology spillovers (Mowery, 1986). Because of this, some of the resources required to launch new aircraft may in fact be supplied by the government. Firms originating from countries with large defense expenditures may therefore benefit from greater resources and be more likely to launch products on their own than firms from countries with less government support, which may be more prone to form horizontal alliances. We assessed government support to a firm launching a new aircraft with the logarithm of the defense budget of the country from which the firm originates (Defense Budget) one year prior to the focal prototype first flight. The defense budget is a proxy for the magnitude of resources available to fund new projects launched in the country. Through its knowledge of the domestic defense budget at the time when the project is initiated, i.e. before prototype first flight, a firm can estimate the funding it is likely to receive and therefore its ability to pull the project through on its own. By using defense budget data one year before prototype first flight, we make sure that the relevant information for deciding on autonomous or collaborative production is indeed available to the firm. Defense budget data for the 1945-2000 period were collected from the Stockholm International Peace Research Institute (SIPRI) and converted into billions of constant 1970 dollars.

We also included two variables to control for the impact of conflicts on firms decisions to launch new aircraft through alliances. A first Cold War dummy denotes whether a project was launched during the period of East-West tension (Cold War = 1) or after the fall of the Berlin wall in 1989 (Cold War = 0). Indeed, the cold war may have led to greater collaboration among firms from allied countries. A second Wartime dummy traces whether a new product was launched in a country engaged in a more localized conflict (Wartime = 1). In our period of observation, such conflicts include the war in Korea (1950-1953), Vietnam (1964-1973) and the Gulf (1990-1991) for US firms, the war in Indochina (1946-1954), Algeria (1954-1962) and the Gulf (1990-1991) for French firms, the war in the Falklands (1982) and the Gulf (1990-1991) for UK firms, the Falklands

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5 Examination of our data reveals that, in all cases, the decision on collaborating or producing autonomously has been made before prototype first flight.

6 Our sample does not cover the “second” war in Iraq which began in 2003.
war (1982) for Argentine firms, the three Indo-Pakistan wars (1947-1948, 1965, 1971) for Indian and Pakistani firms, the two Arab-Israel conflicts (1967, 1973) for Israeli firms, as well as the Gulf war (1990-1991) for Canadian and Dutch firms. Indeed, in addition to the impact they may have on defense budgets, local conflicts may lead to less international cooperation with firms from countries that are not engaged in the same war.

Finally, we controlled for industry structure in each product domain with a variable (Number of Competing Aircraft) that captures the number of aircraft offered in the same category (Helicopter, Fighter, Jet or Propeller aircraft) at the time of product launch. We operationalized this variable by listing all products in the same category whose prototype first flight had taken place during the ten years prior to the focal product’s prototype first flight. We chose this product-based measure of industry structure rather than a more traditional firm-based measure because the high incidence of horizontal alliances in the aircraft industry might lead to overestimate the real level of competition. While prior literature on alliance formation has suggested that more fragmented industries offer greater opportunities for collaboration (Hagedoorn, 1995), thus leading to a greater collaborative propensity, it could also be argued that horizontal alliances have a stronger impact on market power in more concentrated industries (Jarillo, 1988; Kogut, 1988).

Statistical Method

To test our hypotheses, we used a logistic regression model because of the dichotomous nature of the dependent variable and the fact that we included both continuous and dummy variables as predictors. Logistic regression models are more appropriate than discriminant analysis for qualitative dependent variables when dummy variables are included as predictors and the normality assumption might be violated (Hair, Anderson, Tatham and Black, 1998). As the 310 projects in the sample were launched by only 79 different firms, some projects shared the same parent firm. To deal with this problem of non-independence among the observations, we created a

7 We also ran the same models with the more traditional measure of concentration (number of firms competing in the same product domain), which did not substantially affect the results.
categorical variable (Firm) that identified each parent firm and we adjusted the standard errors of the logistic regression coefficients by clustering the sample on this variable.\textsuperscript{8}

RESULTS

Table 1 provides the descriptive statistics and the correlation matrix for all the variables. Nine bivariate correlations are relatively high: Fighter with Military and Civil; Helicopter with Product Complexity; Jet with Product Complexity, Military and Civil; Cold War with Year; Defense Budget with Firm Size; as well as Production Experience with Alliance Experience. These links were to be expected given (i) the military nature of fighter aircraft, (ii) the technical features of helicopters and jets compared to other aircraft, (iii) the predominance of civil aircraft in the jet transport segment of the industry, (iii) the end of the cold war in the late eighties; (iv) the fact that differences in national defense budgets have produced differences in firm size because of the strong military component in this industry, and (iv) the fact that alliance experience is measured at the product domain level and is therefore included in production experience.

