

Escaping the Prior Knowledge Corridor: What Shapes the Number and Variety of Market Opportunities Identified Before Market Entry of Technology Start-ups?

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The choice of the firm's market environment is one of the fundamental decisions of firm founders. We study the pre-entry generation of founders' market choice sets by investigating their search for market opportunities in which the firm's technological resources, as embodied in a product or service, can be commercialized. Analyzing data collected through personal interviews with founders of 496 technology ventures, we find that founding teams with more diverse industry experience and more diverse external knowledge sourcing relationships identify not only a larger number of but, in particular, more varied (distant) market opportunities. However, the extent to which strategic variety of such opportunities is identified depends on the founders' technological expertise, whereas technological expertise is less relevant in identification of the number of opportunities. Furthermore, by showing that the extent and nature of the firm's pre-entry opportunity set has a significant effect on the likelihood of subsequent firm diversification, we document how initial constraints in founders' choice sets can have a lasting impact on the growth potential that the new firm exploits over time. We discuss the implications of our findings for the literatures on organizational learning and innovation, entrepreneurship, as well as the strategy literature examining firm growth, diversification, and value creation.

Key words: choice sets; opportunity identification; external knowledge sourcing; entrepreneurship; market search landscapes; resource-based view; diversification; organization habitat selection; distant search

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1. Introduction

Schumpeter (1926) argued that the simultaneously creative and destructive process by which independent entrepreneurs commercialize new technological resources is a key driver of technological change, industry evolution, and economic growth. One of the most fundamental, yet oftentimes also most difficult, steps for entrepreneurs seeking to commercialize a new technology is the identification of markets in which the technological resource can create value for end customers (Penrose 1959, Jolly 1997, Kor et al. 2007). For instance, Rosenberg (1994) pointed out that the history of technological progress is rife with examples in which inventors failed to see important market opportunities arising from their new technologies—from the telegraph to the laser.

The array of market opportunities that an entrepreneur is able to identify for the venture's technological resources is key for understanding organizational emergence. Research has shown that the nature of the market that the venture enters has a major influence on its performance potential (Gruber et al. 2008) and strong imprinting effects on its identity, its structure, and the capabilities and assets it needs to develop (Boeker 1989,

Helfat and Lieberman 2002). A larger *number* and *variety* of market opportunities identified prior to the firm's initial entry create broader strategic choice for firm founders. But, because of search costs, founders are limited in their capacity to identify both a large number and a large variety of market opportunities. Because this imprinting effect is so important to later venture performance, it behooves us to begin to move up the causal chain and begin to explore what factors influence the strategic choice of market opportunities on entry.

We shall argue that what distinguishes which type of market opportunity set can be identified is the founders' *technological expertise*—the greater this expertise, the better the technological capabilities that these founders can deploy in adapting their technological resources to address customer needs in a broader *variety* of different market domains. By demonstrating that the value of technological expertise is relative to the emphasis of founders' search on the number or variety of opportunities, we point out that initial strategic choices are limited even prior to the start of the company and reveal important conditions under which the founders' strategic choices are systematically more, or less, constrained.

Furthermore, by showing that the extent and nature of the firm's pre-entry market opportunity set has a significant effect on the likelihood of diversification in subsequent stages of venture evolution, we document how initial constraints in founders' choice sets can have a sustained impact on the growth potential that the new firm exploits over time.

The theoretical development of our study draws on two perspectives. First, by building on resource-based theory in strategy (Penrose 1959, Prahalad and Hamel 1990, Danneels 2007), we discuss how resource fungibility allows founders to create strategic choice for the venture's initial market entry by identifying alternative market opportunities in which the firm's resources, as embodied in a product or service, can create value. Second, we draw on the organizational learning and entrepreneurship literatures to deepen our understanding of how founders' knowledge influences the identification of market opportunities (March 1991, Dixon 1999, Zahra 2008, Fern et al. 2011). Because extant research demonstrates that entrepreneurs are primed to identify those market opportunities that correspond to their prior knowledge (Shane 2000), we examine in more detail how the founding teams' preexisting industry knowledge (i.e., the number of different industries in which the founding team had gathered experience prior to new firm creation) is related to the number and variety of opportunities identified. Furthermore, because founders tend to be largely unaware of opportunities that lie beyond their prior knowledge endowments, we also examine the founders' ability to escape their limiting prior knowledge corridor by sourcing new knowledge from actors outside the boundaries of the firm. Arguably, external knowledge inputs may help founders to construct an opportunity choice set with a larger number and variety of options. Similar to recent innovation studies by Laursen and Salter (2006) and Leiponen and Helfat (2010), we are interested in the number of different knowledge sourcing relationships (suppliers, financiers, consultants, etc.) that founders may tap in their external search. In our case of market search, founders can ask different external actors whether they know of any customer problems that could be addressed with the functionality inherent in their technological resources.

Considering that choice sets are seldom palpably evident to the firm's agents, but have to be uncovered (often involving considerable effort and cost), there is an unfulfilled need to begin to understand how founders' knowledge endowments and external knowledge sourcing activities affect the number and variety of market entry options that comprise the market entry choice set.

2. Background: Resource Fungibility, Market Opportunities, and Knowledge Constraints

One of the fundamental arguments in resource-based theory is that firm resources are fungible and can create benefits for customers in several different product market domains (Prahalad and Hamel 1990). In her groundbreaking work, Penrose (1959, p. 25) noted that the "services yielded by resources are a function of the way in which they are used—exactly the same resource when used for different purposes or in different ways and in combination with different types or amounts of other resources provides different service." This distinction between an upstream resource and a downstream product market is crucial, because it highlights the fact that agents need to link their technological resources with an identified market demand to create value for the firm (Dougherty 1992, O'Connor and Veryzer 2001, Afuah 2002). In turn, the ability to identify multiple markets in which the firm's resources can be commercialized allows firms to exploit these growth options in diversification. Specifically, Penrose (1959, p. 42) emphasized that "[i]f we can discover what determines entrepreneurial ideas about what the firm can and cannot do, that is, what determines the nature and the extent of the 'subjective' productive opportunity of the firm, we can at least know where to look if we want to explain or to predict the actions of particular firms...we are on the trail of the theory of the growth of the firm."

For people to realize that their technology can be commercialized in a particular market, they need to have knowledge about customer needs. However, this information is diffused in the economy and not readily available for everyone, so at any given time only few people will know about the existence of a customer need in a particular segment in society (Hayek 1945). In other words, peoples' individual life experiences create a "knowledge corridor" that primes them to identify certain market opportunities but be blind to others (Ronstadt 1988). In Shane's (2000) study of the commercialization of a particular technology (three-dimensional printing) developed at MIT, of the eight entrepreneurs who sought to commercialize this technology, not one identified more than one market opportunity for the new technology because of their limited prior knowledge of customer needs in other markets. For instance, the entrepreneur who was familiar with orthopedics identified an opportunity in custom-fitted orthopedic devices for the medical market, whereas another entrepreneur with a background in architecture identified an opportunity in creating models for architects.

These findings suggest that when an entrepreneur relies solely on her prior knowledge in market opportunity identification, her pre-entry opportunity set tends to be smaller and less varied than if she had consulted others. As a consequence, her strategic choice set in

making the entry decision will be more limited, and thus she may miss out on entering an unobserved market domain—an “organizational habitat” (Gruber et al. 2010)—that offers more favorable conditions for new firm creation. Although we do not want to go as far as Hannan and Freeman (1977) and Aldrich (1979) to suggest that the firm’s environment determines who will survive (whereas the firm’s agents have passive influence only), the market nonetheless has a fundamental effect on the potential to create value for the venture and, hence, its performance (Gruber et al. 2008). In fact, the market opportunities that founders identify for the firm’s technological resource base can differ vastly along key dimensions such as market size and growth, competitive rivalry, and demand uncertainty. Take the eight markets identified for the three-dimensional printing technology mentioned above: their projected market sizes alone ranged from 10 million to several billion U.S. dollars.

Given these observations, it is of major importance to develop a deeper understanding of how the founders’ knowledge (that is, their preexisting industry knowledge endowments and new knowledge that they may acquire from external sources) influences the identification of not just more market opportunities but, in particular, more varied opportunities, because only then will founders have a qualitatively rich strategic choice among potential market entry options.

Yet, given that each identified market opportunity presents a value creation option for the venture, the importance of the pre-entry opportunity set may reach well beyond enabling strategic choice for the founders’ initial market entry decision. Drawing on the core ideas from Penrose’s (1959) *Theory of the Growth of the Firm*, discussed at the beginning of this section, it seems that the pre-entry opportunity set could also be of fundamental importance for realizing future growth options in entrepreneurship. In other words, the knowledge constraints observed for the initial entry choice may, in fact, have an even farther-reaching influence on the growth potential that the new firm exploits over time through diversification.

Against this backdrop, our study sets out to investigate two related research questions:

(1) How do differences in founders’ internal knowledge endowments and in external knowledge sourcing influence the number and the variety of market opportunities identified prior to the first entry?

(2) How do the number and the variety of market opportunities identified prior to the first entry affect the likelihood of subsequent firm diversification?

