Alliance Portfolio Diversity and Market Scope : Direct and Interaction Effects on Biotech Firms' Exit

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Resume

The present study aims at contributing to the on-going debate on the benefits and disadvantages of organizational diversity by exploring the following research questions: *What role do alliance portfolio diversity and market scope play in small high-tech firms' exits?* and *How do firms balance these types of diversity in their struggle for survival?*

Several reasons have motivated this paper. *First*, previous research examined alliance portfolio diversity (APD) and market scope separately and came up with contrasting results – in each case some studies found positive effects and some others negative effects at a firm level. In this paper we consider APD and market scope together and argue that since managers make the descisions about their firms' market diversification and alliance strategy simultaneously, academic research should study their interaction effect that may help to clarify the contrasting results of existing studies.

Second, while economic and innovative outcomes have traditionally received the most interest from academic research dealing with alliances and alliance portfolios, APD and its impact on firms' survival remained in the shadow of theoretical and empirical contributions. The present paper fills this gap by exploring the contradiction of positive and negative consequences of APD for small and young high-tech firms in terms of their exit.

Third, in contrast to the literature on large firms few studies have addressed the theme of market scope (diversification) in small entrepreneurial firms, either at a theoretical or empirical level (Iacobucci, 2005). In the present paper, diversification literature is revisited for small innovative firms in order to theoretically argue and empirically explore the role market scope plays in these firms' survival.

The empirical part of the paper is a quantitative study of the population of French biotech firms having participated in the industry over 9 years (1994 – 2002), representing 313 firms. Event history analysis has been used as a statistical method. The results show that APD has a curvilinear relationship (inverted U-shaped form) with biotech firms' exit. Greater market scope increases the probability of biotech firms' exit (linear relationship). Finally, the most interesting result concerns the interaction effect between APD and market scope. Combining greater diversification with increasing alliance portfolio diversity enhances biotech firms' chances to survive up to a certain point, where joint effect of two facets of organizational diversity lead to their failure.

Key words : alliance portfolio diversity, market scope, firm exit, biotechnology industry

1. INTRODUCTION

The intriguing question for scholars in strategy and entrepreneurship domain is – why do some organizations survive while others, especially young ones, fail to do so? Scholars study survival because it affects industry evolution (Mitchell, 1994), it is a performance measure (Coff, 1999), it affects stakeholders (Mitchell, 1991), and it affects economic vibrancy (McGrath, 1999). The present paper deals with two particular determinants of small high-tech firms' survival – alliance portfolio diversity (APD) and market scope. Specifically, the research question studied is as follows: *What role do APD and market scope play in high-tech firms' exits?* and *How do firms balance these types of diversity in their struggle for survival?*

Several reasons have motivated this research. *First*, previous research examined alliance portfolio diversity (APD) and market scope separately and came up with contrasting results – in each case some studies found positive effects and some others negative effects at a firm level. In this paper we consider APD and market scope together and argue that since managers make descisions about their firms' market diversification and alliance strategy simultaneously, academic research should study their interaction effect that may help to clarify the contrasting results of existing studies. *Second*, while economic and innovative outcomes have traditionally received the most interest from academic research dealing with alliances and alliance portfolios, APD and its impact on firms' survival remained in the shadow of theoretical and empirical contributions. The present paper fills this gap by exploring the contradiction of positive and negative consequences of alliance portfolio diversity for small and young high-tech firms in terms of their exit utilizing a unique longitudinal data set of French biotech firms (1994-2002). *Third*, in contrast to the literature on large firms, few studies have addressed the theme of diversification in small entrepreneurial firms, either at a theoretical or empirical level (Iacobucci, 2005). In the present paper, diversification literature is revisited for small innovative firms in order to theoretically argue and empirically explore the role market scope (i.e., market diversification) plays in these firms' survival.

Alliance portfolio diversity refers to alliance partners' different operational contexts (upstream, downstream, horizontal). There are several reasons to believe why and how APD might impact firm survival. On the one hand, from transaction cost economics perspective, alliance portfolio diversity implies complexity and leads to increased transaction costs (e.g., portfolio monitoring costs, moral hazards risk, joint rent sharing problems, etc.), and negative economic performance (Goerzen & Beamish, 2005). By consequences, the risk of failure is

high, especially for small firms evolving in changing environment (e.g., biotech firms). On the other hand, network and resource-based theories advance arguments about positive impact of alliance partner diversity on firms outcomes (i.e., survival) in terms of better access to diverse information and partners' resources and capabilities (Gimeno, Folta, Cooper, & Woo, 1997; Silverman & Baum, 2002). We expect both effects (positive and negative) to intervene.
Market scope refers to the number of different markets where biotech firms develop their technologies and sell their products and/or deliver services (e.g., human health, agriculture, nutrition, environment). Market scope is considered as reflecting organizational capital that offers survival benefits (Dowell, 2000; Bercovitz & Mitchell, 2007). However, small firms lack the resources and managerial skills to manage activities in diversified business (Robson et al., 1993). A greater scope may create thinly dispersed resources, which leads to failure. We suggest that in the case of small entrepreneurial firms, widening market scope will increase the probability of these firms' exit.

While previous studies have investigated the direct effect of APD (Silverman & Baum, 2002) and market scope (e.g., Bercovitz & Mitchell, 2007), though the former to a lesser extent, in this paper we go further and examine the interaction effect of these factors both reflecting organizational diversity. After presenting the theoretical rational explaining APD and market scope direct effects on biotech firms' exit, we develop arguments about possible survival consequences of balancing both alliance an diversification strategies.

2. ALLIANCE PORTFOLIO DIVERSITY AND FIRMS' EXIT

Academic research in strategy and entrepreneurship approached the study of alliance portfolio diversity from two standpoints. *First*, scholars within economizing perspective (e.g., transaction cost economics) underlined possible negative consequences of alliance portfolio diversity in terms of deteriorated performance (Goerzen & Beamish, 2005) and at some point decreasing innovativeness (Sampson, 2007). *Second*, relevant arguments from strategizing perspective (e.g., resource-based and network theory) have been advanced to point out positive consequences of alliance portfolio diversity in terms of firms' growth and centrality in the network (Powell, Koput, & Smith-Doerr, 1996), better visibility and status (Zucker & Darby, 1996), and survival (Silverman & Baum, 2002). Therefore, academic literature in strategy and entrepreneurship has developed contrasting arguments about APD consequences for a firm. In this paper, we discuss the contrasting predictions from economizing and strategizing perspectives about the effect of alliance portfolio diversity on firms' exit.

