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Publication date:
2016

Document version
Version created as part of publication process; publisher's layout; not normally made publicly available

Citation for published version (APA):

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Download date: 09. dec., 2018
Resource combinations influence on new firm growth, studying new entrants in a high tech industry

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Abstract — Understanding the influence of resources on the new firm’s growth remains a difficult challenge for scholars. Prior research has suggested that the impact of human capital or technological resources is limited and does not provide an explanation on why some new firms grow faster than others. In this research we propose to explore the complementary and substitution effects between these resources using Kauffman Firm Survey (KFS) Dataset. We also introduce market resources to further understand the influence dynamics of resources in early stage growth. We follow the evolution of a sample of firms in a high tech industry to test our hypotheses. The results show that besides the direct effects of human, technological and market resources, it is the complementary and substitution effects across them that provides additional valuable information to understand their impact on new firm’s growth.

Keywords— technology entrepreneurship, resource-based view, human capital, growth.

I. INTRODUCTION

The size of new high tech firms’ ambitions to transform existing industries is sometimes inversely proportional to the resources their control. The dynamism of technology markets is said to offer opportunities to new entrants that might not be existent in other markets [1], where the room for innovative proposals is more limited, or where the incumbents control on industry resources limit the maneuvering options of new entrants.

Despite the promises that the high tech market might offer, they also have challenges of their own. For example new entrants might struggle to find relevant markets [2], or might be unable to manage the innovation challenges of transforming their technological opportunity into business opportunities [3].

Prior research efforts to explore the influence of resource configurations in new high tech firms’ growth have pointed to the expected value of resources such as human capital [4], technology resources [5], or other complementary market resources [6]. Nevertheless, past research has often been limited to study the relationship between resource positions and market performance at a specific moment in time, assuming that resources positions would translate in performance outcomes at the same time [7]. Furthermore in some cases the analysis of the past results has not helped to clarify the influence of resources such as human capital [8].

In this research we advance the study of the influence of resource positions in the long term growth of new entrants in high tech industries. We follow for eight years a group of high tech firms that enter the high tech manufacturing industry from 2004. The longitudinal panel data allows us to study the effects of the resources positions and also explore the complementary effects between them which is the major contribution of this study.

This research starts with a literature review that introduces the theoretical development that supports the proposed hypotheses. It follows with the description of the research design, covering the method and data used, as well as the measures adopted. The research follows with a presentation of the data analysis results, a discussion of the findings and identification of implications and final conclusions.

II. LITERATURE REVIEW

A. The value of resources in high tech startups

New firms in high tech markets face the challenge to establish a position in a traditionally dynamic and competitive environment, portrayed in the visual image of having the new firm “swimming with sharks” [9]. Prior research on new entrants in the high tech markets point towards the importance of understanding the competitive environment, using Teece’s framework as a reference [10], Gans & Stern [6] suggested the importance of understanding whether the market you aim to compete is a “market for products”, where the new venture can expect to control the whole process up to the final customer; or whether the new venture faces a “market for ideas” where it is better to focus on establishing partnerships with existing partners and provide them with patents other IP in exchange for royalties or similar types of commercial agreements.

In order to deliberate on what could be a crucial decision, entrepreneurs in high tech firms have to rely on limited resources. In particular, entrepreneurs entering new technology markets are observed to face a situation where they have limited information on the market, and at the same time the market has limited information on the new venture and its capabilities [11].
As a result, scholars have paid special attention on how entrepreneurs manage to act and make decisions regardless of the remnant uncertainty given these circumstances [12].

A plausible explanation to the ability of entrepreneurs to act and make their new high tech firms grow in a hostile market environment is that they have access to unique combinations of resources. Prior research on the influence of new firms’ resources on future performance has studies on the influence of human capital [4], technological resources and market resources [13], but few studies have been able to explore the combination (and interactions) of the different resources that could be influential for high tech startups [14]. In particular it remains unclear whether the “more” of a resource the “better” for the future performance of the high tech firm, or whether it is actually the complementarity or substitution effects that help us to understand why prior isolated research could not identify significant effects [14].

### B. Hypothesis development

The theoretical development to support the hypothesis covers the expected influence of the individual resources and then hypothesized on the potential influential combinations of resources.