3. Hypothesis

3.1. Internal Knowledge, External Knowledge, and the Firm’s Pre-Entry Opportunity Set

To increase our understanding of the role of founders’ knowledge in market opportunity identification, we combine extant insights drawn from the organizational learning and entrepreneurship literatures to argue that the two primary bases for opportunity identification are (i) the founders’ internal prior knowledge endowments (Shane 2000, Shane and Venkataraman 2000) and (2) the founders’ activities in acquiring new knowledge from external actors (Aldrich and Zimmer 1986, Argote 1999, Dixon 1999, Aldrich and Ruef 2006).

First, we have already pointed out that founders are primed to identify those opportunities that reflect their prior industry experience (Shane 2000, Fern et al. 2011). Following this logic, one can expect a positive relationship between the number of different industries represented in the founding team’s background and the size and variety of the firm’s opportunity set. Recent empirical results support this logic, as they indicate that entrepreneurs with experience in different industries identify a larger number of opportunities prior to the start of their firms (Gruber 2009).

Second, extant research has also shown that external knowledge sources can add important new insights to all kinds of organizational activities (Allen 1977, Dixon 1999, Singh 2000, Chesbrough 2003, Menon and Pfeffer 2003, Ozgen and Baron 2007). Hence, despite the fact that prior work has not yet provided systematic insights on the question whether external knowledge sourcing can enhance the identification of market opportunities for technologies, we have no reason to believe that this should not be the case. Although the relationship between the number of different knowledge sources tapped by founders and opportunity identification is likely far from perfect (e.g., because founders may not have extended their relationships very broadly), those founders who do tap a larger number of external sources in their search for market opportunities should, on average, be more likely to receive new knowledge on market opportunities than founders who engage with fewer external sources, or none at all.

In light of the existing evidence, we take it as a given that founding teams (i) that are more diverse in terms of their industry experience and (ii) that tap different external knowledge sources will be more prolific in their market opportunity identification. Rather, we focus our theorizing on the extent to which number versus variety of market opportunities can be identified. Specifically, we argue that the extent to which variety of strategic choice sets can be established depends on founders’ level of *technological experience*. This type of experience provides founders with the ability to assimilate market-related knowledge in technology-to-market linking and to recognize how their technological resources

can be employed to cater to more distant market opportunities. In other words, technological experience seems to be key for understanding the *leveraging capacity* of the venture's technological resources.

To understand why this is the case, one has to look more closely at the process of technology leveraging. This process entails two main steps (Danneels 2007), both of which demand technological expertise. First, technology leveraging requires the characterization of the firm's technological resources in their own right, that is, "delinked" from any concrete application in a product. Here, technological expertise is needed to obtain a thorough understanding of the firm's technological base, that is, its generic and specific properties, its tangible and intangible components, and its functionalities (capacities, limits) (Galunic and Rodan 1998, Danneels 2002). Second, technology leveraging requires the application of the firm's technological resources to new products that address new customers ("relinking"). In this step, technological expertise is key for understanding whether the firm's technological resource base can be transformed (i.e., refined, reconfigured, or combined with other resources) so that it can render services for the market domain proposed by an external actor (Penrose 1959, Danneels 2002).

Both of these points suggest that founders with greater technological experience will be more fully aware of their technology's leveraging capacity than technologically inexperienced founding teams. Hence, when founders with strong technological experience have information on potential market demand (drawn from their own experience or obtained from external sources), they will be less likely to discard such inputs as being "not useful" because they can better understand how the proposed market demand relates to and can be catered to with their technological resources (Cohen and Levinthal 1990). All else equal, founders with strong technological experience should thus see a larger number of market opportunities for their venture than founders with weaker technological experience. We propose the following moderating relationships.

HYPOTHESIS 1A (H1A). *The greater the founders' technological experience, the more the positive relationship between the number of different industries represented in the founding team's experience and the number of market opportunities identified prior to market entry will be enhanced.*

HYPOTHESIS 1B (H1B). *The greater the founders' technological experience, the more the positive relationship between the number of different external knowledge relationships tapped and the number of market opportunities identified prior to market entry will be enhanced.*

We further argue that technological expertise will be even more important for the construction of an opportunity set with higher variety than for the construction

of a large opportunity set. Specifically, founders' capacity for resource leveraging will become increasingly strained when the market-related knowledge pertains to more distant markets (March 1991, Menon and Pfeffer 2003). Faced with such distant market knowledge, technologically experienced founding teams will be in a better position to understand how the firm's technological resources can be reconfigured or combined with other resources so that their firm can cater to that market (Danneels 2007). In contrast, technologically inexperienced founding teams may elect to focus primarily on market-related knowledge that is close to the knowledge they already possess, because they do not possess the assimilation capacity that is necessary to understand how their technological resources can be used to produce offerings for more distant markets. The overall market opportunity set will then assume a less varied character than in the case of founding teams with strong technological experience.

Thus, the level of technological experience of the founding team could play a particularly important role in the construction of a varied opportunity set for the firm's technological resources. Hence, we propose the following moderating relationships.

HYPOTHESIS 2A (H2A). *The greater the founders' technological experience, the more the positive relationship between the number of different industries represented in the founding team and the variety of market opportunities identified prior to market entry will be enhanced.*

HYPOTHESIS 2B (H2B). *The greater the founders' technological experience, the more the positive relationship between the number of external knowledge sources tapped and the variety of market opportunities identified prior to market entry will be enhanced.*

Although we expect that technological experience also facilitates the identification of a larger number of opportunities (see H1A), the arguments just presented also suggest that technological expertise could be seen almost as a *conditio sine qua non* for the generation of opportunity variety, and thus to be more important for the variety of a firm's choice set than for the number of alternative options in the choice set.

HYPOTHESIS 3 (H3). *Technological experience will have a greater moderating influence on opportunity variety than on opportunity count.*

3.2. Pre-Entry Market Opportunity Identification and Post-Entry Diversification

Extending our theoretical development to the firm's evolution after the initial entry, we argue that the pre-entry market opportunity set is also of fundamental importance for seeding future diversified growth options in entrepreneurship. A higher number and/or variety of

market opportunities identified prior to entry will naturally provide a larger and more visible search landscape (Levinthal 1997), which means that more opportunities for diversification will be evident for exploitation once the firm has overcome its initial entry efforts. Specifically, our hypotheses will investigate how the number and the variety of market opportunities identified prior to the first entry affect the likelihood of subsequent firm diversification.

Two main arguments indicate that ventures with a larger pre-entry market opportunity set will be more likely to diversify over time. First, the identification of additional opportunities prior to the first entry means that founders are aware of future growth options for their venture. One can think of the identified market opportunities as real options that confer the ability to exploit the opportunity if it has favorable outcome predictions (McGrath 1997). Hence, unless there is an exogenous shock that will negatively affect the outcome potential of all of the identified market opportunities, having more options at one's disposal means that there is a higher chance that any one of these options is associated with a favorable outcome (Leiponen and Helfat 2010). For instance, in some market domains, customer demand may be growing strongly, whereas in other markets, regulatory changes may improve the firm's rent-earning potential.

Second, because a larger number of pre-entry options means that there is a higher chance of having *favorable* diversification opportunities among these options (Leiponen and Helfat 2010), founders with a larger pre-entry opportunity set will be compelled to design an organization that is able to benefit from these opportunities. For instance, founders may create a flexible (modular) organizational structure and technological architecture that facilitates entry into these domains (Brown and Eisenhardt 1998, Helfat and Eisenhardt 2004). Similarly, they may establish a brand name, complementary assets, and other infrastructures that more readily accommodate such diversification moves. Because these measures will decrease market entry costs, diversification will become more attractive.

HYPOTHESIS 4A (H4A). *The larger the pre-entry opportunity set of the venture, the higher the likelihood of subsequent diversification.*

To understand how the *variety* of the firm's opportunity set will affect the decision to diversify, we draw on extant research discussing the costs and benefits associated with related versus unrelated diversification (e.g., Helfat and Eisenhardt 2004). Diversification studies generally indicate that entry into closely related market domains will be less costly than entry into distant domains (Markides 1995, Palich et al. 2000). This is because higher relatedness facilitates the sharing of the

firm's tangible and intangible resources as well as capabilities in the development, production, and commercialization of products, and it also demands less managerial capacity to manage economies of scope (Chatterjee and Wernerfelt 1991, Montgomery and Hariharan 1991). As a firm diversifies into a less related market, only resources and capabilities with less specificity can be shared between units, making it likely that firms need to complement their existing resource and capability endowments (Helfat and Eisenhardt 2004).

Related diversification thus allows firms to obtain important economies of scope. Yet the attractiveness of the destination market also provides key inducements for founders to enter a new domain (Chatterjee and Wernerfelt 1991). In particular, diversification research argues that very closely related domains often fail to provide significant growth potential for diversifying firms, as the entry into such domains does not cultivate new sets of customers for the firm (Montgomery and Hariharan 1991).

Overall, these arguments suggest that, on one hand, founders will be drawn to closely related diversification options because of the associated economies of scope, whereas on the other hand, they may be induced to consider less closely related diversification options given that such options could open up important new customer bases for their firms. Yet taking into account that new firms tend to be highly resource-constrained entities, there also seem to be limits in how far afield new ventures can go in their diversification, because the investments required to perform unrelated diversification are often substantial (Rumelt 1974). Hence, most new firms may not have the financial liquidity that is needed to undertake unrelated diversification (Chatterjee and Wernerfelt 1991).