Economizing perspective used in this paper is predominantly informed by the transaction cost theory. In Williamson's (1991) parlance, 'economizing' is concerned principally with efficiency and one's own productive performance. Williamson (1991) submitted that transaction cost economics illuminates a wide range of issues of an economizing kind. More importantly, he maintained that a strategizing effort would rarely prevail if a program is burdened by significant cost excesses in production, distribution, or organization. According to transaction cost economics, alliance portfolio is seen as a specific governance form for organizing transactions (alliances). The proliferation and increasing diversity of business relationships imply increasing complexity in managing alliance portfolio. In a diverse alliance portfolio, different partners and different alliance agreements demand tailor-made decisions. At the same time, as all alliances are parts of the particular firm's alliance portfolio, their management should take into account how the decisions on a particular agreement with a particular partner will influence overall alliance portfolio value. By consequence, the increasing number and diversity of such decisions can be characterized as complex.

The consequences of complexity are increased costs related to expenses on alliance portfolio formation or partnering pro-activeness, monitoring the portfolio, portfolio coordination and relational governance (Gulati & Singh, 1998). These costs are especially heavy for small inexperienced in alliances firms who choose to rely on multiple partners in developing and commercializing their technology. In addition to possible costs in terms of time and money, alliance portfolio diversity may increase hazards of opportunism. Transaction cost economics recalls that all complex contracts are unavoidably incomplete and relying on contract-as-promise is fraught with hazard (Williamson, 1991). This statement is especially true for the firms operating in uncertain high-tech environments (e.g., biotechnology industry) where the subject of alliance agreement is often intellectual property. In sum, increasing diversity of alliance portfolio will lead to increased costs and deteriorated economic performance that in the case of small resource-poor firms will precipitate exit.

Strategizing perspective informed by the resource-based and network theories underlines the pro-active role firms should play in order to influence their competitive position vis-à-vis their rivals (Besanko, Dranove, & Shanley, 2000). In this case, alliance portfolio diversity is viewed as a strategic instrument that firms should use in order to survive. Through bad times firms may rely on diverse partners who propose different footings (Baum & Oliver, 1991; Oliver, 2001). For example, suppliers might find it in their best interest to extend payment deadlines or provide special volume discounts to assist key customers

through rough financial periods. Similarly, key buyers may be willing to invest – through equity acquisition or collaborative ventures – to enhance the technology and thus the survival prospects of important suppliers (Bercovitz & Mitchell, 2007: 62).

Moreover, alliances with particular partner types (upstream, horizontal, and downstream) can be seen as affiliations that provide access to valuable resources, and serve a signalling function when other market participants are unsure about a focal producer's underlying quality (Podolny, 2001, 2005). Affiliations with prominent pharmaceutical companies are especially important, as they are particularly well equipped and have access to information that are critical to bringing a product to the market, such as experience in product testing, in working with regulatory authority's approval process, in product marketing, and in selling a product or technology (Powell et al., 1996). Upstream affiliations in biotechnology derive from firms' links with prominent organizations such as research institutions, and universities. These affiliations point out a firm's ability to conduct high-quality research and to manage the research process (Zucker & Darby, 1996). In addition, scientific partners could enhance the quality of a young firm's research in the future. Finally, horizontal affiliations derive from other biotech partners. These affiliations indicate the potential for access to industry-specific knowledge, like how to secure resources such as finance, scientists, equipment, and laboratory space, as well as managerial knowledge of structuring, designing, and managing biotech organization to maximize innovation and learning (Kim & Higgins, 2007). Overall, the focal firm can indirectly benefit from its different affiliations which provide resources enhancing the value of its internal resource or provide it with opportunities to internalize external resources (Lavie, 2006). In particular, resource-rich partners offer intangible assets such as their knowledge and expertise, reputation and legitimacy, perceived reliability and quality that enhance the firm's legitimacy and capacity to acquire additional resources (Weigelt & Camerer, 1988).

The contrasting arguments that reflect costs on one side, and benefits of diversity, on the other side, point to the curvilinear relationship between alliance portfolio diversity and firms' exit. While previous research has discussed the pros and cons of alliance portfolio diversity, there are neither straightforward theoretical predictions nor sufficient empirical evidence to inform us about which effect (positive or negative) is dominant or which one comes first, if the relationship is curvilinear. Therefore, we formulate a hypothesis about APD curvilinear relationship:

> ***Hypothesis 1***. *Alliance portfolio diversity has a curvilinear relationship with biotech firms' exit*

3. MARKET SCOPE AND FIRMS' EXIT

Diversification literature in strategy and entrepreneurship presents contrasting arguments about market scope effect on firms' performance and survival depending on diversity types. *First of all*, the distinction is made between related and unrelated diversification. There is a broad theoretical agreement that related diversification increases performance, while unrelated diversification decreases it. Related diversification, it is argued, enables a firm to leverage its resources by sharing knowledge and assets across businesses, yielding economies of scale and scope (Hitt, Hoskisson, & Kim, 1997). Conversely, unrelated diversification is thought to decrease performance because it takes firms into unfamiliar settings where they lack expertise (Stern & Henderson, 2004). *Second*, the distinction is made between the mode of diversification that means the extent to which the firm relies on internal business development vis-à-vis acquisitions as means of entering new lines of activity (internal vs. acquisition diversification) with the opportunities and threats they present. *Third*, diversification is traditionally viewed as a cross-industry phenomenon. Firms, though, diversify not only across businesses but also within them as they extend existing product lines and expand into new ones. Though previous studies have shown mild impact of cross-industry diversification on firms' performance, there is good reason to believe that diversification matters a great deal within businesses (Stern & Henderson, 2004).

