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Social Capital and the Linkages of High-Tech Companies to the Military Defense System: Is there a Signaling Mechanism?

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ABSTRACT. This study investigates linkages of new Israeli high-tech companies to the military and defense system. We examine the impact of social capital, signaling, and learning spillovers on resource acquisition in terms of investments and the financial performance of companies with and without linkages. Social capital, signaling, and learning spillovers are examined as they impact individual and organizational resource acquisition and performance of 200 new Israeli high-tech companies. The study contributes to the existing literature of entrepreneurship by suggesting the relevance of knowledge spillovers, signaling theory and social capital to the context of the interface between defense and civilian spheres.

KEY WORDS: high-tech companies, linkages with military and defense systems, signaling, social capital, venture performance.

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1. Introduction

New organizations suffer from a liability of newness, which leaves them more susceptible to institutional pressures, enhancing weaknesses due to limited experience and legitimacy, and constraining access to resources (Stinchcombe, 1970; Aldrich and Fiol, 1994). Some research suggests that new firms aiming to attract potential stakeholders (such as venture capitalists and other sources of financing) might use linkages with prestigious agents as sources of signaling their attractiveness. Smaller, start-up organizations, due to the information asymmetry that characterizes them, need to solve these asymmetry problems for their potential investors (Certo et al., 2001). Thus, for example, an independent board structure can signal the presence of an effective monitoring mechanism, thereby enhancing firm value (Deutsch and Ross, 2003). They also need to compensate for their comparative lack of experience, reputation, and access to networks, as compared to more experienced and established firms.

In our study, we apply the notion of the signaling role of linkages with prestigious outside agents, to the case of entrepreneurial firms in Israel with and without linkages to the military and defense system (MDS). We examine the impact of these linkages on the investments raised by the firms and on firm performance.

The role of the military has historically been a critical factor in government-supported R&D, and the issue of civilian spillovers continues to be a major topic of interest (Kash, 1989). Military R&D has generated a wealth of contemporary civilian industries, including commercial aircraft, computers, semiconductors, microwaves, radar,

satellites and nuclear energy, although examining to what extent military R&D accounts for the proliferation and emergence of these industries is no easy task (Rosenberg, 1987). Leslie (2000) emphasizes the important role of the military and the Department of Defense in the formation of the Silicon Valley. He claims that the Department of Defense was the original angel of the Silicon Valley, as military contracts put many companies in business and helped companies like HP to expand. Later on, companies like HP served as models for a subsequent generation of start-ups and spin-offs.

Similar to the USA, and unlike most other high-technology environments, the Israeli military accounts for the majority of government R&D expenditure. Unlike the US, however, it has a tradition of operating in an innovative, cost-efficient manner (Honig, 2001). Employees of Israeli military R&D firms seem to demonstrate considerable entrepreneurial behaviors that may account for a vibrant and robust industrial environment (Azulay et al., 2002). Thus, the Israeli military (Israel Defense Forces, or IDF) is often credited with playing a major role in the creation and sustained success of the Israeli high-tech industry (Breznitz, 2002).

With the exception of Breznitz (2002), few studies have systematically examined the impact of the individual and organizational linkages with the military and defense system on venture performance. Breznitz' study focused on the long range effects of the membership in a specific military software unit upon its graduates and upon the software industry in general. We build on this by examining a wider range of industries, and by comparing variables related to both institutional signaling and knowledge transmission.

This study raises two research questions:

Do linkages of the companies with the MDS affect the ability to obtain startup capital?

What type of linkages best impact performance, such as sales revenues?

In order to shed some light on these two questions, we examine the role of linkages in providing both signaling and learning spillovers between entrepreneurial firms and the military defense system (MDS). We compare high-tech Israeli firms that vary according to a range of factors, including social capital, signaling, and knowledge spillovers, measuring both their comparative success and their ability to attract resources. Our research sample consisted of the team members of 200 young high-tech firms from many sectors, such as electronics, software, medical equipment, communication, etc.

Our findings largely support our hypotheses. Firms that were producing products for the defense industry had much greater access to capital. This suggests that for investors, including institutional investors, who seek promising opportunities, a firm's linkages with the military and defense system may serve as an important signal of promising performance. These signaling effects may be helpful to new technological start-ups that have not yet proven to be viable. We found that firms that were suppliers to the defense sector had also better performance. Aspects of military experience were influential in both attracting capital, and in performance.

We begin with a discussion of the Israeli environment, followed by theoretical issues related to social capital, knowledge diffusion, and signaling theories, also presenting our research hypotheses. We follow with an examination of the descriptive aspects of new high tech Israeli ventures, including the military background of entrepreneurs and their linkages with the defense sector. After discussing our findings of defense related relationships, we conclude with a discussion of defense linkages and the implications for theory, policy making, and further research.