Based on these observations, we can now make predictions about the relationship between the variety of the firm's pre-entry opportunity set and the likelihood of firm diversification. Considering the tension between the lower costs of a closely related entry and the possibility to cater to entirely new customer bases in distant diversification, it seems that the highest likelihood of diversification can be encountered with those founders who have an opportunity set offering moderate variety (reflecting moderately related entry options): for these founders, diversification will look most appealing, because they can benefit from fairly low entry costs and from the growth potential offered by the relatively newer customer set. In contrast, founders with an opportunity set that comprises closely related entry options will face low costs of entry yet are fairly limited in their ability to build new customer bases for their ventures. Finally, founders with highly diverse opportunity sets face the highest costs of entry—costs that seem to be prohibitively high for new ventures, making entry less likely despite of the growth potential inherent in

developing a completely new customer base. Given these patterns, we expect an inverted U-shaped relationship between the variety of the firm's pre-entry opportunity set and firm diversification.

HYPOTHESIS 4B (H4B). *There is an inverted U-shaped relationship between the variety of the venture's pre-entry opportunity set and the likelihood of subsequent diversification.*

4. Methodology

4.1. Data and Sample

To test our hypotheses, we required data on identification of market opportunity, founding teams, external knowledge sourcing, diversification moves, and several other organizational characteristics as controls. Because publicly available databases do not provide the data required to examine our propositions, we collected primary data using preformatted, personal face-to-face interviews with the founders of high-technology ventures located in Germany and in the United Kingdom. To develop the survey instrument, we conducted an extensive pilot study (including interviews with 14 founders of technology ventures), then developed the survey instrument and pretested it with six founders, four venture capitalists and business angels, and six academics. Because extant studies have considered chief executive officers and founders to be highly knowledgeable and valid sources of information (Glick et al. 1990), we pursued a key-informant approach and, via personalized letter, contacted the founders of 1,730 German and 454 British technology ventures randomly selected from the membership data of national firm registries in both countries; therefore, using these data sources does not impose any sort of bias. Following prior research, we included only technology ventures that were independently held (McDougall et al. 1994). Face-to-face interviews were conducted in late 2007 with founders of 496 technology ventures (396 in Germany and 100 in the United Kingdom), which corresponds to an aggregate response rate of 23%. We also conducted 41 additional face-to-face interviews with a second founder drawn from the German sample to assess potential response bias and found no indication of such bias (see §4.3). The interviews lasted, on average, 45 minutes. Respondent firms had a median founding year of 2002 and represented the following technology areas: software (13%), manufacturing machines (12%), information technology (11%), medical technology (10%), physical and chemical process engineering (7%), communication (6%), electronics (6%), Internet (5%), measuring technology (4%), energy and environmental engineering (4%), services (3%), multimedia (3%), new materials and nanotechnology (3%), laser technology (2%), and others (11%).¹

4.2. Definition and Measurement of Variables

4.2.1. Dependent Variables. Corresponding to our theory development, we used two dependent variables to investigate pre-entry market opportunity identification, namely, (i) the *number* of additional market opportunities identified prior to the first market entry and (ii) the *variety* of the venture's pre-entry market opportunity set. Furthermore, we used the dependent variable *diversification after the initial market entry* to investigate the role of the firm's initial opportunity set in subsequent diversification moves.

Number of additional market opportunities: This variable records the number of alternative market opportunities entrepreneurs considered prior to the first market entry (for similar count measures, see, e.g., Hill and Birkinshaw 2010, Shepherd and DeTienne 2005, Singh 2000, Ucbasaran et al. 2009). Through a multistage question,² respondents were asked to indicate whether, prior to first market entry, they had considered commercializing their technological resources in market domains different from the market they eventually entered. We counted the number of additional market opportunities.

Variety of market opportunities: Respondents who indicated that they had considered additional markets prior to entry were then asked to describe those markets with a few keywords, which were used to develop our measure of variety. Although this is the first study to measure the variety of market opportunities identified for an emerging firm's technological resources, the strategy literature offers widely accepted measures for assessing the relatedness of firms' diversification moves into new markets (e.g., Rumelt 1974, Palich et al. 2000) that can be employed to derive a consistent measure for the variety of a firm's opportunity set. In particular, relatedness measures based on the Standard Industrial Classification (SIC) system have become part of the standard toolkit used in empirical diversification research (Montgomery 1982, Markides 1995). The SIC system uses four-digit codes to provide a hierarchical classification of distinct business categories. Researchers have used this system to establish the degrees of relatedness of diversification moves, with *narrow distance* diversification reflected in diversification moves outside the four-digit SIC code but within the same two-digit code and *broad distance* diversification occurring when firms move into different two-digit SIC codes (Wood 1971). Hence, diversification at the three-digit SIC code level connotes greater familiarity than diversification on the two-digit level (Robins and Wiersema 1995).

Utilizing the relatedness information offered by the SIC system, we generated the variety score for the firm's opportunity set in two main steps. First, we used the SIC system to derive a consistent categorization of the market opportunities that the firms identified prior to their

first entry. Second, we used the relatedness information contained in this categorization of the firm's opportunities to compute a variety score for each firm's opportunity set. Both steps are explained in more detail below.

1. Using descriptions of the market opportunities identified by each firm, one of the researchers involved in the present study and one external researcher categorized each market opportunity according to the SIC system. We then compared how we categorized each market opportunity (interrater agreement: 0.93) and discussed any differences in our coding until we reached agreement. For instance, a technology venture producing engines may have identified three market opportunities—that is, to produce engines for cars, for motorcycles, and for oil drilling. The corresponding SIC categories logged for that venture are as follows: 3714 for “motor vehicle parts and accessories”; 3751 for “motorcycles, bicycles, and parts”; and 3533 for “oil and gas field machinery and equipment.”

2. Based on the systematic categorizations of each firm's market opportunities, we used the relatedness information contained in the SIC system to compute a variety score for each firm's opportunity set. In line with the literature on firm diversification, we determined the degree of relatedness of the firm's opportunities by examining the SIC codes represented in the firm's opportunity set. Specifically, we performed pairwise comparisons of the SIC codes of all opportunities in the firm's opportunity set and assigned a distance score to each opportunity pair. Because opportunities that share the same firm four-digit SIC code are more closely related than opportunities that share the same three-digit level or just the two-digit level, we assigned a distance score of 1 to an opportunity pair that shared the same three-digit code, a score of 2 to a pair that shared the same two-digit code, and a score of 3 to a pair that shared just the one-digit code. In other words, the higher the score, the greater the distance between a given pair of opportunities. Finally, following the logic of variety measures employed by previous studies (e.g., the Blau index),³ we squared and summed up all pairwise distance scores to arrive at the variety score for the firm's market opportunity set. To illustrate this computation, consider the example introduced above, that is, a venture that identified opportunities to produce engines for cars (SIC code 3714), for motorcycles (SIC code 3751), and for oil drilling (SIC code 3533). There are three pairwise comparisons (and corresponding distance scores) that allow us to compute the variety score: cars–motorcycles (same two-digit level, i.e., distance score 2), cars–oil drilling (same one-digit level, i.e., distance score 3), and motorcycles–oil drilling (same one-digit level, i.e., distance score 3). The summation of the squared pairwise scores ($4 + 9 + 9$) yields a variety score of 22 for the firm's opportunity set. This example indicates that larger values of this score correspond to market opportunity

sets with greater variety and, therefore, indicate greater strategic variety in the possible market entry choices for firm founders.

Diversification after the initial market entry: Our third dependent variable captures whether the ventures diversified during their early-stage development, that is, within five years after the initial entry. Like Montgomery and Hariharan (1991), we employed a dummy variable indicating firm diversification (0 = no; 1 = yes). We created this variable by using information on (i) the time of the venture's initial market entry (year and month) and (ii) the time (year and month) of entry into any other market domains.

4.2.2. Independent Variables.

External knowledge sourcing relationships: The Yale and Parliamentary Assembly of the Council of Europe (PACE) surveys on innovation document the wide range of knowledge sources frequently used in innovation in the United States and Europe, respectively (Arundel et al. 1995, Klevorick et al. 1995). We followed recent studies (Laursen and Salter 2006, Leiponen and Helfat 2010) in assessing the number of different external relationships that the founders tap in their search for market opportunities. Using five-point Likert-type scales (from 1 = “not used” to 5 = “very high use”), respondents reported the knowledge they obtained prior to their firm's first market entry from five main types of external actors (i.e., actors who are typically outside the boundaries of the firm) who frequently engage with firm founders: suppliers, family and friends, venture capitalists and/or business angels, consultants, and potential customers (because they may have knowledge about analogous markets and thus suggest novel market opportunities). To obtain our measure, we followed the procedure used by Laursen and Salter (2006) and coded each of the knowledge sources as a binary variable, with 0 indicating no use of a particular source and 1 indicating the use of a particular source. We then created the linear sum of all external knowledge sources used per firm (Laursen and Salter 2006, Leiponen and Helfat 2010); in other words, a value of 5 indicates that the firm used all five knowledge sources in market opportunity identification, whereas a value of 0 indicates that none were used. Similar to the construct used in Laursen and Salter's (2006) study, our variable also has a high internal consistency (Cronbach's $\alpha = 0.83$). We mean centered the variable.