In the present paper, what we call market scope refers to the firms' internal within-industry diversification. Specifically, we define market scope as the number of different markets where biotech firms develop their technologies and sell their products and/or deliver services (e.g., human health, agriculture, nutrition, environment, etc.). From the first sight, the cited markets seem to be unrelated. For instance, the pharmaceutical market for drugs has different clients and legal regulation, in comparison to the agriculture market for pesticides. However, a deeper look permits seeing the important synergies between the markets within biotechnology industry in terms of shared technology (e.g., genetics for human health application and plants) and common raw material (e.g., plants for drug creation and for cosmetics). Therefore, in the present paper we refer to market scope of biotechnology firms as a related diversification. By contrast to previous studies dealing mainly with large, old and substantially diversified companies in traditional industries, we explore diversification of small and young companies in high-tech industry (biotechnology). In these firms, diversification occurs: (a) as a survivalist strategy (Robson et al., 1993); (b) as a result of entrepreneurial "dynamics" (Donckels et al., 1987); (c) as the result of family or entrepreneur

capital accumulation (Scott & Rosa, 1996). In the present paper, we explore the benefits and threats of market scope as a survivalist strategy.

The primarily benefit of related diversification is risk reduction (Iacobucci & Rosa, 2005; Bercovitz & Mitchell, 2007). Risk reductions are obtained when the cash flows of different products/services in different markets correlate imperfectly, so that the firm's overall market scope breadth reduces the variance, and thus the overall risk, of the business (Lubatkin & Chatterjee, 1994). In sum, broader scope – as evidenced by a number of different markets – may diversify risk. Firms having a broader market scope also have more diverse sets of organizational routines than do focused firms. Routine variety provides survival advantages by supporting broader search and increasing routine recombination opportunities (Dowell, 2000; Karim & Mitchell, 2000; Bercovitz & Mitchell, 2007). Those businesses having more diverse routine sets will be better positioned to identify a richer set of potential solutions and better endowed to more astutely evaluate the viability of these alternatives (Cohen & Levinthal, 1990). Based on these arguments, previous studies established a negative link between broader market scope and firms' exit (e.g., Rosa, 1998; Bercovitz & Mitchell, 2007).

This findings appear to conflict with arguments concerning market scope that arise in several literatures. For example, economists highlight how pursuing broad scope strategies may degrade performance by reducing a firm's ability to take advantage of economies of scale (Scherer & Ross, 1990). Ecological studies note the challenge of bounded rationality that constraints the size of operations and number of routines that firms can manage efficiently (Barnett & Freeman, 2001). For instance, Robson et al. (1993) found that in the case of very small firms (those with less than 30 employees) employment growth is higher for non-diversified than for diversified firms. These results evidence that in very small firms, entrepreneurs lack the resources and managerial skills to manage activities in diversified business.

Taking into account the contrasting theoretical predictions, we can expect a curvilinear relationship between market scope and firms' exit. At the same time, it is partly an empirical issue whether excessive scope creates systematic problems or, instead, whether firms usually can manage their market scope effectively. In particular, if firms find it difficult to retrench from over-expansion, then scope might have a nonlinear relationship with survival, first contributing and then detracting (Bercovitz & Mitchell, 2007). Therefore we hypothesize:

> ***Hypothesis 2****: Market scope has a curvilinear (U-shaped) relationship with biotech firms' exit.*

4. ALLIANCE PORTFOLIO DIVERSITY AND MARKET SCOPE INTERACTION EFFECT

Our final hypothesis addresses the way in which market scope interacts with alliance portfolio diversity. We suggest that firms take strategic decisions to enter into alliances with diverse partners and to diversify their business concurrently. In other words, market scope and alliance diversity are two interrelated facets of organizational diversity. We expect, on the one hand, biotech firms to use alliances as a support in their diversification moves, since diverse alliance portfolio allows the firms to accumulate superior information for building and focusing internal capabilities in order to solve problems and/or exploit opportunities (Gulati, 1999; McEvily&Zaheer, 1999). On the other hand, we consider market scope enhancing alliance portfolio diversity survival benefits in terms of providing different footholds preventing the firm from exit (information, resources, etc.) and decreasing the probability of opportunistic behavior of alliance portfolio partners. Further, we develop these arguments.

APD may increase market scope survival benefits. When a firm decides to diversify its activities to a new related market, it seeks to use its rare knowledge about a market opportunity to realize this rent-generating potential, the exploitation of an opportunity (Shane and Venkataraman, 2000; Alvarez and Busenitz, 2001). In this case, the firm faces two interrelated problems. "First, it must assemble the resources necessary to capitalize on the rent-generating potential of these opportunities. Without successfully coordinating these resources, there would often be no rents generated at all. Second, it must find a way to appropriate at least some of the rents that will be generated when they take advantage of these opportunities. Without this effort, there would be no payoff associated with taking advantage of a market opportunity. Moreover, these economic actors must find a way to accomplish these tasks at the lowest cost possible" (Alvarez & Barney, 2004). Rosa (1998) shows that small entrepreneurial firms pursue a diversified activity (usually in a related area) when economic conditions are good. When economic conditions are less favorable, the entrepreneur usually stops diversifying and "tightens his or her belt". We suggest that since internal diversification demands investment in resources and capabilities acquisition and development (it means, time and money), firms entering into alliances with diverse alliance portfolio may refer to their alliance partners with different capabilities and resources to support their growth and assure survival.

Further, the information gains from the diversity of alliance portfolio can lead to capability refinement and development of diverse routines. Those businesses having more

diverse routine sets will be better positioned to identify a richer set of potential solutions and better endowed to more astutely evaluate the viability of these alternatives, particularly when choosing the markets for related diversification (Cohen & Levinthal, 1990).

In its turn, market scope can enhance APD survival benefits. The number and variety of external ties of the focal firm will increase with widening scope (Bercovitz & Mitchell, 2007). This means an increasing probability of having non-redundant ties within a focal firm's alliance portfolio with associated informational and network position benefits. Moreover, related diversification by the focal firm serves to intensify the strength of existing ties by increasing the interactions between the players – as suppliers provide materials for multiple markets products/services and buyers purchase products with multiple applications (Bercovitz & Mitchell, 2007), and as alliance partners entering multi-purpose alliances in order to develop products/services with multiple applications. In this way, broad market scope enhances the buffering role of different alliance partners in preventing small entrepreneurial firms from survival-threatening environmental shocks.