1.1. *The Israeli environment*

Israel has received considerable recognition for its growing high-tech sector, encompassing as it does thousands of new technological start-ups that have appeared during the last decade (Trajtenberg, 2000). Israeli companies represent the third largest numerical component of the technology oriented Nasdaq stock exchange (after Canada), representing 20% of all Nasdaq listed foreign companies. The capital market has also recognized the importance of Israeli start-ups: between 1998–2000, there was more per-capita venture capital in Israel than in any of the

other 24 countries participating in the GEM study (Reynolds et al., 2001).

The Israeli military (IDF) is often credited with helping to create and sustain the success of Israeli high-tech industry, and that military R&D nourished the emergence of Israel's technology-based industries and propelled civilian technology-based firms to their present status (Honig, 2001). Israeli key informants for the GEM study noted R&D transfer from the military to the civilian sector as a crucial factor behind the progressive development of technological entrepreneurship in Israel, in that the accumulated technological know-how and the well-trained scientists, engineers and technicians in various fields have contributed to the development of Israel's high-tech industries (Lerner and Avrahami, 2000).

Another frequently expressed opinion is that certain patterns of military service, especially among members that served in special technological units, provide highly functional resources assisting individuals who start new technological ventures (Honig, 2001). Levy (1997) as well as Azmon and Izraeli (1993) claimed that the military service in the IDF is a formative period in the life of Israel's young people and a source of personal status, and that the cultural codes, the social relations, the values and customs acquired in the army have a profound influence on the career of many Israelis. The important role of the military establishment in Israeli society attracted our interest regarding the influence of social capital accumulated in the MDS and its potential signaling and spillover effects in the resource acquisition process and performance of high-tech firms.

Recently, Megiddo (2005) claimed that the heavy government investment in defense technology created, as a by-product, a cadre of experienced, well-educated engineers. These individuals were said to benefit from previous multi-billion dollar investment in Israeli defense, and that many of the achievements of the medical technology ventures in Israel can be related to their linkages with the military defense system (MDS). Breznitz (2002) focused on the role played by the Israeli military in creating and sustaining the highly innovative and internationally competitive Israeli software industry. Breznitz argued that although the state of Israel did not create the prestigious military software center (MAMRAM and its School) in order to shape and sustain the Israeli software innovation system, MAMRAM had a significant impact on the creation and development of the industry in Israel, and on its continuing success. His study showed that graduates and reserve personnel of a prestigious software unit create a dense network of knowledge, recruitment, and venture capital. This network not only lowers the transaction costs associated with doing business throughout the Israeli software industry, but it also enables its members and their companies to tackle and solve R&D problems that are beyond their present knowledge or skills (p. 6). Furthermore, the IDF's policy of not seeking property rights or patents on technologies developed under its sponsorship serves to promote knowledge spillovers and diffusion from the military to civilian commercial application. Accordingly, military graduates freely transfer technology to the civilian market when they finish their service period, representing a rather unique model in public policy terms. In addition, other positive effects lie in the experience gained by the MAMRAM management personnel. Not only do participants learn how to manage their units under constraints, with tight budgets and deadlines, they also have the unique experience of working with a very high quality workforce and of managing, while still in their early 20s, some of the most experienced personnel from private industry. It should be noted that mandatory induction in Israel yields a more diversified and perhaps talented labor pool than provided by military organizations in countries that rely primarily on volunteer and professional personnel.

1.2. *Theoretical perspectives and hypotheses*

Our underlying premise in this study is that high-tech companies having linkages with military and defense systems benefit from these linkages in numerous ways, including knowledge transfer, institutional legitimacy, and positive network effects. Three theoretical perspectives provide the rationale for our expectation: The first is *social capital* theory, the second

is *signaling theory*, and the third is *knowledge diffusion and spillover effects*.

We suggest these effects combine by using Bourdieu's notion of the multifarious capitals (Bourdieu, 1986a, b, 1987; Fine, 2001). Their combination provides us with a conceptual framework for the development of our research hypotheses that are tested empirically in the context of the Israeli high-tech sector.