\textsuperscript{8} We used the Huber-White sandwich “cluster” procedure provided by STATA. The results we obtained when using this cluster procedure are substantially the same as those obtained when not using it (i.e. running a simple robust logit): both standard errors and confidence intervals remain virtually unchanged, which suggests that non independence among observations is unimportant.

Table 2 displays the logistic regression results. Inclusion of the three explanatory variables and of the interaction between Product Complexity and Production Experience (models 3 and 4) improves significance compared to the model with only controls (model 1). The significance of the controls is not affected by the introduction of the three main effects (model 3), neither is the significance of the main effects by the introduction of the interaction term (model 4). In contrast, the impact of Production Experience is significant only when Product Complexity is introduced in the equation. Indeed, model 2, which features only Production Experience, Alliance Experience and the controls and leaves out Product Complexity, confirms the expected impact of Alliance Experience on alliance formation but reveals no significant link between Production Experience and
expansion mode choice. This supports our claim that accurately modeling the influence of firm resource endowment on expansion mode choice requires taking into account varying levels of resource requirements at the product level. The full model (model 4) is significant (chi-square = 103.43, p<0.01) and provides general support for our four hypotheses. As predicted in hypothesis 1, the more complex a product, the more likely a firm will undertake it through a horizontal alliance rather than autonomously (p< 0.01). Confirming hypothesis 2, firms with greater production experience are more likely than less experienced firms to undertake projects on their own rather than through horizontal alliances (p < 0.05). Consistent with hypothesis 3, the interaction between Product Complexity and Production Experience has a significantly negative impact on the likelihood to undertake projects through horizontal alliances rather than autonomously (p < 0.10), suggesting that the fit between project resource requirements and resources available to the firm is a strong determinant of product expansion mode. More precisely, the impact of limited Production Experience on the likelihood to collaborate is stronger for firms launching more complex products. The joint test of the main effect of Production Experience and the interaction effect is indeed significant at high levels of Product Complexity, i.e. values greater than the mean (p < 0.05). At lower levels of Product Complexity, the joint effect is no longer significant. This suggests that the impact of the match or mismatch between needed and available resources is particularly salient at high levels of Product Complexity. Finally, as predicted in hypothesis 4, firms undertaking projects in product domains where they have greater Alliance Experience are more likely to opt for horizontal alliances rather than for autonomous expansion (p < 0.01).

As for controls, our results for the Year variable indicate that the propensity for firms to collaborate rather than to produce autonomously has increased over time (p < 0.01). This is consistent with prior alliance literature which has shown an increase in the rate of alliance formation (e.g. Hagedoorn, 1993). We also find that helicopters are more likely to be produced through horizontal alliances than propeller aircraft, the excluded category (p < 0.01) and that firms are more likely to choose horizontal alliances over autonomous expansion to produce both purely
military ($p < 0.10$) and purely civil ($p < 0.05$) aircraft than to develop dual-use products, the excluded category. This may result from the fact that dual-use aircraft address a larger market, which makes it comparatively easier for a single firm to recoup its development investments by marketing such products on its own. Finally, as expected, both Firm Size ($p < 0.10$) and Defense Budget ($p < 0.05$) significantly increase the likelihood that firms will undertake product expansion on their own. It is interesting to note that, similar to the above mentioned finding on Production Experience, the influence of Firm Size is significant only when Product Complexity is accounted for (i.e. in models 3 and 4 but not in models 1 and 2). Again, this is consistent with the view that the influence of firm-level factors on the choice of expansion mode is contingent on product resource requirements.