Founding team industry experience: Following the notion that founders are primed to identify opportunities that reflect their prior industry experience (Shane 2000, Fern et al. 2011), the number and variety of identified opportunities is likely to be related to the industry experience present in the founding team. Hence, we asked respondents to indicate in which industries each member of the founding team had gathered prior work experience. We created the sum of all the individual industries represented in the founding team and mean centered the variable.

Technological experience: Following Wiersema and Bantel (1992) and Gruber et al. (2008), we assessed the average level of technological experience in the founding team because it represents the group's overall characterization. Specifically, respondents rated the level of technological experience that their team possessed at founding using a five-point Likert-type scale (1 = "very low" to 5 = "very high").⁴

4.2.3. Control Variables.

Founding team size: We also controlled for founding team size, because measures of team composition may be size dependent. Team size was measured using the count of individuals in the founding team (prior to the first entry) (Wiersema and Bantel 1992).

Entrepreneurial experience: Prior entrepreneurial experience influences people's firm creation and business opportunity identification practices (McGrath and MacMillan 2000, Gruber et al. 2008). Respondents reported the number of founders who had previously started a firm. We created a dummy variable to capture whether the founding team possessed prior entrepreneurial experience (1) or not (0).

Marketing experience: Following Wiersema and Bantel (1992, p. 95), we used the average level of marketing experience in the founding team to represent the group's overall characterization. Specifically, respondents rated the level of marketing experience that the team possessed at founding using a five-point Likert-type scale (1 = "very low" to 5 = "very high").

Aspirations for the new firm: Because individuals have limited information-processing capacity and because the search for alternative solutions is not an effortless activity, search activities are influenced by aspirations (Simon 1955). Measuring aspiration levels is, however, not a straightforward issue in empirical research (Greve 2003). In particular, in entrepreneurship one may distinguish between founders who seek to establish high-growth ventures that create considerable wealth from those who seek to achieve modest levels of firm growth and value creation. As a proxy for respondents' aspirations in new firm creation, we thus asked them about the firm value that they aspired to achieve within five years after founding and performed a logarithmic transformation of the stated values to obtain our aspirations measure.

Self-developed technology (vs. licensed-in technology): Employing a percentage scale, we asked respondents to indicate the degree to which the technology they sought to commercialize was completely licensed in (0%) or developed completely internally (100%).

Seed funding prior to market entry: The search for market opportunities can depend on the influence of external stakeholders. Because 19% of all technology ventures in our sample obtained some form of equity funding (business angel, venture capitalist) during the

seed stage *prior* to the initial market entry, we utilized a dummy variable to indicate whether the emerging firm acquired such seed funding (1) or not (0).

Generality of technological resources: The *ex ante* evaluation of the generality of an innovative technology is a key theoretical question and represents a difficult challenge in empirical analyses. In this vein, research as early as Penrose (1959) has highlighted the fungibility of resources and argued that such fungibility depends strongly on an agent's subjective perceptions and creativity. However, we also know that some technological resources may lend themselves to additional market opportunities more easily than others (Galunic and Rodan 1998). We accounted for this influence by employing a measure of technological resource generality; we constructed an index that captures the percentage of new firms (in a particular technology field) that considered more than one market opportunity.^{5,6}

Time before entry: Search activities involve both direct and indirect costs. We thus controlled for the total time spent on setting up the new firm. Following prior research (Brüderl et al. 1996), we capture how many months it took from the start of active preparation of the new firm to its first market entry.

Time after entry: Opportunity identification behavior might be influenced by the macro environment during firm creation, so we controlled for each firm's age by calculating the time since entry (in months).

Country (Germany/United Kingdom): Firms in our sample are located in Germany and the United Kingdom. Because opportunity identification behavior might be influenced by factors specific to a particular country (such as culture or education), we control for the country in which the firm was founded (Germany = 0, UK = 1).

4.3. Inspection of the Data Set

We conducted several tests to inspect the quality of our data. If the measures affect how the respondent reacts and responds to subsequent items, there is the potential for divergence between observed and true relationships among constructs, a methodological artifact called common method bias. We employed Harman's one-factor test to analyze the extent to which such bias might influence our findings (Podsakoff and Organ 1986). In a conservative approach to this test, the principal components factor analysis of the three core variables (i.e., external knowledge sourcing breadth, technological experience, internal knowledge breadth) showed that two factors had eigenvalues greater than 1 and jointly accounted for 71% of the variance. Common method bias does not appear to be a problem in this data set because (a) more than one factor was identified, (b) the first factor accounted for only 36% of the variance, and (c) no general factor emerged in the unrotated factor structure.

Because our research design included interviews with a second key informant from the founding team in

41 technology ventures, we could conduct a limited reliability test (e.g., assessing potential retrospective bias). We found nearly complete agreement (>0.97) between the responses of the two informants from the 41 firms, so these additional interviews validated the conclusion, drawn from the preparatory interviews and the pretest of the questionnaire, that founders have a clear memory of major decision elements in the founding process. This finding is not so surprising because we know from studies in a range of subjects that people typically have clear memories of important events and facts in their lives (Malhotra 2009), and founding a firm is such an event. Similarly, Miller et al. (1997) noted that the risk of retrospective bias is greatly diminished when, as in the current case, simple, objective facts and concrete issues are assessed and the confidentiality of respondents is assured.

4.4. Method and Statistical Interpretation

This research relied on three analytic methods. The first dependent measure, which is the number of additional market opportunities identified prior to the initial market entry, takes on only nonnegative integer values and consists of a preponderance of occurrences of zeros and ones. Because ordinary least squares regression would lead to biased, inefficient, and inconsistent estimates in cases where the dependent variable is not normally distributed, we employed a negative binomial model to estimate the market opportunity counts of firms. We preferred the negative binomial model to Poisson regression because a likelihood ratio test of our data indicated overdispersion; that is, the variance was greater than the mean (Hausman et al. 1984). The second dependent variable of our study, the variety of the firm's market opportunity set, is double censored because it ranges between a minimum of 0 and a maximum of 90. Thus, we used a Tobit model for our analysis of market variety (Wooldridge 2002), basing our analysis of determinants of a venture's variety score on those firms that identified more than one market opportunity ($n = 197$). Finally, the third dependent variable of our study, diversification after the initial entry, is a binary variable. Hence, we specified a probit model for our analysis of firm diversification (Wooldridge 2002).

We corrected all estimation models for potential biases resulting from self-selection (Hamilton and Nickerson 2003). In our case, founders of technology ventures may identify larger opportunity sets because of unobservable or hard-to-measure factors that could be correlated with right-hand-side variables. Following Heckman (1979), we corrected for self-selection in two steps. First, we estimated a probit model that captures the decision to identify additional market opportunities. Specifically, we estimated whether founders engaged in the identification of additional opportunities as a function of our control and main predictor variables. We also included a

variable that significantly predicted this decision but did not significantly influence the count of additional market opportunities: a measure capturing whether founders wrote a business plan prior to the first entry (measured as a dummy variable). Second, we estimated our main models as a function of identified variables and corrected for a potential self-selection bias by including the inverse Mills ratio, that is, an index generated from the probit estimates.

Given the nonlinear nature of our models, it is important to note that the estimated coefficients do not represent marginal effects, making an interpretation of the results—except for the direction of an effect—difficult (Hoetker 2007, Zelner 2009). This feature of nonlinear models is compounded for the calculation of interaction effects, as the coefficient of an interaction term in a nonlinear model does not provide direct information about the statistical significance or magnitude of the moderating relationship of interest (Holburn and Zelner 2010). For instance, it could be that the interaction effect may change signs over some set of the values of the sample. To address these issues, we follow recent methodological advances to examine how the structural form of the nonlinear model as well as the moderation of the focal variable contribute to the overall moderation shown by the significant coefficient (Wiersema and Bowen 2009, Bowen 2010a).

5. Results

5.1. Descriptive Results

The correlation matrix and summary statistics are shown in Table 1. Correlations are $|0.5|$ or less, indicating that collinearity of covariates should not be a concern. We also computed variance inflation measures for all variables, but found only small variance inflation factor values. As Table 1 indicates, founders in our sample considered, on average, 1.84 market opportunities prior to choosing the initial market for their technology ventures. As an example of such a technology venture, picture one of the information technology start-ups in our data set: with the support of external knowledge sources, its founders identified hospitals and universities as market opportunities for their nascent venture.