The factor that has been receiving particular attention in studying the emergence and future performance of high tech startups is human capital [8]. In the context of the new firm, with limited tangible resources, human capital is expected to be a major source of heterogeneity when studying the development of the new firm. Prior research has suggested that in the context of startups, although overall prior experience has not always been a significant factor [8], the education and entrepreneurial experience of the entrepreneur could be an influencing factor [4] as they could provide unique competencies to manage the development of the firm in an uncertain context. In this sense we would expect that:

- **H1**: New firms’ human capital have a positive influence on firms’ growth.

In the competitive and dynamic context of high tech industries, technological resources could play a differential factor for new firms [11, 15]. The possible value of patents and other visible technological resources as symbols of quality of the new firm, could facilitate the interactions with potential customers, and even influence investors’ valuation of the firm and its potential success [5]. Therefore, the strength of technological resources of the new firm is expected to be a valuable predictor of performance while entering the market.

- **H2**: New firms’ technological resources position have a positive influence on firms’ growth.

To succeed in a competitive technology-driven market the new high tech firms are expected to be able to understand market dynamics which combines a technology-push with a demand-pull perspective that will “construct” their business opportunity [16], [17]. The ability to manage marketing activities are seen as a valuable indicator of the capacity of the entrepreneur to understand and respond to market needs [18]. Therefore the development of market assets such as brands could play the function of marketing resources [13] and would impact on the future evolution of the high tech firm in the high technology context.

- **H3**: New firms’ market resources position have a positive influence on firms’ growth.

Prior research observation that “more” of a specific valuable resource does not necessarily impact in “better” performance [14] which opens questions on what type of resource combinations might actually be key for new high tech firms. In this sense, we hypothesize that a combination of technological and market resources should portray the expected positive impact of being ambidextrous which combines technology-push and demand pull [16]. We also propose that human capital, in particular prior entrepreneurial experience in the same industry, could be a complementary resource to the technology or market resources of the new firm [19], [20]. Therefore, the following is suggested:

- **H4a**: The combination of technology and market resources have a complementary positive effect.
- **H4b**: The combination of human capital and technology resources have a complementary positive effect.
- **H4c**: The combination of human capital and market resources have a complementary positive effect.

### III. RESEARCH DESIGN

**A. Method & Data**

This research not only aims to assess the influence of resources but also the impact of specific resource combinations in the growth of high tech firms. We use a longitudinal data panel to capture the time effects of the resources of the new firm and the use of panel data to explore technology entrepreneurship research questions offers possibilities to gain new insights on the phenomenon [7]. Prior research using cross-sectional approaches have often been questioned regarding the influence of new firm resources because it does not show delayed effects which could impact beyond the moment of observation [8].

We use a subsample from the Kauffman Firm Survey (KFS) data to test the above presented hypotheses. The KFS is a longitudinal panel data set (baseline in 2004 and seven waves of data till 2011) of new businesses in the US, registered on the Dun & Bradstreet (D&B) database. It tracks up to 4,800 firms newly registered in 2004. For more information on the KFS survey design and methodology, please see Robb & Reynolds [21].

Based on Chapple et al.’s classification and definition [22], high technology firms are identified as those that operate in “high-technology employers” or “high-technology generators” industries given the R&D activities and employees’ profiles in that industry. The NAICS industry code was used to categorize between high-technology (“employers” or “generators”) or non-
high technology firms. In order to explore the influence of resources, we have selected a specific high tech sub-industry with a higher R&D intensity (based on the 2008 US Census data [23]) that includes chemical, machinery, computer, and transport equipment manufacturing industries. The number of firms from this high tech industry sampled in the dataset is = 159 new technology-based firms that reported their activities from 2004 to 2011.

B. Measures

1) Dependent variable

This research aims to clarify how different resources influence high tech firms’ growth. Prior research has used sales growth as an indicator of the acceptance of the firm’s products and services in the market [24]. We have recorded the logarithm of the reported revenues for each firm and year and used it as the dependent variable of the model.

2) Independent variables

The measures for firms’ human capital are the number of work experience in years (2004, when the firm starts), the number of previous businesses started, and the number of previous businesses started in the same industry. We also control for age and educational background (from 1 to 9 depending on highest degree attained) to explore whether these factors could provide additional information. To study the influence of human capital combined with other resources, we use the measure of whether the entrepreneur had entrepreneurial experience in the same industry or not (E. E. same industry coded as yes or no) as it provides specific knowledge that is expected to be a major determinant compared to the various human capital measures.