As we have underlined earlier in the paper, the potential problem with alliances is the risk of alliance partners' opportunistic behavior, which becomes even more present with increasing complexity and diversity of an alliance portfolio. It is especially true in the case of alliances between large and small firms, when in some circumstances such alliances can even threaten the survival of an entrepreneurial firm (Alvarez & Barney, 2001). Academic literature has suggested several ways of how a small firm can deal with this problem. Alvarez & Barney (2001) noted that building trustful relationships and bringing other resources to the alliance besides a single technology can reduce alliance partners' opportunistic behavior. From this point of view, we suggest that market scope plays an important role in decreasing the probability of alliance partners' opportunistic behavior. First, the increased interactions among alliance partners, as a consequence of a broader market scope, favor trustful relationships. Second, firms who broaden market scope through related diversification, in effect develop new technology applications. This process is innovative and provides strong incentive for an alliance partner to continue investing in the alliance relationship with a focal firm, and therefore providing support necessary for the focal firm's survival.

Overall, theoretical arguments from alliance and diversification research articulated above permit to formulate the following hypothesis:

> ***Hypothesis 3****.The probability of exit will be lower for biotech firms combining broad market scope and diverse alliance portfolio.*

5. METHODS

5.1. DATA AND SAMPLE

In order to examine the relationships between alliance portfolio diversity, market scope and firms' exit, we conducted a quantitative research on the full population of French biotech firms having participated in the industry over 9 years (1994-2002), representing 313 firms (Mangematin et al., 2003). This is the most comprehensive research ever conducted on the French biotech industry, and includes all firms claiming to be engaged into the biotech industry and accepted as such in the census of biotech small and medium enterprises (SMEs) conducted regularly by the French research and technology ministry. From 1994, we updated the database for each incumbent and new biotech venture.

We believe that biotechnology sector is an appropriate and interesting context to study firms' exit for the following reasons. *First*, the majority of actors are young and small firms struggling for survival. In the biotechnology sector the technological environment is highly uncertain and technological trajectories unsettled, thus making biotech firms' struggle more difficult. *Second*, the particularity of French biotech firms' data permits to extend previous biotech studies in the following way. Most of the scholars who have studied the biotech industry have analyzed large American and Canadian biotech companies (*e.g.*, Baum and Silverman, 2004; Niosi, 2003). In the present study I include the population of French biotech firms in order to reflect the particularity of European biotech sector, where 1) the number of high-powered biotech companies characteristic for American continent is too small, 2) there are many private companies participating in the industry which do not channel money from public investors, and 3) depending on the countries, some biotech activities may represent substantial parts of the national economy (*e.g.* agricultural biotech or animal food for France).

5.2. VARIABLES AND MEASURES

Dependent variable – Exit is a dummy variable taking the value of "1" when a firm officially terminates its activities and is removed from the national register of enterprises. The exit data were obtained from VERIF (www.verif.fr), electronic data sets containing operational information about all French companies whenever present in national register of organization.

Independent variables – APD & Market Scope. Alliance portfolio diversity is operationalized using Blau's (1977) index of heterogeneity. This index is one of the most widely used in previous studies on alliance diversity (Koka & Prescott, 2002; Lee, 2007; Powell et al., 1996). The computational formula is $1–\Sigma\ p_k^2$, where p is the proportion of

alliance partners in the *k*th category (horizontal, downstream and upstream position in the value chain). The maximum of Blau's (1977) index is computed as follows: (k-1)/k = (3-1)/3 ≈ 0.7. APD squared measure was included in statistical models to test the hypothesized curvilinear relationship.

We used two approaches to capture *Market Scope*. First, a continuous variable taking values from 1 to 6 reflects the number of biotech firms' markets where they realize their sales: human health, nutrition and agriculture, animal health, environment, cosmetics, research materials. Accordingly to France Biotech (national association of French biotech firms), 47% of firms have at least one activity in human health, 10% in cosmetics, 7% in animal health, 5% in human nutrition, 4% in animal nutrition. Finally, 9% of French biotech firms produce research kits (Kopp, 2003). Second, we created three dummy variables Scope1 (firms having only one main market), Scope2 (firms having 2 main markets), and Scope>3 (firms having more than 3 main markets) in order to further explore the interaction between APD and Market Scope. In our sample, 42% of biotech firms work mainly for one market, 23% have two markets, and the remaining 35% are present at more than 3 main markets.

We used several data sources to compile strategic alliance events and determine market scope. First of all, the databases of two electronic industry newspapers - Gazette du Laboratoire (www.gazettelabo.fr) and Pharmaceutiques (www.pharmaceutiques.com) were screened. Second, we visited each biotech firm's web site in order to complete and check the information this firm's alliances and market scope. Finally, we called the remaining firms without completed information one by one to get the first-hand information.

Control variables. Research on firms' exit has quite a long record. Previous studies mobilized different theoretical perspectives that make accent on particular factors responsible for population dynamics. They could be regrouped in the following four categories: (1) resources (patents, risk capital, general and specific human resources); (2) firms' characteristics (age, size, business model, market scope); (3) environmental factors (population density, population growth in sales, industry sector); (4) inter-organizational links (total number of alliances). Table 1 presents the descriptive statistics and the correlations.

TABLE 1

Descriptive Statistics and Correlations[1]