1.3. *Social capital in the resource acquisition process*

A considerable body of literature points to privileges enjoyed by entrepreneurs in the mobilization of resources, through social capital derived from their backgrounds and networks (Brush and Green, 1998; Green et al., 1999; Leana and Van Buren, 1999; Davidsson and Honig, 2003). From an entrepreneurial perspective, social capital provides networks that facilitate the discovery of opportunities as well as the identification, collection, and allocation of scarce resources (Birley, 1985; Greene and Brown, 1997; Uzzi, 1999). Social capital is multidimensional, it may be structural or relational, and occurs at both the individual and the organizational levels (Nahapiet and Ghoshal, 1998). It is often operationalized through the identification of networks and network relationships, sometimes defined by the strength of ties, repetitive group activity such as the frequency of meetings and other formal interactions, as well as informal gatherings and other social activities, including social and family relationships. Since we draw on Bourdieu's (1986a, b, 1996) ideas, we detail some of his contributions on social capital.

For Bourdieu (1986a, b) capital, with its various manifestations, is understood as a social construct, not least in its meanings as well as in its effects (Fine, 2001, p. 55). Capital for Bourdieu can be treated as if open to projection, both across various aspects of capitalist society as well as to other modes of production (Fine, 2001, p. 17). This leads Bourdieu to posit a variety of types of capital, in other words, multifarious capitals, divided into a number of broad categories – economic, cultural, social and symbolic. Cultural capital is typically marked by socially but differentially recognized and constructed qualifications, not least those formally given by education but also other forms of social attainment to which rank might be attained. Symbolic capital is represented by prestige, as in honor (Fine, 2001, p. 55). The place reserved for social capital is one focused on the context of social connections or networks (Bourdieu, 1986b, p. 248, 1996, p. 361). For example, the networks of relations embodied within large-scale corporations may give rise to a concentration of symbolic capital (Fine, 2001).

Bourdieu also claimed that capitals are fungible, in that various types of capital can be understood as assets that are subject to cycles, generate returns, are distributed, acquired and inherited. Equally, there is accumulation, preservation (or depreciation), and transformation of the different types of capital (Bourdieu, 1987, p. 4). Also, Bourdieu was concerned with the relationship between the various types of capital and of how one can be converted into another (Bourdieu, 1986a, b). He used exact analogy with the conversion of one form of economic value to another, as in the 'exchange rate' or 'conversion rate' among different forms of capital and power (Bourdieu 1996b, p. 265). Bourdieu claimed that diverse forms of capital are not detached from their social context but they are possessed by individuals, in particular private property and economic capital (Fine, 2001, p. 57).

In the context of entrepreneurship, new ventures and small firms differ markedly from large corporations in terms of the links they maintain (Acs and Audretsch, 1990; Pennings and Lee, 1999). Small firms are more likely to develop bonds of trust and mutual adjustment with external actors such as suppliers and clients, although the conditions give rise to arm's length relationships. Much research on the resource mobilization process also reflects a social embeddedness approach, emphasizing the importance of founders' social ties in constructing a firm's base of financial, physical, human, and other resources (Green et al., 1999). The concept of embeddedness suggests that economic activities are heavily rooted in social structure and relations. Granovetter (1973, 1985) observed that at all levels of firms where transactions take place, corporate conduct is connected by net-

works of personal relations. Because much economic behavior is closely embedded in networks of interpersonal relations, weak ties provide an advantage by expanding networks and information that would otherwise be inaccessible or costly (Burt, 2000).

In contrast to the weak ties argument, Fukuyama (1995) emphasized the value of "strong ties" among individuals within cohesive bounded social networks or communities. The importance of intra-organizational trust derived from strong ties has been noted in, for example, the diamond market and ultra-orthodox Jews (Coleman, 1988) and among members of rotating credit associations (Coleman, 1990). Whether it reflects strong or weak ties, social capital accrued by the founders and teams of high-tech companies are predicted to facilitate economic activity.

Green, Brush and Hart (1999, p. 106) describe a leveraging process whereby entrepreneurs leverage individual, human and social resources to acquire and build organizational, physical and financial resources. This is a cyclic process in that the human and social resources are posited to affect the development of other resources.

Following this argument, we suggest that those firms having social capital originating in the linkages with military-defense systems, would benefit from these linkages during the process of resource acquisition. Therefore, we expect them to attain more financial resources than other firms with no such linkages.

1.4. *Signaling and resource acquisition*

At the heart of signaling theory is information asymmetry (e.g., Spence, 1974). "Economic agents frequently must counteract with each other without the full information about important characteristics of the other party. For example, buyers may not know the quality of the product a seller offers, employees may be uncertain about the quality of a prospective employer's work environment and investors may have little knowledge of the likely profitability of a new company. These informational asymmetries may lead to market failure. When markets are vulnerable to this kind of failure, it is in many parties' interests to find ways to communicate the missing information" (Deutsch and Ross, 2003, p. 1004).