We measure technological resources using the number of patents that the new firm holds, and marketing resources using the number of trademarks that have been registered by the new firm. Both measures have been used in prior research as tested indicators of technology and marketing capabilities in an organization which correlates with the concept of resources for new high tech firms [13]. We have used as indicator of technology or market resources of the firm their relative position in relation to other firms in this specific high tech industry. To do this, we established the high or low position of each firm in relation to other new entrants in the industry by calculating the average number of patents and trademarks for each firm across the eight years of data and compared it with the industry average. As a result, this indicator is much richer and provides a comparative perspective the number of IP, or the overall number of patents or trademarks.

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IV. DATA ANALYSIS & RESULTS

The descriptive statistics for the dependent and independent variables can be seen in Table I. From the descriptive data of the sample, it can be observed that in this high tech manufacturing industry the log of the revenues has an average of 12.05. The average age of the owners in the new firm is 48 with a level of education above undergraduate, close to 80% are males. They have on average of 15 years of work experience and have a previous startup experience. Less than half of them (46%) have prior entrepreneurial experience in the same industry. From the firms in the sample, 20% of them have above average (high) number of patents, and 23% of them have above average (high) number of trademarks.

We analyzed the longitudinal panel data using a random effects Generalized Least Squares (GLS) regression. GLS models do not produce biased estimates compared to Ordinary Least Squares models because generate repeated measurements from the same firms across the years. For similar examples using this method, please see Katila & Chen [25].

We run four models in the regression analysis. The first model does not explore any of the interactions and it responds to the first three hypotheses (H1, H2, and H3). In each of the following models we explore the remaining hypotheses (H4a, H4b, and H4c). For each model we reported the Wald Chi² and the R² as indicators of the probability that the coefficients of the model are different from zero and as an indicator of how well does the model explain the changes in the volume of revenues generated by new high tech firms entering the industry. Results are detailed in Table II.

The overall R² of the model (0.16; p<0.00) provides an indicator of the potential insights that the different coefficients provide in relation to our understanding of the phenomenon. In more detail we cover the results in relation to the different hypotheses.

In more detail, we follow with a description of the hypotheses results for each of the models.
A. Human Capital, Technology and Market resources

The expected positive influence of the human capital measures (work experience, entrepreneurial experience, and entrepreneurial experience in the same industry), results in only a significant, and positive, influence of entrepreneurial experience in the same industry (0.63; p<0.1). The other variables did not show a significant effect. Only gender that was being introduced as a control variable showed positive and significant effects (1.37; p<0.01), suggesting that males are more likely to have higher levels of revenues in new high tech firms. Thus the assessment of H1 would be limited to specific measures that captures entrepreneurial experience within the same industry where the new firm is now operating.

In relation to H2, we observe that technological resources (whether the average number of patents is higher than the industry average) shows to be a significant (although with a not too strong probability) indicator of new firms’ revenue growth (0.76; p<0.2).

In relation to H3, we cannot describe the effects of the market resources as trademarks do not show significant coefficients in relation to the evolution of the revenues of the high tech firms.

B. Combination of resources, complementary effects.

Following the structure of the theoretical development, we observe H4a which proposes that technology and market resources could have complementary effects is not significant. In fact, from the different possible interaction effects between technology and market resources, the data suggests that firms that have higher patent intensity but lower trademark intensity than the industry are more likely to have higher revenues (1.04; p<0.2).
As we explore H4b, we test whether the combined effects of specific human capital (entrepreneurial experience in the same industry) and technology resources would have an additional positive impact. The results suggest that a combination of experience and possession of higher than industry average levels have a strong and significant impact on the revenue generation (1.55; p<0.05). Having experience but no patents has also a positive influence, although with less intensity (0.54; p<0.2).

Finally, we test H4c, where we expected to see experience in the same industry and market resources (trademarks) would have a positive influence on revenue's growth. Nevertheless, the data does not show significant coefficients. In fact, it suggests that not having experience in the same industry and having higher levels of trademarks than the industry average (-0.62; p<0.2) has actually negative effects on the likelihood of generating revenues in the period of time under study.

In all models used, it is observed that the time effects of the years are significant. Introducing the year effects allows us to discriminate the influence of the factors under study and the survival effects generated by those firms that survive through the years and could otherwise bias the coefficients of the factors that define the hypotheses.

V. DISCUSSION & IMPLICATIONS

The main contribution of this study is to offer a better understanding on the influence of resources on new high tech firms growth - in particular on the combination of key resources in this type of industry context. The results of the research point to several findings that are discussed in more detail.