**DISCUSSION**

The resource requirement and availability framework we put forth appears to be a good predictor of product expansion mode in the aircraft industry in the period we analyzed. Our results show that a misfit between the resources required by a product expansion opportunity and the resources available to the firm induces managers to opt for a horizontal alliance rather than for autonomous expansion. Moreover, the interaction effect between required and available resources shows that the greater the resource requirement of the envisioned product, the more a lack of firm resources leads managers to opt for a horizontal alliance, especially for those product expansion projects which require substantial resources. Thus, both product and firm heterogeneity, as well as their interaction, seem to be driving economic organization, in particular the *make or ally* choice. Our findings confirm the importance of considering product-level characteristics and the resource requirements they create as determinants of governance, beyond the rent appropriation considerations raised by TCE.

Our finding on the link between production experience and expansion mode choice is consistent with the argument on the strategic dimension of resources which deters expert firms from collaborating because they fear the erosion of competitive advantage through leakage and
replication (Rumelt, 1984; Hamel, 1991; Conner and Prahalad, 1996, Liebeskind, 1996; Mayer and Salomon, 2006). Our result on the influence of alliance experience on alliance formation also lends credence to the fundamental TCE concern with rent appropriation by confirming the influence of the capability to deal with inter-organizational issues on the choice of autonomous versus cooperative expansion (Simonin, 1997; Williamson, 1999; Sampson, 2005).

We also find that larger firms tend to favor autonomous product expansion over horizontal alliances, which suggests that, regardless of their product domain capabilities, larger firms are better able to gather resources needed to expand on their own. It thus appears that larger firms benefit from advantages such as reputation, social connections and political clout, which might give them easier access to financial resources, labor and physical assets (Hannan and Freeman, 1984), despite the fact that such resources are often considered to be perfectly tradable.

In addition, firms originating from countries with larger military expenditures also tend to opt for autonomous product expansion over horizontal alliances. This reveals that, in the aerospace industry, the government is a significant provider of resources through subsidies and government research programs, thus increasing the resources available to domestic firms.

Contributions

Our findings contribute to the theory of firm growth, as well as to the governance and the alliance formation literatures.

First, our study extends Penrose’s theory of firm expansion by considering alternative modes of growth. While Penrose (1959) primarily focused on organic growth and, to a lesser extent, on acquisitions, we consider horizontal alliances as a means of product expansion. Whereas Penrose argued that resource conditions influence the decision to expand, we show that they also impact the mode of expansion. Penrose (1959) argued that firms expand in order to find new uses for their underleveraged resources. Our approach complements this view by highlighting the importance of matching these firm resources with project resource requirements (Poppo and Zenger, 1998). More specifically, while acknowledging the influence of excess resources in the decision to expand, we
argue and show that the match or mismatch between the resources required by the expansion opportunity and the resources available to the firm influence the choice of expansion mode. Consistent with Penrose (1959), our results show that firms tend to engage in organic product expansion when they already possess the necessary resources. Conversely, they form horizontal alliances when they lack resources to launch on their own new products with higher resource requirements. While Penrose (1959) discussed the role of acquisitions as a means to obtain additional resources, we extend this logic and consider alliances as another mode of external expansion when the resources required exceed the resources available to the firm.

Second, building on Winter (1988), Hennart (1988) and Poppo and Zenger (1998), we propose and test a theoretical framework which explains product expansion mode, and thus the boundaries of the firm, by integrating production and exchange concerns. While TCE explains governance choices based on rent appropriation concerns, we propose a broader governance choice model which also considers the production challenge by focusing on the fit between resources required and resources available. Thus, we respond to Winter’s (1988) call for integrating the production and exchange dimensions by simultaneously taking into account firm and product heterogeneity on the one hand and inter-organizational costs on the other hand. Complementing Poppo and Zenger (1998) who studied the make or buy choice, we provide evidence for the influence of both production and exchange considerations on the make or ally choice.