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Exit																					
2. Dissolution	.72*																				
3. Divestment	.66*	-.02																			
4. APD_Blau	.06*	.08*	-.01																		
5. MarketScope2	-.05	-.01	-.05*	-.01																	
6. MarketScope3	.07*	.04	.03	.01	-.24*																
7. Market Scope	.05*	.03	.00	.01	.17*	.91*															
8. Human health market	-.04	-.06*	-.01	-.01	-.35*	-.47*	-.63*														
9. Agriculture & nutrition market	.03	.05*	-.02	.07*	.15*	-.24*	-.18*	-.35*													
10. Environment market	-.02	-.02	.01	-.05	-.07*	-.09*	-.12*	-.14*	-.07*												
11. Patent Portfolio Diversity	.02	.02	.08*	.06*	.02	.01	.01	-.05*	.06*	.02											
12. Inventors (ln)	.01	-.05*	.07	.13*	-.04	-.02	-.04	.13*	-.15*	-.06*	-.24*										
13. Staff (ln)	-.02	-.05	-.08*	-.03	-.05	-.06*	-.08*	.15*	-.04	-.10*	-.08*	.33*									
14. Growth of Employees	.02	-.05	-.11*	-.03*	-.01	-.01	-.02	.02	-.00	-.01*	-.01	-.03	.00								
15. Performance (ln)	-.05*	-.00	.01	-.01	.04	.05*	.07*	-.14*	.07*	.03	.04	-.16*	-.01	.00							
16. Venture Capital	-.01	.01	-.03	.06*	-.07	-.07*	-.10*	.13*	-.06*	-.07*	-.06*	.33*	.07*	.01	-.26*						
17. Age (ln)	.03	-.03	.07*	.08*	.04*	.02	.03	-.03	.06*	-.04	-.03	.17*	.35*	-.02	.14*	-.09*					
18. Left-truncated	-.01	-.03	.02	.07*	.08	-.02	.01	-.04	.07*	-.05*	-.02	.10*	.16*	-.04	.08*	-.12*	.70 *				
19. Population Density	.16*	.08*	.14*	.06*	-.03*	.04	.03	.05	-.09*	-.01	.05*	.08*	-.01	.02	-.09*	.19*	.01	-.26*			
20. Industry Sales Growth	.03	-.01	.05*	-.01	-.01	-.00	-.00	-.01	.01	.01	.00	-.04	.00	-.02	.04	-.13*	.01	.04	-.17		
21. Total alliances (ln)	-.02	-.02	-.01	.11*	-.14*	.00	-.05*	.07*	.01	.09*	.01	-.02	.02	.03	.01	.01	.04	.02	.04	-.05	
Mean	.95	.02	.02	.47	.36	.42	1.6	.41	.36	.20	1.1	1.0	2.5	2.9	-1.0	.35	1.7	.51	217	-.09	.03
S.D.	.21	.15	.14	.45	.15	.24	.84	.48	.15	.16	.73	.71	1.5	3.1	4.6	.15	.75	.50	52	.23	1.99

[1] n= 313 firms

* p <0.05

Some of the controls had an important correlations with each other (e.g., age and size or number of inventors and overall staff), and we dropped them from the statistical models. Therefore, we report the results with the following control variables: *Patent portfolio diversity*: Blau's index of heterogeneity *Staff*: number of employees; *Performance*: yearly ratio of net profit/turnover); *Population density, Population growth in sales*; *Total Alliances*: firms' total number of alliances per year. Logistic transformation was applied to the variables having non normal distribution (total alliances, size, population growth in sales).

We lagged all independent and control variables to test the impact of their values in t-1 on biotech firms' exit in the year t

5.3. STATISTICAL METHOD

We had a choice of several statistical models: event-history methods and logistic regression analysis to test the hypothesis. Following previous studies on firms' exit (e.g., Silverman et al., 1997), we use both exponential hazard rate event-history estimation and logistic regression analysis to examine the effects of the above variables on the probability of biotech firms' exit. The specifications offer nearly identical results (Mitchell & Singh, 1996). Below we report only the event-history results, specified as: $h(t) = e^{\{\beta \mathbf{X}\}}$, where h(t) is exit hazard rate, and **X** is a vector composed of the independent variables. This method is suitable for this analysis since fitting parametric survival models is appropriate for data exhibiting delayed entry, gaps, and time-varying covariates (StataCorp., 2003). Therefore, we estimate a multiple destination survival model by estimating a number of single-destination models separately, one for each destination (dissolution and divestment separately, and pooled together).

6. RESULTS

Table 2 presents parametric survival models with exponential distribution for a dummy codification of exit (dissolution and divestment pooled together), Model 1 is the baseline model including only control variables. Model 2 introduces our first independent variable *Alliance portfolio diversity* and its squared measure. Model 3 is run with the second independent variable – *Market scope* (continuous variable). Model 4 includes both independent variables, and Model 5-7 test interaction effects between APD and Scope1, Scope2, and Scope3.

6.1. ALLIANCE PORTFOLIO DIVERSITY MAIN EFFECT

Hypothesis 1 posited a curvilinear relationship between APD and biotech firms' exit. Alliance portfolio diversity and its square measure have been found significantly related to firms' exit (Model 2, see Table 2) therefore confirming Hypothesis 1. We found an inverted U-shaped relationship, though it is skewed to the right, pointing out that APD mainly increases the probability of firms' exit. However, this effect is inversed when alliance portfolio diversity measure approaches the inflection point (at APD = 0.6), which attests the inversing tendency of APD to decrease hazard rate of exit.

6.2. MARKET SCOPE MAIN EFFECT

Hypothesis 2 posited a curvilinear relationship between Market scope and biotech firms' Exit. When testing the main effect with continuous variable of market scope ranging from 1 to 6, we found a curvilinear relationship taking a U-shaped form which confirms our Hypothesis 2 (Model 3, see Table 2). The inflection point was identified at Market scope ≈ 2. Our results partially confirm previous findings underlining the positive impact of market diversification on firms' survival (Bergovitz & Mitchell, 2007), although we make a caution pointing that for biotech firms working for more than two markets the probability of exit increases.

6.3. ALLIANCE PORTFOLIO DIVERSITY AND MARKET SCOPE INTERACTION EFFECT

Hypothesis 3 argued that the probability of exit will be lower for biotech firms combining broad market scope and diverse alliance portfolio. First, we run a model with both independent variables – APD and Market scope (Model 4). The results show that both main effects remain significant: APD has an inverted U-shaped form relationship with biotech firms' exit, while Market scope shows a U-shaped form effect. Next, we tested interaction effects of APD with Market scope. Since it is statistically difficult to interpret interaction coefficients of two curvilinear effects, we split the variable Market scope in three categories: Scope1, Scope2 and Scope>3 and run models with interaction effects of APD with each of these variables.