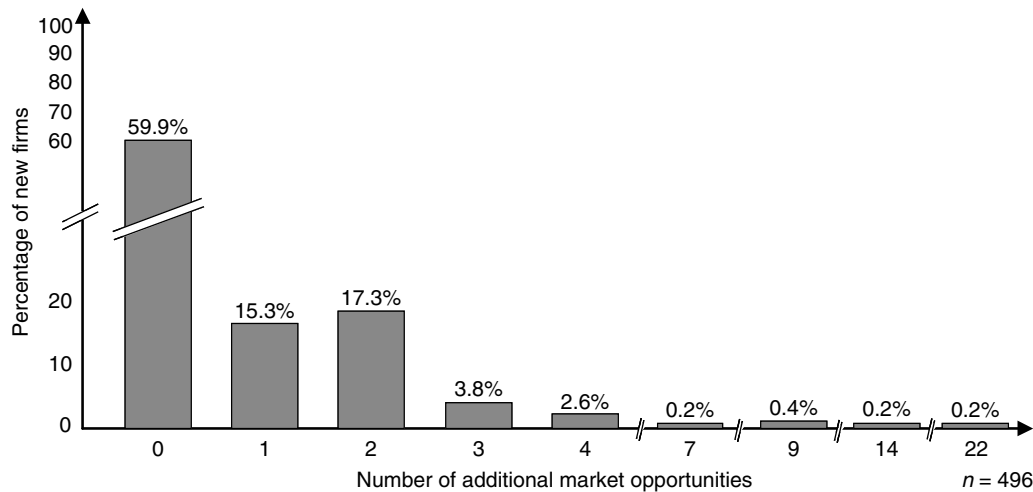
Figure 1 shows the distribution of the market opportunity count variable. Overall, these results are in line with earlier research on market opportunity identification by technology start-ups (Gruber et al. 2008), and they not only suggest that firms have different search strategies (Laursen and Salter 2006) but also that they often consider no additional alternatives when making key strategic decisions (Schwenk 1984). Figure 2 provides descriptive evidence concerning the types of market opportunities identified in technology ventures by specifying the variety of the firm's market opportunities set. Although the distant and, thus,

Table 1 Descriptive Statistics and Correlation Matrix

Variable	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Number of additional market opportunities	0.84	1.64	0.00	22.00	1.00															
2 Variety score of the firm's opportunity set	16.09	18.45	1.00	90.00	0.50	1.00														
3 Diversification within 5 years	0.28	0.49	0.00	1.00	0.15	0.07	1.00													
4 External knowledge sourcing relationships	0.00	2.19	-2.41	2.59	0.47	0.18	0.10	1.00												
5 Technological experience	0.00	0.80	-3.34	0.66	0.03	0.25	-0.06	0.03	1.00											
6 Team industry experience	0.00	0.92	-0.94	4.06	0.15	0.13	0.02	0.08	-0.06	1.00										
7 Team size	3.10	1.82	1.00	11.00	0.23	0.21	0.04	0.10	0.08	0.16	1.00									
8 Entrepreneurial experience	0.39	0.49	0.00	1.00	0.16	0.07	0.09	0.06	-0.04	0.28	0.18	1.00								
9 Marketing experience	0.00	1.18	-2.24	1.76	-0.09	0.01	-0.24	-0.09	0.14	-0.01	-0.10	0.05	1.00							
10 Aspirations	0.02	0.06	0.00	0.69	0.13	0.16	-0.03	0.02	-0.02	0.07	0.08	0.11	0.04	1.00						
11 Self-developed technology	0.70	0.36	0.00	1.00	-0.06	-0.09	0.02	-0.11	-0.01	0.04	-0.02	0.14	0.08	-0.03	1.00					
12 Seed funding prior to market entry	0.19	0.39	0.00	1.00	-0.02	0.04	0.13	0.02	-0.12	-0.06	-0.06	0.05	-0.05	0.03	0.07	1.00				
13 Generality of technology	0.80	0.48	0.00	2.78	0.32	0.19	0.10	0.13	-0.06	0.02	0.09	0.03	0.04	-0.02	0.02	-0.02	1.00			
14 Time after entry (in months)	57.12	30.99	0.00	98.40	-0.04	-0.03	0.14	-0.06	-0.05	-0.08	-0.02	-0.07	-0.19	-0.10	0.04	-0.07	0.14	1.00		
15 Time before entry (in months)	14.37	17.67	0.00	84.00	0.07	-0.04	-0.07	0.06	0.10	-0.08	0.06	-0.01	0.06	-0.01	0.00	0.01	-0.18	-0.21	1.00	
16 Firm location (Germany/United Kingdom)	0.20	0.40	0.00	1.00	-0.02	-0.05	-0.08	-0.04	0.17	-0.07	0.03	-0.12	0.27	-0.13	0.13	0.05	-0.26	-0.12	0.23	1.00

Note. Correlations > 0.09 are significant at the 5% level; statistics for Variable 2 are based on $n = 197$.

Figure 1 Number of Additional Market Opportunities Identified Prior to the First Market Entry



unconstrained search space offers potentially unlimited possibilities for knowledge recombination, agents tend to exhaust the local solution space before identifying more distant opportunities, an important empirical pattern that reinforces predictions in search theory that distant (exploratory) market opportunities tend to be more difficult to identify (March 1991).

Finally, the summary statistics reported in Table 1 also indicate that 28% of all ventures in our sample diversified within five years after their initial entry. Additional analysis found that 40% of the subset of ventures that identified multiple markets prior to the initial entry diversified, compared with only 21% of the firms that identified only one market prior to entry. So those firms that identified manifold entry opportunities were significantly

more likely to later diversify than those that identified only one opportunity ($p < 0.05$).

5.2. Multivariate Results: Market Opportunity Count and Market Opportunity Variety Models

Results of the negative binomial regressions analyzing the market opportunity count are presented in Models 1–5 of Table 2, and the results of the Tobit models predicting the variety of the firm's market opportunity set are given in Models 6–10 of Table 2. In a hierarchical analysis, Models 1 and 6 estimate a specification of control variables for each of the two dependent variables, and the other models add the substantive variables as well

Figure 2 Variety Score of the Firms' Pre-Entry Market Opportunity Sets

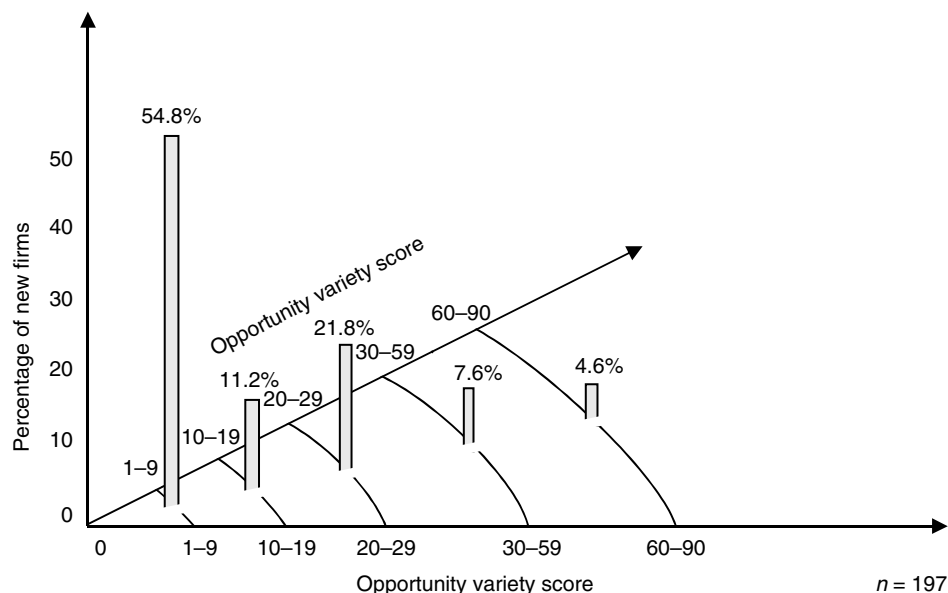


Table 2 Negative Binomial and Tobit Regression Models: Market Opportunity Count and Market Opportunity Diversity (Prior to Initial Entry)