Third, we contribute to the alliance formation literature by highlighting the influence of product heterogeneity on the make or ally choice. Prior research on alliance formation has focused on firms’ resource and capability endowment and modeled firms’ propensity to form alliances on the basis of the strength and scope of this endowment, regardless of the resource needs that arise from the particular features of each expansion project (Eisenhardt and Schoonhoven, 1996; Stuart, 1998; Ahuja, 2000). Instead, we model the decision to expand through alliances or autonomously on a project-by-project basis, as a function of both product and firm features and their interaction. Our results demonstrate that the impact of firm resources on the make or ally decision is contingent
upon project characteristics. Indeed, the influence of firm resources becomes significant only when product characteristics are accounted for. In addition, a firm’s resource limitations do not influence its likelihood to collaborate in a linear way; the effect of such limitations is enhanced by the resource needs the project generates. Hence, project resource requirements not only condition but also exacerbate the firm’s likelihood to choose collaboration over autonomous expansion. While prior research has yielded somewhat ambiguous results on the link between firm resources and alliance formation, our findings provide a better understanding of the resource determinants of inter-firm collaboration. Indeed, earlier research has alternatively emphasized resource weaknesses and resource strengths as the main determinants of alliance formation (Shan, 1990; Mitchell and Singh, 1992). Approaches emphasizing firm resource needs and firm attractiveness as a potential partner have provided a first attempt at resolving such contradictions: complementary strengths and weaknesses in the partners’ resource endowments are seen as the primary drivers of alliance formation (Eisenhardt and Schoonhoven, 1996; Ahuja, 2000). This view assumes that a firm’s resource needs and resource strengths relate to resources that are different in nature: one partner’s strengths compensate for the other’s weaknesses and vice-versa. However, our findings suggest that resource needs may not always relate to different resource categories but rather to sufficient quantities in the same resource categories; similarly, attractiveness may not necessarily result from the possession of different resources but rather from additional quantities of the same resources. Indeed, our focus on horizontal alliances between incumbents in the same industry suggests that most firms in our sample possess the same broad array of resources but that some firms have accumulated more of these resources than others. This view is consistent with Hennart (1988) who argued that horizontal alliances, which he labels scale alliances, are characterized by the similar nature of partner contributions (Dussauge, Garrette and Mitchell, 2000). Our results on the significant impact of product resource requirements on the choice between horizontal collaboration and autonomous expansion further suggest that firms form horizontal alliances to pool similar resources with competitors in order to jointly match the resource requirements of expansion projects.
that they would be unable to address on their own. In contrast, for projects with more limited resource requirements, the same firms may opt for autonomous expansion.

**Limitations and Future Research**

We acknowledge that our measures present some limitations. In particular, our measure of firms’ available resources could be improved. Future studies should take into account both the scope and the depth of the firms’ resource endowment along the value chain, identifying the strategic nature of resources as well as their redeployability to the new project (Poppo and Zenger, 1998). Along the same lines, future research should attempt to capture resource requirements more directly by assessing the scope and magnitude of resources needed to implement the new project. Finally, our measure of a firm’s ability to deal with inter-organizational concerns does not distinguish between transaction costs and coordination costs for a particular activity and partner (Gulati and Singh, 1998). Future research should try to directly measure these costs (Masten, Meehan and Snyder, 1991) and disentangle their independent effects on governance choice separately from the firms’ ability to cope with them.

Also, our findings might be limited in their generalizability because they are derived from an industry with particular demand and supply conditions, in which national boundaries and public policy play an important role, either fostering autonomous production, or possibly promoting collaboration with allies. However, we find support for all our hypotheses even when controlling for government influences on industry conditions through a series of factors (the military or civil nature of products, defense budgets and war periods), leading us to believe our results are not driven by industry specificities.

More fundamentally, a possible limitation of our research is that we conceive the *make or ally* option as a firm launching a new product as the single or joint prime contractor, regardless of the extent to which the firm insources or outsources the product’s components. Therefore, the *make* option we consider does not coincide with full internalization. Indeed, prime contractors routinely collaborate with suppliers and complementors (for engines, systems, electronics etc.), with
universities and with government research centers (Masten, 1984). Similarly, we consider the
decision to form a horizontal alliance independently from any simultaneous choice regarding
insourcing, outsourcing and vertical collaboration (Dyer, 1996). We recognize that these various
governance choices might influence one another. Indeed, outsourcing or vertical partnerships might
make it possible for firms with more limited resources to launch relatively complex new products
without forming a horizontal alliance. Unfortunately, our data do not allow us to systematically
trace such arrangements.