Due to the information asymmetry that often characterizes smaller start-up organizations, they frequently need to solve knowledge gaps for their potential investors (Certo et al., 2001). For example, an independent board structure can signal the presence of an effective monitoring mechanism, thereby enhancing firm value.

In the case of new entrepreneurial high tech firms, signaling is particularly relevant, as many of these organizations are established on the basis of new teams, often with no previous entrepreneurial experience. Despite the fact that investors rate the importance of the team as one of the most critical criteria for investment (Macmillan et al., 1985) they may have difficulty accessing this experience due to the lack of systematic information regarding the track record of a new start-up team (Zacharakis and Meyer, 1998). As a result, entrepreneurs must draw from and build new relationships and networks on the basis of previous organizational roles and positions. Reputation and trust affect their ability to use social capital instrumentally (Green et al., 1999). Thus, the importance of creating a signaling effect for entrepreneurial firms includes their access to limited and valuable resources. For example, Deutsch and Ross (2003) highlighted the signaling role of directors for entrepreneurial new firms. These authors state that because a firm's reputation determines how willing others are to deal with the firm (and on what terms), the firm cares a great deal about cultivating the right reputation. Since, because of their lack of history, new firms cannot build their reputation on past actions, they may attempt to "rent" the reputations of other agents to enhance their own legitimacy and positions in the market. In their study, the superior entrepreneurial firms "rent" the reputation of prestigious outside directors to separate themselves from other firms by attempting to attract stakeholders crucial for their survival. Consistent with signaling theory, high-value IPO firms may seek mechanisms for communicating their high quality to potential investors (Certo et al., 2001).

In this study, we apply this notion of the signaling role of prestigious outside agents for

entrepreneurial new firms aiming to attract potential stakeholders (such as ventures capitalists and other sources of financing) to a different area of the interface of military and civilian spheres. We apply it to the examination of the potential signaling role of the linkages with the military and defense system (MDS) that some of the Israeli firms have and others have not. In such cases, we contend that linkages with prestigious agents, as the military and defense systems in Israel may be used as a signaling mechanism for investors of the greater future potential of those high tech companies that established various linkages with the MDS. Such linkages may assist entrepreneurial new high-tech firms, signaling that their relationships with the MDS signify their high potential, (e.g. technological innovative capacity), to gain the support of potential financing sources (venture capitalists, government agencies), even in cases when they have not yet completed products.

Applying this line of argument to our case of the linkages of new high tech companies with the MDS, does not necessarily assume improvement of human capital or greater future performance of firm as result of their use of the signaling mechanism. Rather, it points to the symbolic and social significance of obtaining such signaling linkages, that is, the legitimization and recognition provided for those involved in investment decisions. This approach does not assume a positive relationship between such linkages and performance.

Recently, Breznitz (2002) argued that the military should be viewed not only as mechanism for producing highly-trained professionals in the software industry, and as a source of new technologies via various spin-offs, but also as one of the main nodes in the national innovation system that diffuses information, spurs collective learning, and creates standards for the entire industry. Given the social structure of Israeli society, where the military and the defense system play a major role in shaping national culture (Gal, 1986; Moskos and Wood, 1988; Ben-Eliezer, 2001), we predict that the social capital formed during military service will positively impact the resource acquisition of Israeli new technology-based ventures. However, these social relations and their signaling effects would not necessarily lead these firms toward better performance. Rather, we aim to point to the possibility of translating social relations and symbolic capital accumulated in the military and defense system to the process of entrepreneurial resource acquisition. Although this argument is not necessarily limited to high-tech companies, we focus on the resource acquisition and performance of new high-tech ventures that typify globalization and the new economy.

In this study, we utilize an organizational view arguing that the creation of an organization is not just an individual enterprise. Rather, we view it as a collective, network-building achievement, centering on the inception, diffusion, and adoption of a set of ideas among a group of people who become committed and transform their ideas into a social institution (Van de Ven et al., 1984, p. 95). Following this notion, we maintain that the creation of many Israeli high-tech start-ups is embedded in networks of people who developed work relationships during their military service, where they became committed to the idea of establishing a new venture. Not only the team, but also the innovative technological ideas, may be derived from the technologies with which they became acquainted during their military service.

The basic argument proposed is that entrepreneurs having linkages to the military and defense establishment can benefit from these linkages in the following areas:

- Acquiring and mastering advanced technologies
- Producing ideas for new products
- Acquiring know-how in the efficient management of technological projects
- Locating suitable human resources for establishing high-tech companies
- Identifying appropriate suppliers
- Identifying customers for the companies' products.