Independent variables	Model 1 coeff. [SE] Count	Model 2 coeff. [SE] Count	Model 3 coeff. [SE] Count	Model 4 coeff. [SE] Count	Model 5 coeff. [SE] Count	Model 6 coeff. [SE] Variety	Model 7 coeff. [SE] Variety	Model 8 coeff. [SE] Variety	Model 9 coeff. [SE] Variety	Model 10 coeff. [SE] Variety
<i>Team industry experience</i>		0.15* [0.06]	0.15* [0.06]	0.15* [0.06]	0.14* [0.06]		2.42† [1.40]	2.76* [1.33]	3.06* [1.36]	2.90* [1.34]
<i>External knowledge sourcing relationships</i>		0.64*** [0.03]	0.64*** [0.03]	0.64*** [0.03]	0.64*** [0.03]		3.93* [1.69]	3.81* [1.58]	3.87* [1.57]	3.85* [1.56]
<i>Team technological experience</i>			0.05 [0.07]	0.05 [0.07]	−0.04 [0.09]			6.95*** [1.52]	6.79*** [1.47]	6.80*** [1.52]
<i>Team industry experience × Technological experience</i>				−0.01 [0.07]					2.87* [1.35]	
<i>External knowledge × Technological experience</i>					0.05 [0.04]					1.71* [0.73]
<i>Team size</i>	0.09* [0.04]	0.06† [0.03]	0.06† [0.03]	0.06* [0.03]	0.06† [0.03]	1.82† [1.01]	1.54 [0.94]	1.42† [0.85]	1.37* [0.80]	1.43* [0.85]
<i>Entrepreneurial experience</i>	0.44** [0.14]	0.33* [0.13]	0.34* [0.13]	0.34** [0.13]	0.34* [0.13]	1.64 [2.95]	0.75 [2.98]	0.85 [2.86]	0.73 [2.83]	0.91 [2.85]
<i>Marketing experience</i>	−0.12* [0.06]	−0.10* [0.05]	−0.11* [0.05]	−0.11** [0.05]	−0.11* [0.05]	0.23 [1.13]	0.04 [1.09]	−0.03 [1.05]	0.01 [1.03]	−0.05 [1.05]
<i>Aspirations</i>	2.04† [1.12]	1.78* [0.73]	1.71* [0.73]	1.71** [0.73]	1.66* [0.71]	44.76 [38.55]	43.74 [38.08]	34.01 [35.94]	33.3 [36.60]	34.1 [35.87]
<i>Self-developed technology</i>	−0.33† [0.18]	−0.06 [0.15]	−0.06 [0.15]	−0.06 [0.15]	−0.06 [0.15]	−5.64 [4.01]	−5.61 [3.99]	−4.19 [3.87]	−3.91 [3.89]	−4.29 [3.93]
<i>Seed funding prior to market entry</i>	0.12 [0.17]	−0.04 [0.15]	−0.04 [0.15]	−0.04 [0.15]	−0.04 [0.15]	1.55 [3.30]	1.95 [3.47]	2.75 [3.33]	3.08 [3.28]	2.72 [3.34]
<i>Generality of technology</i>	0.73*** [0.16]	0.54*** [0.15]	0.55*** [0.16]	0.55*** [0.16]	0.55*** [0.16]	7.52* [3.55]	7.08† [3.68]	9.07* [3.67]	8.46* [3.67]	9.04* [3.69]
<i>Time since entry (in months)</i>	0.01 [0.03]	0.02 [0.02]	0.03 [0.02]	0.03 [0.02]	0.03 [0.02]	0.24 [0.52]	0.27 [0.50]	0.32 [0.46]	0.34 [0.46]	0.32 [0.47]
<i>Time before entry (in months)</i>	0.00 [0.00]	0.00 [0.00]	0.00 [0.00]	0.01 [0.00]	0.01 [0.01]	−0.07 [0.07]	−0.06 [0.08]	−0.07 [0.08]	−0.06 [0.08]	−0.07 [0.08]
<i>Firm Location (Germany/United Kingdom)</i>	−0.24 [0.19]	−0.30* [0.15]	−0.31* [0.16]	−0.31** [0.16]	−0.34* [0.16]	−1.62 [3.58]	−3.45 [3.50]	−5.25 [3.48]	−5.83† [3.47]	−5.28 [3.48]
<i>Inverse Mills ratio (selection correction)</i>	−1.08*** [0.25]	−0.64*** [0.20]	−0.63** [0.20]	−0.63*** [0.19]	−0.63** [0.19]	−1.25 [7.07]	−0.13 [7.10]	2.68 [6.52]	3.56 [6.53]	2.51 [6.68]
<i>Constant</i>	−0.36 [0.42]	−1.32*** [0.36]	−1.35*** [0.36]	−1.35*** [0.36]	−1.35*** [0.36]	3.92 [10.90]	−3.31 [11.14]	−8.21 [10.52]	−8.71 [10.38]	−7.97 [10.72]
<i>Log likelihood</i>	−565.00 496	−434.85 496	−434.59 496	−434.59 496	−434.31 496	−804.90 197	−801.00 197	−792.03 197	−789.50 197	−790.01 197
<i>Observations</i>										

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests).

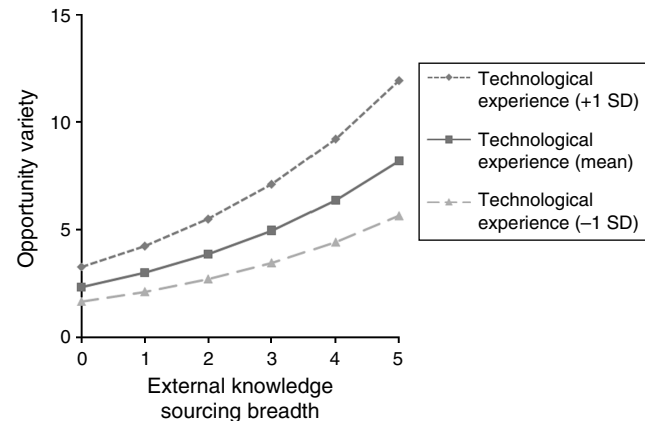
as the interaction terms. The results shown in Table 2 are highly robust across the models, and the significant predictor variables significantly increase the explanatory power of our models, as measured by twice the difference in the log likelihoods and compared to a chi-square statistic with degrees of freedom equal to the number of newly added variables (Models 1 and 2, $p < 0.001$; Models 6 and 7, $p < 0.05$; Models 7 and 8, $p < 0.001$; Models 7 and 9, $p < 0.05$; Models 7 and 10, $p < 0.05$).

The results presented in Table 2 indicate positive and significant relationships between founding team industry experience and the number/variety of market opportunities identified. Similarly, the results indicate positive and significant relationships between founders' external knowledge sourcing and the number/variety of market opportunities identified.

Building on these baseline relationships, H1A and H1B examine the moderating role of founders' technological experience on the number of market opportunities identified (i) through the industry knowledge available internally and (ii) through external knowledge sources. As noted in the Methodology section, the properties of nonlinear models do not allow for direct substantive interpretation of interaction effects based on the estimated coefficients. Models 4 and 5 indicate that both moderating relationships are insignificant. Furthermore, following Bowen (2010a, b), we find that both moderating effects are insignificant across the range of the predicted dependent outcomes. We thus reject H1A and H1B. Apparently, technological experience is not required to generate more market opportunities.

In terms of opportunity *variety*, however, we find significant coefficients for both interaction terms. To assess these effects, we not only compute and visualize the marginal effects of the interaction terms over meaningful changes in the values of the key independent variable (see Figures 3 and 4), but we also examine how the structural form of the nonlinear model as well

Figure 4 Market Opportunity Variety: Interaction Effect Between Breadth of External Knowledge Sourcing and Technological Experience

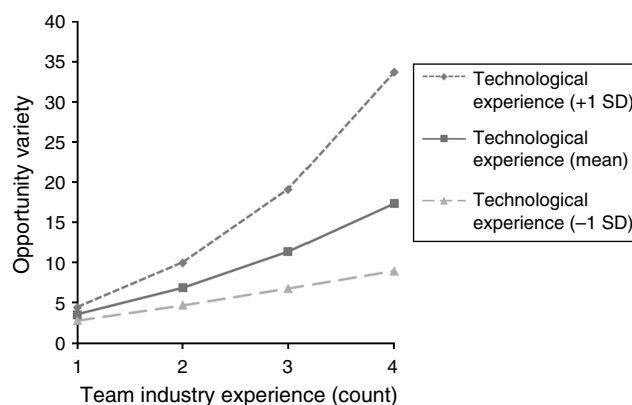


as the moderation of the focal variable contribute to the overall moderation shown by the significant coefficients (Wiersema and Bowen 2009). First, Figures 3 and 4 clearly indicate a positive moderating relationship between team industry knowledge/external knowledge sourcing breadth and technological experience. Second, we perform the analysis suggested by Bowen (2010a, b) to examine how the secondary (i.e., true) moderating effect as well as the structural moderating effect (caused by the nonlinear nature of the Tobit model) contribute to the total moderating effect in both cases. These analyses indicate that the secondary moderating effect is positive and significant across the whole range of the dependent outcomes. Hence, we claim support for H2A and for H2B. Technological expertise can thus be seen as highly critical to achieving variety in pre-entry market opportunity sets, thereby providing nascent technology firms with a broader choice among market environments for the first entry.

Hypothesis 3 suggested that technological experience will be more important for achieving a more varied opportunity set than for achieving a larger opportunity set. Given the nonsignificance of the moderating effects of technological experience in the opportunity count models and the strongly positive, significant moderations in the opportunity variety models, we can claim support for this hypothesis without further statistical testing.

Looking at the controls, we note that the founding team size has the expected significant relationship with both dependent variables. There is also the expected significant positive relationship between prior entrepreneurial experience and number of identified opportunities (already documented in earlier research; Gruber et al. 2008). Consistent with prior research, we also find a negative relationship between marketing experience and the number of identified opportunities (Gruber et al. 2010). It appears that people with

Figure 3 Market Opportunity Variety: Interaction Effect Between Team Industry Experience and Technological Experience



functional marketing backgrounds are conditioned and confined by their experience in known environments (they are trapped in the knowledge corridor) rather than being open to the identification of novel market opportunities—an observation that is consistent with Danneels (2007), who shows that marketing expertise is of a first-order rather than a second-order nature; that is, marketers tend to have local market knowledge, not second-order competence to identify alternative markets. Moreover, we find that technological experience by itself does not have a significant relation to the number of opportunities identified and that founders' aspirations provoke search for more opportunities but not a greater variety of opportunity.

Finally, in a post hoc analysis, we explored whether industry experience and external knowledge sourcing interact to generate larger and/or more varied opportunity sets. However, we could not find any significant evidence in support of this relationship, which means that there is no “trade-off penalty” from seeking to expand both internal industry experience (by expanding the founding team) and external knowledge sources (by expanding the number of sources).