Furthermore, collaboration and internalization can be complements rather than substitutes,
as a firm’s collaborative relationships might bolster internal development efforts by providing
access to a broader scope of knowledge and innovations (Cohen and Levinthal, 1990;
Even though we recognize potential complementarity between internal activities and collaboration
with third parties (Harrigan, 1988; Bradach and Eccles, 1989), the substitutive choice we examine
refers to a higher level decision: either to fully retain or to share with potential rivals the decision
making power over all aspects of product expansion, including governance choices. Our study
shows that firms make such higher level decisions on the basis of the match or mismatch between
required and available resources. We therefore suggest that horizontal alliances are not alternatives
to other inter-organization ties, and are not complementary but rather substitutes to autonomous
expansion.

In addition, we do not contrast the make and ally options to the buy alternative, which could
extend as far as licensing agreements on one side and corporate acquisitions on the other
(Villalonga and McGahan, 2005; Yin and Shanley, 2008). Future research should develop a more
comprehensive theory which takes into account these other alternatives. In spite of its limitations,
we believe our framework could be used as a basis to model the full set of governance options, i.e.
the make-buy-or-ally choice whether it applies to vertical or horizontal linkages (White, 2000).
Indeed, even when transaction costs and appropriation concerns allow for the buy option, we
believe that production considerations, i.e. the match between required and available resources, play a role in guiding the governance choice (Poppo and Zenger, 1998). Further, even corporate acquisitions could be explained by the model given that they are similar to alliances in that they entail both transaction and coordination/integration costs, although the latter might be higher for acquisitions than for alliances (Borys and Jemison, 1989; Wang and Zajac, 2007). Moreover, whereas in this paper we develop our framework for the choice of product expansion mode, we also believe our theory is generalizable to the choice of development mode for other instances of firm expansion such as business diversification (Yip, 1982) and geographical expansion (Hennart and Park, 1993). Indeed, resource requirements have been discussed in both the diversification and internationalization literatures (Collis and Montgomery, 1997; Hymer, 1976), but their interplay with resource availability in a joint production and exchange framework has not yet been assessed for development mode choices (Yip, 1982; Shaver, 1998). This suggests a fruitful avenue for future research which would provide evidence on the generalizability of our framework to other instances of firm growth.

Finally, we believe our study offers additional avenues for future research. In particular, it shows that weaker (i.e. less well resource-endowed) firms choose to form horizontal alliances rather than to undertake expansion projects autonomously. This might suggest that horizontal alliances are a fallback option that firms choose when they do not possess the necessary resources to carry out product expansion on their own. This in turn raises the issue of whether such governance choices are effective or not. By demonstrating that a firm’s resource endowment determines its decision to produce on its own or to cooperate with other industry incumbents, our study clearly calls for considering endogeneity when examining alliance performance. Future studies on alliance performance should therefore take into account the endogeneity of governance choice (Shaver, 1998) and assess alliance performance relative to other governance alternatives.
FIGURE 1
Model and Hypotheses

<table>
<thead>
<tr>
<th>Product Resource Requirement</th>
<th>Firm Resource Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Complexity</td>
<td>Production Experience</td>
</tr>
<tr>
<td>H3</td>
<td>H1</td>
</tr>
<tr>
<td>H2</td>
<td>H4</td>
</tr>
<tr>
<td>Horizental Alliance vs. Autonomous Expansion</td>
<td>Alliance Experience</td>
</tr>
</tbody>
</table>
# TABLE 1

**Summary Data and Correlations**

\( N = 310 \)