TABLE 2

Parametric Survival Models with Exponential Distribution for Exit[□]

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Constant	-12 *** (1.25)	-12 *** (1.25)	-10 *** (1.92)	-10 *** (1.99)	-12 *** (1.29)	-11 *** (1.26)	-12 *** (1.25)
Alliance Portfolio Diversity							
APD_Blau		3.32** (1.45)		3.36** (1.50)	3.54* (1.90)	2.71* (1.50)	4.60*** (1.83)
APD_Blau^2		-2.80** (1.37)		-2.94** (1.45)	-2.79† (1.77)	-2.39† (1.50)	-4.14*** (1.72)
Market Scope							
Market Scope			-2.81† (1.79)	-2.96* (1.70)			
Market Scope^2			0.76* (0.44)	0.79* (0.42)			
Scope1					-0.15 (0.46)		
Scope2						-3.41** (1.91)	
Scope3							0.75* (0.21)
Interactions							
APD x Scope1					0.07 (1.41)		
APD^2 x Scope1					-0.63 (1.34)		
APD x Scope2						3.78** (1.12)	
APD^2 x Scope2						-3.06** (1.50)	
APD x Scope3							-3.79* (2.41)
APD^2 x Scope3							3.72* (2.37)
Controls							
Patent Portfolio Diversity	0.72† (0.43)	0.75* (0.43)	0.75† (0.44)	0.78* (0.44)	0.84* (0.46)	0.84** (0.44)	0.88** (0.45)
Staff	0.03 (0.06)	0.02 (0.07)	0.03 (0.07)	0.02 (0.07)	0.02 (0.07)	0.01 (0.07)	0.01 (0.07)
Growth of Employees	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Performance	-0.03*** (0.01)	-0.03*** (0.01)	-0.03 (0.02)	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.02)	-0.02 (0.02)
Left-truncated	0.56** (0.28)	0.59** (0.28)	0.60** (0.28)	0.61** (0.29)	0.61** (0.28)	0.77*** (0.29)	0.62*** (0.28)
Population density	0.03*** (0.00)	0.03*** (0.00)	0.03*** (0.00)	0.03*** (0.00)	0.03*** (0.00)	0.03*** (0.00)	0.03*** (0.00)
Industry sales growth	1.21*** (0.40)	1.27** (0.40)	1.16*** (0.42)	1.22*** (0.43)	1.24*** (0.42)	1.24*** (0.42)	1.27*** (0.42)
Total alliances	-0.06 (0.05)	-0.16** (0.07)	-0.08 (0.05)	-0.18** (0.07)	-0.17** (0.07)	-0.20*** (0.08)	-0.17** (0.07)
Wald chi 2	138.55	150.31	137.19	152.88	143.62	151	145
Log-likelihood	258.04***	261.49***	240.41***	243.50***	241.65***	246.31***	243.14***

□ n = 313, 1,400 observations

*** p < 0.01 ; ** p < 0.05 ; * p < 0.08; † p < 0.10

The results of the model with APDxScope1 interaction were not significant (Model 5). Next, we run the model (Model 6) with the interaction of APDxScope2. The coefficients were significant: negative for Scope2 main effect (as opposed to scope1 and scope3), proving an inverted U-shaped form relationship for APD (positive coefficient of APD direct measure, and negative coefficient of APD squared measure), and similar inverted U-shaped form relationship of APD and Scope2 joint effect. This means that for biotech firms selling their products/services on two markets, greater APD increases the probability of exit up to a certain point, which is contrary to the prediction of Hypothesis 3. Finally, Model 7 was run with APD x scope3 interaction effect. The results contrast those obtained in Model 6 with APDxScope2 interaction. For biotech firms doing business on three and more markets, the probability of exit increases. Interestingly, when combining broad market scope (Scope>3) and increasing APD, the probability of exit decreases, which confirms Hypothesis 3. However, statistically we found that joint effect of APD and Scope>3 has a U-shaped form. This means that the beneficial for biotech firms' survival joint effect of APD and Scope>3 is inversed when too much diversity makes its management complicated and costly increasing the risk of exit.

In sum, Hypothesis 3 received partial support: when a biotech firm increases its market scope from 2 to 3 and more, the joint effect of APD and Market Scope becomes negative, thus decreasing the probability of exit.

6.4. CONTROL VARIABLES EFFECTS

The analysis of control variables effects across all statistical models shows that *Patent Portfolio Diversity* reflecting geographical protection of a focal firm's patents increases the probability of exit. Patents are costly means of intellectual property protection that require economic outlays from the deposition stage up to the delivery of the patent and its validation in different countries, depending on the specification in the application. These expenditures are committed before the economic value of the patent becomes certain. In other words, a patenting biotech firm must make huge investments in rent potential (up to 41,000€ for a European patent, not including costs of maintenance) without any guarantee of rent appropriation (Deberdt, 2005). Thus, the positive relation between *Patent Portfolio Diversity* and *Exit* might not seem surprising.

Control variables capturing biotech firms' *Growth of employees* and *Performance* had negative and statistically significant coefficients. It means that well-performing and growing biotech firms are less exposed to the risk of exit. However, biotech firms' *Size* as measured by the number of employees did not show a significant effect on firms' exit. Biotech firms

created before the industry take off in 1994 are more likely to exit (*Left-truncated*). This can be explained by selectivity of biotechnology industry technological and competitive environment, and inability of certain firms to adapt their business to these changing conditions. The results reflecting *Population density* and *Industry sales growth* effects point out increasing probability of biotech firms' exit. We suggest that these results reflect French biotechnology industry highly competitive character (increased population density leading to biotech firms' failure) and the tendency to the industry consolidation (exit by divestment). Finally, the impact of Total alliances on biotech firms' exit, as expected, was found to be negative, though this impact was only significant when including alliance portfolio diversity variable.

7. DISCUSSION AND CONCLUSION

7.1. Implications for research and practice

The key idea that we attempted to develop in this paper was to argue that different facets of organizational diversity (in our case, alliance portfolio diversity and market scope) should be studied together, since their joint effect may differ from their independent effects. The decisions about entering alliance strategy and broaden market scope are part of the focal firm's general strategy. Therefore, the question about how to balance alliance portfolio diversity and market scope and the question about which strategic factor matters for the firm is relevant for both academic research and managerial practice. The present study brings the following answers to the above questions.

The results show that biotech firms entering an increasing number of alliances with diverse partners (horizontal, downstream and upstream) are more likely to exit the industry. This finding is consistent with the arguments of economizing perspective informed by the transaction cost theory (Williamson, 1991). Specifically, the cost of managing diversity of alliance portfolio and the lack of resources and experience, as well as sufficient bargaining power in negotiating alliance contracts could be cited to explain the positive effect of APD on firms' exit. However, when biotech firms have all three types of alliance partners the probability of exit diminishes pointing out APD curvilinear (inverted U-shaped form) relationship with biotech firms' exit. The comparison of this finding with previous research results should be done with caution since there is only little number of academic papers published on alliance portfolio diversity and they reported contrasted results of APD consequences in different empirical settings. For instance, Goerzen & Beamish (2005) found

that Japanese multinational companies having diverse alliance partners showed a diminishing economic performance. If we admit that performance and survival have similar antecedents, our finding of APD negative impact on biotech firms' survival confirms Goerzen & Beamish's (2005) results. Silverman & Baum (2002) conducted their study on the sample of Canadian biotech firms. The scholars found that APD enhanced these firms' survival chances. Our findings contrast Silverman & Baum's (2001) results. In France, small biotech firms are more likely to exit if they diversify their alliance portfolios, unless they have only one type of alliance partner (i.e., either big pharma, university or another biotech firm) or all three types.