5.3. Multivariate Results: Diversification Models

We present the results of the probit models estimating the likelihood of firm diversification in Table 3. Model 1 presents the results of a specification using just the control variables. Model 2 investigates the effect of the

Table 3 Probit Models: Diversification After the Initial Entry

Independent variables	Diversification within 5 years after the initial entry			
	Model 1 coeff. [SE]	Model 2 coeff. [SE]	Model 3 coeff. [SE]	Model 4 coeff. [SE]
<i>Market opportunity count</i> (prior to initial entry)		0.09* [0.05]		
<i>Market opportunity variety</i> (prior to initial entry)			0.01 [0.00]	0.02* [0.01]
<i>Market opportunity variety</i> ² (prior to initial entry)				−0.001* [0.00]
<i>Team industry experience</i>	−0.02 [0.07]	−0.04 [0.07]	−0.02 [0.07]	−0.03 [0.07]
<i>Team technological experience</i>	−0.03 [0.08]	−0.05 [0.08]	−0.04 [0.08]	−0.03 [0.08]
<i>Team size</i>	−0.01 [0.04]	−0.02 [0.04]	−0.01 [0.04]	−0.01 [0.04]
<i>Entrepreneurial experience</i>	0.34* [0.14]	0.32* [0.14]	0.34* [0.14]	0.34* [0.14]
<i>Marketing experience</i>	−0.29*** [0.06]	−0.28*** [0.06]	−0.29*** [0.06]	−0.29*** [0.06]
<i>Aspirations</i>	−0.33 [1.11]	−0.68 [1.13]	−0.36 [1.11]	−0.25 [1.13]
<i>Self-developed technology</i>	0.00 [0.18]	0.02 [0.18]	0.00 [0.18]	0.03 [0.18]
<i>Seed funding prior to market entry</i>	0.53** [0.20]	0.53** [0.20]	0.52** [0.20]	0.55** [0.20]
<i>Generality of technology</i>	0.13 [0.16]	0.05 [0.16]	0.12 [0.16]	0.13 [0.16]
<i>Time since entry</i> (in months)	0.05† [0.03]	0.05† [0.03]	0.05† [0.03]	0.05* [0.03]
<i>Time before entry</i> (in months)	0.00 [0.00]	−0.01 [0.00]	0.00 [0.00]	0.00 [0.00]
<i>Firm location</i> (Germany/United Kingdom)	0.03 [0.19]	0.03 [0.19]	0.03 [0.19]	0.02 [0.19]
<i>Inverse Mills ratio</i> (selection correction)	−0.69** [0.24]	−0.66** [0.24]	−0.68** [0.24]	−0.59* [0.25]
Constant	−0.80† [0.44]	−0.80† [0.44]	−0.80† [0.44]	−1.02* [0.46]
Log likelihood	−260.16	−257.88	−260.11	−257.72
Observations	496	496	496	496

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests).

market opportunity count variable, whereas Models 3 and 4 examine the effects of *market opportunity variety* on firm diversification. The significant predictor variables significantly increase the explanatory power of our models (Models 1 and 2, $p < 0.05$; 1 and 4, $p < 0.05$).

Hypothesis 4A predicted that the larger the pre-entry opportunity set of the venture, the higher the likelihood of subsequent diversification. We find support for this hypothesis in Model 2 of Table 3, as the coefficient of the *market opportunity count* variable is positive and significant.

Hypothesis 4B proposed an inverted U-shaped relationship between the variety of the venture's opportunity set and the likelihood of diversification. We investigate this hypothesis in Models 3 and 4. Specifically, we see that the linear term of the variable capturing market opportunity variety is by itself insignificant (Model 3); however, we find evidence of a significant inverted U-shaped relationship in Model 4, as both the linear and the squared term are significant. We thus claim support for H4B.

Turning to the controls, we note that founding teams with prior entrepreneurial experience are significantly more likely to diversify than teams without such experience—a result that not only extends current understanding of this important type of experience endowment in firm creation but also fits well with the earlier observation that firms led by founders with entrepreneurial experience identify a larger number of opportunities prior to the first entry (Gruber et al. 2008). Taken together, these findings suggest that experienced entrepreneurs have learned that the value inherent in technological resources can be unearthed by identifying multiple market opportunities and by exploiting these opportunities through diversification moves. Furthermore, we find a negative effect of marketing experience on diversification; again, this finding corresponds well to the already identified negative relationship in the opportunity count models and thus provides additional support for the arguments that we put forth to explain this effect. Finally, we note that ventures that obtained seed funding prior to the first entry are more likely to exploit additional value creation options through diversification moves.

6. Discussion

Choice sets are rarely evident for the firm's agents, but they have to be identified, often involving considerable effort and cost. This research focused on two main characteristics of such choice sets by examining the generation of the number and variety of solutions for a fundamental organizational problem—the choice of the market entry domain in new firm creation. Our study has produced the following primary results.

First, our baseline results indicate positive relationships between team industry experience/external

Table 4 Summary of Findings

	Less technological experience	More technological experience
Few industries represented in the team	Few opportunities Very low opportunity variety	Few opportunities Low opportunity variety
Many industries represented in the team	Many opportunities Low opportunity variety	Many opportunities Very high opportunity variety
Few external sources	Few opportunities Very low opportunity variety	Few opportunities Very low opportunity variety
Many external sources	Many opportunities Low opportunity variety	Many opportunities High opportunity variety

knowledge sourcing and the number and the variety of opportunities identified in new firm creation. More importantly, however, our findings reveal that the extent to which founders are able to generate variety in their market opportunities significantly depends on their level of technological experience, whereas technological experience is not required to generate large numbers of opportunities, because all opportunities can be closely related. So we suggest that by providing the capability to assimilate market-related knowledge, the founders' technological experience can be regarded as a platform from which preexisting industry knowledge in the founding team and newly sourced external knowledge can be ratcheted into creating greater variety in the firm's set of opportunities.⁷ Notably, without this key assimilation capability, founders identify less varied opportunities and thus are strongly constrained in their strategic entry choice. We provide a systematic summary of these important results in Table 4.

Second, those market opportunities that had been identified prior to the initial entry, yet remained unexploited at first, represent real options that may be exploited later on through diversification moves. By demonstrating that the extent and nature of the firm's pre-entry opportunity set has a significant effect on the likelihood of diversification in subsequent stages of venture evolution, we document how initial constraints in founders' choice sets can have a sustained influence on the growth potential that the new firm exploits over time.

These findings provide a number of insights for the literatures on organizational learning and innovation, entrepreneurship, and strategic management.

6.1. Theoretical Contributions

6.1.1. Contribution to the Literature on Organizational Learning and Innovation. By investigating the search for market opportunities for the firm's technological resources, our results contribute to the literature on organizational learning and innovation in three ways.

First, although several scholars have argued that knowledge search benefits innovating firms, their research has dealt primarily with search for technologies per se (e.g., Levinthal 1997), not the *search for the markets* in which technology resources can be commercialized. Such a search for markets in which technologies create value for the firm is one of the least understood yet important types of organizational search (Helfat and Lieberman 2002) because the search results deeply imprint the nascent firm's trajectory. The failure to identify important markets means that firms seeking to exploit their technological resources may miss key value creation opportunities (Gruber et al. 2008) and that some key benefits of technological progress are considerably delayed (Danneels 2007) or may be lost to society entirely (which losses, we may never know).

Extending the "landscape" metaphor frequently used in studies on technology search (Levinthal 1997) to the realm of market searches, one can view the venture's identified market choice set as that area of the landscape of all potential market opportunities that is "visible" to the founding team. Depending on the venture's preexisting knowledge endowments (industry and technological experience) and its external knowledge sourcing activity, we have seen that the *visible area* of the landscape is a more, or less, constrained subset of the total landscape. In other words, because of their superior ability in market opportunity identification, some founders are able to see many different parts of the landscape, whereas for other founders only a small part of the landscape is visible. It is important to recognize, however, that the identification of numbers of opportunities does not necessarily mean an increase in the founders' vision distance on the landscape, because all of the identified opportunities may be closely related (see Table 4) and thus reside in a small part of the landscape comprising local optima. Furthermore, it is important to recognize that when it comes to the choice of the market entry domain, founders who are able to overview a large area of the landscape will be in a position to select that market opportunity that provides them with the greatest chances for creating a successful firm (which may be a global performance maximum on the landscape), whereas founders who oversee only a small area of the landscape will have no other option than to exploit the local maximum of that small area.

Second, our findings enrich our understanding of organizational search processes and outcomes by examining the role of agents' experience endowments and external knowledge sources in shaping both the number and variety of opportunities identified prior to the launch of an innovation. The empirical literature on knowledge search has typically stopped short of examining the role of such antecedent knowledge on the number and variety of the search outcomes (Knudsen and Levinthal 2007).

Third, the team-level knowledge endowment patterns identified in this study help to further our understanding of learning in organizations because most research on learning has tended to examine macrolevel knowledge transfer between organizations and provides no insights at the team level on the mechanisms through which experience (here, technological experience) affects learning outcomes (Argote 1999, Argote et al. 2003, Zellmer-Bruhn 2003).

6.1.2. Contribution to Entrepreneurship Research. Opportunity identification is considered a defining element of the entrepreneurship field (Shane and Venkataraman 2000, McMullen and Shepherd 2006, Zahra and Wright 2011, Grégoire et al. 2010). This paper considerably advances our understanding of opportunity identification, because the extant literature highlights the constraining effects of prior knowledge in opportunity identification (the prior knowledge "corridor") yet has not offered insights into the factors that may help founders to *enrich* the pool of opportunities available for exploitation. Our results show in some detail how the founders' industry and technological knowledge as well as the founders' activities in external knowledge sourcing shape the number and the variety of pre-entry opportunities in the creation of new technology firms. In so doing, we not only document important patterns that lead to larger and/or more varied opportunity sets but also reveal the key enabling effect of technological experience in creating opportunity variety.