|          | Mean | S.D. | Min | Max | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  |
|----------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1        | Alliance | 0.27 | 0.45 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2        | Product Complexity | 4.26 | 1.10 | 1.26 | 6.78 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 3        | Production Experience | 3.01 | 3.06 | 0.00 | 16.00 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 4        | Prod. Complex. * Prod. Exp. | 0.18 | 3.12 | -14.47 | 13.36 | -0.09 | 0.08 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| 5        | Alliance Experience | 0.34 | 0.82 | 0.00 | 5.00 | 0.35 | 0.50 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 6        | Helicopter | 0.41 | 0.00 | 1.00 | 0.08 | -0.63 | 0.24 | -0.20 | -0.20 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |
| 7        | Fighter | 0.27 | 0.45 | 0.00 | 1.00 | -0.03 | 0.26 | 0.13 | 0.16 | 0.00 | -0.33 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 8        | Jet | 0.24 | 0.43 | 0.00 | 1.00 | 0.05 | 0.51 | -0.13 | -0.02 | 0.05 | -0.30 | -0.34 | -0.34 | -0.34 | -0.34 | -0.34 | -0.34 | -0.34 | -0.34 |
| 9        | Firm Size | 5.94 | 0.79 | 3.64 | 7.68 | -0.04 | 0.39 | 0.01 | 0.22 | -0.03 | 0.18 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |
| 10       | Year | 1974  | 1949 | 1999 | 0.33 | -0.08 | 0.31 | 0.14 | 0.38 | 0.07 | -0.12 | 0.06 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 | -0.04 |
| 11       | Level of Technology | 3.03 | 1.27 | 5.34 | 8.84 | 0.09 | -0.24 | 0.29 | 0.01 | 0.15 | 0.42 | 0.26 | -0.39 | 0.04 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 |
| 12       | Civil | 0.35 | 0.48 | 0.00 | 1.00 | 0.06 | 0.15 | -0.15 | -0.01 | 0.02 | -0.24 | -0.45 | 0.51 | -0.07 | 0.20 | -0.31 | -0.31 | -0.31 | -0.31 |
| 13       | Military | 0.44 | 0.50 | 0.00 | 1.00 | 0.05 | 0.17 | 0.15 | 0.09 | 0.03 | -0.12 | 0.68 | -0.34 | 0.15 | -0.05 | 0.30 | -0.65 | -0.65 | -0.65 | -0.65 |
| 14       | Defense Budget | 1.12 | 0.61 | 0.10 | 2.01 | -0.20 | 0.13 | 0.26 | 0.00 | -0.11 | 0.14 | 0.02 | 0.08 | 0.46 | -0.05 | 0.14 | 0.00 | 0.14 | 0.00 | 0.14 |
| 15       | Cold War | 0.82 | 0.39 | 0.00 | 1.00 | -0.28 | -0.04 | -0.20 | -0.08 | -0.35 | -0.10 | 0.04 | -0.15 | -0.10 | -0.61 | -0.20 | -0.11 | -0.11 | 0.03 | 0.03 |
| 16       | War Time | 0.16 | 0.37 | 0.00 | 1.00 | -0.07 | 0.18 | 0.05 | 0.06 | -0.03 | -0.04 | 0.03 | 0.12 | 0.17 | -0.08 | -0.02 | -0.01 | 0.02 | 0.35 | -0.09 |
| 17       | Nb of Competing Aircraft | 16.52 | 6.84 | 0.00 | 35.00 | -0.06 | 0.01 | -0.05 | 0.08 | -0.08 | -0.31 | 0.26 | -0.26 | -0.11 | -0.05 | -0.20 | -0.10 | 0.16 | -0.18 | 0.29 | 0.00 |
TABLE 2  
Logit Estimates for Expansion Mode (1 = horizontal alliance)

<table>
<thead>
<tr>
<th></th>
<th>Model 1 (Robust (a))</th>
<th>Model 2 (Robust (a))</th>
<th>Model 3 (Robust (a))</th>
<th>Model 4 (Robust (a))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Complexity</td>
<td>1.13***</td>
<td>.25</td>
<td>1.10***</td>
<td>.26</td>
</tr>
<tr>
<td>Production Experience</td>
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<td>.07</td>
<td>-.14**</td>
<td>.07</td>
</tr>
<tr>
<td>Prod. Complexity * Prod. Experience</td>
<td>.76***</td>
<td>.18</td>
<td>.89***</td>
<td>.18</td>
</tr>
<tr>
<td>Alliance Experience</td>
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<td>.67</td>
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N 310 310 310 310
Wald Chi-square 60.07*** (12df) 105.67*** (14df) 111.84*** (15df) 103.43*** (16df)
Pseudo R square .16 .20 .25 .26

(a) Standard errors adjusted for 79 firm clusters

*** p < 0.01  ** p < 0.05  * p < 0.10
REFERENCES


Argote L. 1999. *Organizational Learning*. Amsterdam: Kluwer