Concerning the market scope, we found that biotech firms who sell their products and/or services on two markets have lower probability of exit as opposed to their focused (single-market firms) or diversified peers (present on more than three markets). This finding supports the argument about biotech firms' diversification as a survivalist strategy. From the resource-based perspective informing the research on diversification, internal related diversification permits to develop new organizational routines and enrich the focal firm's existing knowledge base opening the opportunities for innovation and potential for rent generation (Dowell, 2000; Karim & Mitchell, 2000; Bercovitz & Mitchell, 2007). Those businesses having more diverse routine sets will be better positioned to identify a richer set of potential solutions and better endowed to more astutely evaluate the viability of these alternatives (Cohen & Levinthal, 1990). From the financial point of view, broad market scope also permits risk diversification. However, our results show that when a biotech firm broadens its market scope to more than three markets, the probability of exit increases. Therefore, we report a U-shaped form relationship between market scope and firms' exit. This result nuances Bercovitz & Mitchell's (2007) findings of market scope negative linear relationship with firms' exit.

Finally, the most interesting finding concerns the joint effect of APD and market scope. As we argued, these factors' joint effect differs from the impact they have on biotech firms' exit when studied independently. The probability of exit decreases for biotech firms combining wide market scope (i.e., present on more than three biotech markets) and diverse alliance portfolio. Even though excessive diversity is still harmful for a small firm (statistically we found that APD and market scope joint effect has a U-shaped form), a firm can enhance its survival chances by constituting a diverse alliance portfolio along with diversification strategy.

We believe that the present paper contributes to research in entrepreneurship and strategy in the following ways by:

(1) Advancing theoretical arguments about the possibility and necessity for small entrepreneurial firms to balance different facets of organizational diversity in order to reduce the risk of business exit;
(2) Bringing new empirical evidence on the effect of alliance portfolio diversity on small firms' survival particularly in rapidly changing and innovative environment;
(3) Contrasting previous research findings about the benefits of a greater scope of related market diversification;

7.2. Limitations and Future Studies

We conclude with a cautionary remark about generalizing our findings and interpretations. This research relied upon a single industry, biotechnology, and a unique national context, France. Given this focus, our findings are limited to this specific industry and context, and may not apply to other types of industries, such as slow-moving industries, or to other types of firms, such as established firms. Another potential limitation is the assumption that all partners of the same class of relationship have the same type of information. Partitioning partners into horizontally linked vs. vertically linked is a coarse approach that neglects partner-specific information. However, despite its coarseness, the compositional diversity of a firm's portfolio has a significant effect on firms' exit. As an extension to this paper, it would be fruitful for future research to compare different partitioning approaches. In theory, the composition of a firm's alliance portfolio can be analyzed according to the identities, status, resources, access, and other characteristics of the partner (Goerzen and Beamish, 2005). Further, the data did not permit us to do a finer-grained distinction of exit modes. Future research should test our findings for different gradations in the boundaries of the survival phenomenon: dissolution, divestment, failure to be born, sudden halt, life support, and marginalized state (Chopra, 2005). These gradations give a fuller reflection of the phenomenon that parallels the view that vital energy is a necessary condition for event.

Overall, we see the following possible extensions to the present paper. *First*, subsequent studies should elaborate on alliance portfolio diversity as a more encompassing multi-dimensional construct, including not only partners' diversity, but also such dimensions as a type of alliances and alliance governance diversity. *Second*, future research should continue to explore interaction and moderating effects of different diversity types that firms have to manage concurrently (e.g., partners, functional, governance and organizational diversities).

Third, it is important to understand the relationships of causality between different types of diversity and to study not only their consequences, but also their antecedents.

REFERENCES

Alvarez, S. A., & Barney, J. B. 2001. How entrepreneurial firms can benefit from alliances with large partners. ***Academy of Management Executive***, 15(1): 139-148.

Alvarez, S. A., & Barney, J. B. 2004. Organizing rent generation and appropriation: toward a theory of the entrepreneurial firm. ***Journal of Business Venturing***, 19: 621-635.

Barnett, W. P., & Freeman, J. 2001. Too Much of a Good Thing? Product Proliferation and Organizational Failure. ***Organization Science***, 12(5): 539-558.

Baum, J. A. C., & Oliver, C. 1991. Institutional Linkages and Organizational Mortality. ***Administrative Science Quarterly***, 36(2): 187-218.

Baum, J. A. C., & Silverman, B. S. 2004. Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. ***Journal of Business Venturing***, 19(3): 411-436.

Bercovitz, J., & Mitchell, W. 2007. When is More Better? The Impact of Business Scale and Scope on Long-term Business Survival, While Controlling for Profitability. ***Strategic Management Journal***, 28(1): 61-79.

Besanko, D., Dranove, D., & Shanley, M. 2000. ***Economics of Strategy***. John Wiley & Sons, Inc.: New York.

Blau, P. M. 1977. ***Inequality and heterogeneity***. New York: Free Press.

Chopra, A. 2005. Survival. ***Academy of Management Best Conference Paper***.

Coff, R. 1999. When competitive advantage doesn't lead to performance: Resource-based theory and stakeholder bargaining power. ***Organization Science***, 10(2): 119-133.

Cohen, W. M., & Levinthal, D. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. ***Administrative Science Quarterly***, 35: 128-152.

Deberdt, D. 2005. The cost of a European patent, ***Actuality Proceedings***. Paris: INPI.

Donckels, R., Dupon, B., & Michel, P. 1987. Multiple Business Starters. Who? Why? What? ***Journal of Small Business and Entrepreneurship***, 5: 48-63.