A. Findings Discussion

The study of how new ventures grow has captured the attention of scholars [26], prior research exploring the influence of resources in this process had identified human capital as a determining influence. Nevertheless the contradictory evidences gathered in empirical results casted doubts on the actual impact of this resource on the development of new firms [8]. Meanwhile, our results suggest that there is no significant impact (across the whole panel of data waves 2004-2011) for classic indicators of human capital such as education, work experience or number of prior startups where there is positive influence from a very specific source of human capital that combines entrepreneurial experience in the same industry. In line with recent studies that explore the nature of entrepreneurial knowledge [20], we find that this construct can help to understand better the specific type of human capital that could explain part of the performance heterogeneity.

Existing research on the influence of more tangible resources such as technology or marketing elements (like brands) had mostly assumed that these type of resources should play a positive influence on the development of new ventures. Prior research has mostly focused on how the presence of these resources could be related to the valuation of the new high tech firm [13], [5] while other research had suggested that some of these resources could have a symbolic value for entrepreneurs [27], but without clarifying the impact of these resources in the long term growth of the new firm. Furthermore, in this research we have been able to assess whether the relative position of the new firm in relation to the industry average would be an influencing factor. The findings suggest that technological resources in particular play a role in the future growth of the firm. Recovering the insights from Gans & Stern [6] on new entrants strategies, we have found evidence that in highly dynamic and competitive contexts such as high tech manufacturing industry, possessing protected intellectual property in the form of patents could be a positive influence in the future growth of the firm.

In addition, this research contributes to the open call to further explore the interactions between different types of resources [14]. The study of the interplay between the different types of resources suggests the positive synergies generated by the combination of specific human capital (entrepreneurial experience in the same industry) and technological resources. This novel finding provides much needed evidence to the idea that experienced entrepreneurs in an industry can find ways to exploit technological resources that are expected to offer the opportunity to differentiate them from competitors or other new entrants [11].

B. Implications

The implications of this study and its findings are two-fold. From the academic research perspective, we have advanced the understanding of resources that influence new high tech firms’ growth. In addition, we have provided valuable evidence on the interactions between resources and their complementary effects. Overall our research contributes to the development of human capital and resource-based view in the particular context of high tech industries.

The findings have also practical implications for entrepreneurship managers, investors and stakeholders. The observation that technological resources can be a source of revenues if managed by experienced entrepreneurs in the same industry provides further insights on the assessment of new ventures. Similarly, the results also provide a further understanding on the limited value of other resources such as work experience, in general, in rapidly changing contexts like the high tech manufacturing industry.

C. Limitations and further research

There are limitations in the study, as well as opportunities for further research. First, the measures used to study the constructs have been captured by interviewing the owner/entrepreneur of the firms, there is no third party assessment on the experience of the entrepreneur, or an evaluation of the market-value of the different patents or other resources. Second, although we have narrowed our research to a specific industrial context to control for other sources of heterogeneity, this also means that to strengthen the implications, this study should be replicated in other high tech industries, and even in other geographical contexts such Europe or Asia. Third, this research industry insights come from a specific period of time, the fast-changing nature of high tech industries would make it interesting to test whether the competitive dynamics have changed or stayed as in our temporal setting. Last, we could explore alternative measures to the different constructs under study, aiming to confirm these initial findings and make further generalizations.

VI. CONCLUSIONS

New entrants in high tech industries are subject to the complexity and uncertainty of the technology markets with the additional burden of having limited resources. This research
provides additional understanding on how some firms despite having limited resources manage to establish position and grow.

The analysis of different resource positions’ influence on the growth of new high tech firms provides a much needed insight on how human capital, technology and market resources contribute and interact to impact these new entrants perform in such dynamic markets.

This study provides empirical support to the positive influence of specific combinations of human capital, as well as on the complementary effects of technology resources. Nevertheless, it does not capture positive direct impact from market resources, suggesting that the technology intensity of the industry favors a technology-centric approach to market creation and growth.

The findings provide insights to both technology entrepreneurs, and entrepreneurship stakeholders as it evidences the influence across time of specific combinations of resources.

ACKNOWLEDGMENTS
The authors wish to thank the Kauffman Foundation for providing access to the NORC Enclave for the Kauffman Firm Survey. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Ewing Marion Kauffman Foundation.

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