Along these lines, this is the first study that explicitly addresses the *variety* of opportunities in the firm's pre-entry opportunity set. As highlighted above, such variety is of strategic importance in new firm formation, because it provides founders with a variety of different market domains for the initial entry of their firms and thus a richer selection space for the venture's "organizational habitat" (Gruber et al. 2010). It also sets a broader stage for post-entry diversification.

Although one may like to think that external sources allow founders to reach beyond their limited knowledge of market domains ("to break out of their prior knowledge corridor"), our results suggest that the value that may be derived from external knowledge sources depends on the founders' technological experience. Hence, from a theoretical perspective, one can think of founders' preexisting knowledge endowments as having a *first-degree* effect on opportunity identification (i.e., the founders' existing knowledge of market opportunities) as well as a *second-degree* effect (i.e., the founders' existing ability to assimilate external knowledge on market opportunities).

Our findings also help to develop a more nuanced understanding of the role of pre-entry endowments and path dependence in new firm creation (Eisenhardt and Schoonhoven 1990, Cardinal et al. 2004, Beckman 2006,

Gruber 2009, Fern et al. 2011). We find that even when distant (i.e., potentially path-breaking) knowledge is offered to the new firm, founders' preexisting technological abilities can limit the types of knowledge that can be assimilated and exploited by the new firm. Furthermore, it is important to note that firms that do not possess such abilities (i.e., their founders did not develop the requisite technological experience in some initial period) are "locked out" from new opportunities that the founders cannot recognize (Cohen and Levinthal 1990).

6.1.3. Contribution to Strategic Management Research. Our results also have implications for the resource-based view in strategy. Penrose (1959) argued that agents can pursue new avenues for firm growth by leveraging their resources across market domains. Yet despite the significance of her observations for our understanding of organizations, growth, and value creation (Priem and Butler 2001, Foss et al. 2008), past work in strategy has not adequately explored the construction and exploitation of the firm's opportunity set. Our findings address this gap by showing how agents' experience endowments and external knowledge sourcing activities systematically shape both the number and the variety of opportunities identified by the firm's agents and, hence, the growth options available for exploitation. We also provide unique evidence on the link between the extent and the nature of the firm's pre-entry opportunity set and the likelihood of opportunity exploitation (i.e., additional growth options) over time.

Along these lines, these results also offer insights to the literature on firm diversification. First, most research in this area examines the types of diversification moves (related versus unrelated diversification) firms pursue and how such moves affect performance (Miller 2006). By explicating the factors that are related to the construction of a rich set of related and unrelated diversification options, the present study shifts the focus to the critical, yet much underdeveloped, "front end" of firm diversification. Second, we offer empirical evidence showing how the size and the nature of the identified set of diversification options shapes subsequent diversification moves. Our findings not only indicate that the likelihood of diversification is increasing with an increasing number of diversification options identified prior to the initial entry; they also reveal a curvilinear (inverted U-shaped) relationship between the variety of diversification options identified and the likelihood of diversification. In other words, the likelihood of firm diversification is increasing with increasing variety only up to a point; if the firm's diversification options are too varied (i.e., highly unrelated), the likelihood of diversification then decreases. To the best of our knowledge, this is the first study that documents these important patterns.

6.2. Limitations

This study analyzed data obtained from start-up firms—that is, firms that have a relatively short organizational history, are of small size, and are of low complexity. Although these characteristics provide a relatively clean setting for the empirical investigation, the generalizability of our findings to larger and more established firms is limited. Similarly, by following extant innovation research in selecting the types of knowledge sources to be investigated, we were limited to an examination of different source categories and thus unable to analyze founders engaged with multiple representatives within each source category.

One might argue that some technological resources can be applied to more markets than others. Thus, we conducted several empirical tests to examine whether technological resource characteristics might have influenced the patterns identified in the present research. In addition to utilizing the inverse Mills ratio to correct for potential selection effects and the measure for resource generality to control for technology characteristics, robustness tests were performed. In these tests, we substituted the generality measure with (i) dummy variables for each of the technology fields represented in our sample and (ii) two variables capturing resource characteristics that prior research (Galunic and Rodan 1998) deemed important in resource leveraging (see Endnote 6). Results of these alternative specifications are consistent with those reported in this study. Furthermore, we analyzed the potential for selection biases by conducting a matching analysis in which we examined whether firms that work in the same technology field and possess similar technological resources yet have different market opportunity identification outcomes would systematically differ along key dimensions. Although our examination was fairly comprehensive, the analysis did not indicate any strong pattern that would indicate significant biases in our results. Thus, the post hoc analyses suggest that such effects are probably not an important factor driving the results. It would be useful if future research could offer longitudinal insights (e.g., in-depth case studies), because they could complement our large-scale empirical evidence.

Like in many studies using new firm creation as a context, the current results may be affected by survivor bias. Future research should try to validate the current results using a longitudinal research design starting at a very early stage of firm creation. For instance, Delmar and Shane (2003) sampled close to 36,000 people to identify 223 individuals that were in the process of starting a new firm. Given that the present research focuses on ventures in high technology, the initial sampling frame for identification of a meaningful number of nascent high-tech entrepreneurs needs to be considerably larger.

Finally, we note that the observed patterns must be interpreted with the due caution regarding imputations

of causality associated with single-period measurement. Still, we have confidence in the causal interpretation of our results. First, our survey inquired about the knowledge sources used for identifying market opportunities; that is, they used a wording that indicates a clear causal direction. Second, a clear causal pattern exists between the identification of the pre-entry opportunity set and the post-entry diversification moves that exploit the opportunities identified previously.

6.3. Conclusion

We began this paper by noting that the choice of the firm's market environment is one of the most fundamental decisions of firm founders and key for our understanding of organizational emergence. Our findings demonstrate that initial market entry choices are limited even prior to the launch of the new venture and indicate that these initial constraints in founders' choice sets have a lasting influence on the growth potential that the new firm will exploit over time. By investigating the generation of number and variety of market opportunities in the firm's pre-entry choice set as well as the link to subsequent firm diversification, our research provides fundamental new insights on the role of knowledge in opportunity identification and contributes to a more refined theory of organizational emergence and firm growth.

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Endnotes

¹Using representative secondary data on technology ventures founded in Germany (data of the German Foundation Panel; e.g., Engel and Keilbach 2002), we compared the firms in our sample with the general population of technology start-ups along several key dimensions. We find that our sample tends to slightly overrepresent firms founded in the areas of multimedia/communication and software. Furthermore, we find high correspondence in the qualification of the founding team, as 38.7% of founders had obtained a university degree, whereas 38.5% of founders in the population of technology ventures had obtained a university degree. In addition, a comparison of the firms' start-up size suggests fairly equal employee counts (5.9 versus 5.2 employees).

²"Different founders pursue different approaches to new firm creation. Please try to remember in detail whether, prior to first market entry, you considered utilizing your know-how or technological competence to address customer needs in other target markets. This does not necessarily mean that you did, in fact, go on to enter these markets, but whether or not you identified other target markets prior to the initial market entry of your firm. As an example, when hearing the phrase 'other target markets,' consider brakes for motorcycles and brakes for cars. Should you have offered brakes for different types of

motorcycles and not for other markets such as cars, we would consider you as operating in one target market." Interviewees were then asked whether or not they identified other market opportunities prior to the initial market entry of their firm and, if they had done so, were asked to describe these markets with a few words, beginning with the first identified market.

³There is a longstanding debate regarding the meaning of diversity and how it should best be captured in empirical work (e.g., Montgomery 1982, Pitts and Hopkins 1982, Hall and John 1994). Empirical studies employ different diversity measures such as the Shannon index or the Blau index. These indices typically rely on information related to (i) the number of different categories present in a group and to (ii) the evenness of distribution across these categories. However, the base information contained in the present data is of a different kind, because we draw on distance information between identified market opportunities. We thus adapted the measures used in the diversification literature to fit the purposes of the present study.

⁴We cross-validated this measure with educational information (educational area and type of degree) obtained for each of the members of the founding team. Because intense exposure to a particular domain is required to develop expertise, we created a variable that denotes whether the founding team had at least one member with a Ph.D. degree in a technological area. Findings obtained with this measure are consistent with those obtained using our technological experience variable. Because the technological experience variable also encompasses work-related experience (and not just educational information), we prefer to employ the measure that includes technological work-related experience for our analyses.

⁵Index values ranged from 0.25 to 0.62: software (0.41), information technology (0.42), medical technology (0.39), manufacturing machines (0.38), Internet (0.48), communication (0.39), electronics (0.55), physical process engineering (0.46), measuring technology (0.62), energy and environmental engineering (0.48), services (0.53), multimedia (0.42), new materials and nanotechnology (0.50), laser technology (0.44), and chemical process engineering (0.25).

⁶As alternative ways of controlling for technological characteristics, we included 15 dummies to control for the technological fields represented in our sample. We also utilized two variables derived from Galunic and Rodan (1998) as controls to capture different resource characteristics that are important for leveraging technological resources across market domains: (1) codifiability (tacitness) and (2) contextuality. Models with these alternative control variables have led to results consistent with those of the main models and thus remain unreported.

⁷In this vein, the founding team's technological experience can be seen as an important ingredient of the venture's absorptive capacity (Cohen and Levinthal 1990). Specifically, founding teams with greater technological experience and associated knowledge have a greater capacity to absorb distant market-related knowledge, assimilate it, and apply it.

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