Dowell, G. 2000. Racing and back-pedalling into the future: New product introduction and organizational mortality in the US bicycle industry, 1880-1918. ***Organization Science***, 21(2): 405-432.

Gimeno, J., Folta, T. B., Cooper, A. C., & Woo, C. Y. 1997. Survival of the Fittest? Entrepreneurial Human Capital and the Persistence of Underperforming Firms. ***Administrative Science Quarterly***, 42(4): 750-783.

Goerzen, A., & Beamish, P. W. 2005. The effect of alliance network diversity on multinational enterprise performance. ***Strategic Management Journal***, 26(4): 333-354.

Gulati, R. 1998. Alliances and Networks. ***Strategic Management Journal***, 19(4): 293-317.

Gulati, R. 1999. Network Location and Learning: The Influence of Network Resources and Firm Capabilities on Alliance Formation. ***Strategic Management Journal***, 20(5): 397-420.

Hitt, M., Hoskisson, R., & Kim, H. 1997. International diversification: effects on innovation and firm performance in product-diversified firms. ***Academy of Management Journal***, 40: 767-798.

Iacobucci, D., & Rosa, P. 2005. Growth, Diversification, and Business Group Formation in Entrepreneurial Firms. ***Small Business Economics***, 25: 65-82.

Karim, S., & Mitchell, W. 2000. Path-dependent and path-breaking change: reconfiguring business resources following acquisitions in the U.S. medical sector, 1978-1995. ***Strategic Management Journal***, 21(10-11): 1061-1081.

Kim, J. W., & Higgins, M. C. 2007. Where do alliances come from? The effects of upper echelons on alliance formation. ***Research Policy***, 36: 499-514.

Kopp, P. e. a. 2003. Le Secteur Français des Biotechnologies. Paris: France Biotech.

Lavie, D. 2006. The competitive advantage of interconnected firms: an extension of the resource-based view. ***Academy of Management Review***, 31(3): 638-658.

Lee, G. K. 2007. The Significance of Network Resources in the Race to Enter Emerging Product Markets: The Convergence of Telephony Communications and Computer Networking, 1989-2001. ***Strategic Management Journal***, 28(1): 17-37.

Lubatkin, M., & Chatterjee, S. 1994. Extending mordern portfolio theory into the domain of corporate diversification: does it apply? ***Academy of Management Journal***, 37(1): 109-136.

Mangematin, V., Lemarie, S., Boissin, J. P., Catherine, D., Corolleur, F., Coronini, R., & Trommetter, M. 2003. Development of SMEs and heterogeneity of trajectories: the case of biotechnology in France. ***Research Policy***, 32(4): 621-638.

McEvily, B., & Zaheer, A. 1999. Bridging ties: a source of firm heterogeneity in competitive capabilities. ***Strategic Management Journal***, 20(12): 1133-1156.

McGrath, R. G. 1999. Falling forward: Real options reasonning and entrepreneurial failure. ***Academy of Management Review***, 24(1): 13-30.

Mitchell, W. 1994. The Dynamics of Evolving Markets: The Effects of Business Sales and Age on Dissolutions and Divestitures. ***Administrative Science Quarterly***, 39(4): 575-602.

Mitchell, W., & Singh, K. 1996. Survival of businesses using collaborative relationships to commercialize coplex goods. ***Strategic Management Journal***, 17(3): 169-195.

Niosi, J. 2003. Alliances are not enough explaining rapid growth in biotechnology firms. ***Research Policy***, 32(5): 737-750.

Oliver, A. L. 2001. Strategic alliances and the learning life-cycle of biotechnology firms. ***Organization Studies***, 22(3): 467-490.

Podolny, J. M. 2001. Networks as the Pipes and Prisms of the Market. ***The American Journal of Sociology***, 107(1): 33-60.

Podolny, J. M. 2005. ***Status Signals: A Sociological Study of Market Competition***. Princeton: Princeton University Press.

Powell, W. W., Koput, K. K., & Smith-Doerr, L. 1996. Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. ***Administrative Science Quarterly***, 41(1): 116-145.

Robson, G. C., Gallagher, C., & Daly, M. 1993. Diversification Strategy and Practice in Small Firms. ***International Small Business Journal***, 11(2): 37.

Rosa, P. 1998. Entrepreneurial Processes of Business Cluster Formation and Growth by 'Habitual' Entrepreneurs. ***Entrepreneurship Theory and Practice***, 22: 43-61.

Sampson, R. C. 2007. R&D Alliances and Firm Performance: The Impact of Technological Diversity and Alliance Organization on Innovation. ***Academy of Management Journal***, 50(2): 364-386.

Scherer, F. M., & Ross, D. 1990. ***Industrial market structure and economic performance***. Boston: Houghton Mifflin.

Scott, M., & Rosa, P. 1996. Opinion: Has Firm Level Analysis Reached Its Limits? Time for a Rethink? ***International Small Business Journal***, 14(4): 81-89.

Shane, S., & Venkataraman, S. 2000. The promise of entrepreneurship as a field of research. ***Academy of Management Review***, 25: 217-226.

Silverman, B. S., & Baum, J. A. C. 2002. Alliance-based competitive dynamics. ***Academy of Management Journal***, 45(4): 791-806.

Silverman, B. S., Nickerson, J. A., & Freeman, J. 1997. Profitability, transactional alignment, and organizational mortality in the U.S. trucking industry. ***Strategic Management Journal***, 18(Special Issue: organizational and Competitive Interactions): 31-52.

StataCorp. 2003. ***STATA Survival Analysis and Epidemiological Tables. Reference Manual: Release 8.0.*** College Station, Texas: Stata Corporation.

Stern, I., & Henderson, A. D. 2004. Within-business diversification in technology-intensive industries. ***Strategic Management Journal***, 25(5): 487-505.

Weigelt, K., & Camerer, C. 1988. Reputation and corporate strategy: a review of recent theory and applications. ***Strategic Management Journal***, 9(5): 443-454.

Williamson, O. E. 1991. Strategizing, economizing, and economic organization. ***Strategic Management Journal***, 12(Special Issue: Fundamental Research Issues in Strategy and Economics): 75-94.

Zucker, L. G., & Darby, M. R. 1996. Star scientists and institutional transformation: patterns of invention and innovation in the formation of the biotechnology industry. ***Proceedings of the National Academy of Science,*** 93: 709-716.