1.5. *Knowledge spillovers and diffusion*

The learning process, which eventually determines the strategic direction of the organization, occurs from the very outset of organizational

development, and is particularly relevant to nascent activities. It is during early formulation and emergence that the business opportunity is located, resources are accumulated, products conceptualized, markets identified, and the fundamental building blocks of the organization formed. This learning process allows the nascent entrepreneur to integrate environmental, organizational, and individual processes into something that resembles strategic value (Gartner, 1985). Thus, the importance of knowledge diffusion to a new firm is often critical, as it provides a source of competitive advantage that is not only difficult to duplicate, but also sets the organizational tone and character of the new firm. Technological spillovers are one important source of such knowledge diffusion. A ''technology spillover occurs when the activities of one firm lead to improvements in the technology or productivity of another firm such that the first firm cannot capture all the quasi-rents created by its productive activities. Technology spillovers are informal, nonmarket transfers that occur involuntarily'' (Eden et al., 1997, p. 58).

Before a technology is widely known, lack of information about the benefits and costs imply uncertainty and may discourage existing firms from adopting the technology. There are a number of ways that the technology of one firm can spillover to other firms within their environment. One is by demonstrating the feasibility of a technology. This may entail social, institutional, and political forces, as well as path dependant and standardization factors (David, 1986; Hargadon and Douglass, 2001). It may be particularly difficult when the new technology entails a paradigm shift (Christensen, 1997), as existing firms may be unable or unwilling to accept the new technology. Proven acceptance in an arena outside the intended usage domain, as when military technology is transferred to very different civilian uses, may be one method in surmounting the considerable social, organizational, and market barriers that exist for new technologies. Technology should spread most easily when the producer and potential user are already in contact and the linkages already exist. Technology diffusion happens easiest when the parties are geographically and operational proximate (Poire, 1990).

Learning-by-doing, referred to as tacit knowledge, in comparison to explicit knowledge, occurs rapidly when linkages among firms promote the adoption of common routines, industry norms, and acquisition standards (Polayni, 1967). Spillovers may also occur when technologically-superior firms train local employees in tacit knowledge. Once trained, these employees may be subsequently hired by technologically-inferior firms, and diffuse superior technology. Further, highly-trained local employees may feel compelled to apply their new-found expertise to entrepreneurial ventures, which further diffuses knowledge throughout local markets.

Carlsson and Mudambi (2003) recognize the importance of location and situation regarding R&D investment. A similar argument is made by Poire (1990) in describing Italian industrial networks. This is because R&D –intensive activities tend to be associated with a highly skilled workforce and high value-added activities. Carlsson and Mudambi (2003) highlight the importance of R&D-intensive operations and the presumption of ''spillovers'', i.e. benefits that flow from a particular firm or unit to other firms or units in its proximity. In the literature, R&D spillovers have typically been modeled as occurring in a relatively deterministic and uncontrolled manner (De Bondt, 1997; Eden et al., 1997). However, it is possible that a significant percentage of spillovers actually occur as a result of conscious networking rather than random chance. Carlsson and Mudambi (2003) claim that if conscious networking is the predominant determinant of spillover levels, then the optimal strategy involves viewing the industry or activity as a system and working towards facilitating system development and growth.

Thus, the evolution of technological R&D networks may be somewhat systematic - or, at least, a path dependant process (David, 1986; Carlsson and Mudambi, 2003). Firms at the core of a network enjoy a strategic advantage due to speed and quality, while others in the network either create or acquire knowledge gradually, as the network expands and information is diffused.

1.6. *Hypotheses*

Based on the three conceptual arguments presented above, that of the social capital of entrepreneurs, the signaling mechanism derived from defense-related linkages, and knowledge spillovers and diffusion, we suggest the following hypotheses regarding the potential correlates of the linkages of high tech companies in Israel with the MDS:

H1a: High- tech companies having linkages providing social capital with the military and defense systems attain increased resources in comparison with other high-tech companies that do not have defense-related linkages.

We propose that the linkages of the entrepreneurs of high tech companies with the military and defense systems would be related positively to the resource acquisition of the companies, in particular to their acquiring investments.

As with H1a regarding investments, we expect, in H1b, that the linkages, controlling for signaling and spillover effects, will be related to the companies' financial performance.

H1b: High-tech companies having defense-related social capital linkages will demonstrate better business performance in comparison to other high- tech companies that do not have defense related linkages.

Regarding signaling effects, we anticipate a positive relationship between signaling and both obtaining investment capital and performance, as follows:

H2a: High-tech companies having defense-related signaling attributes are more likely to obtain investment capital.

H2b High-tech companies having defense-related signaling attributes are more likely to demonstrate better performance.

H3a: High-tech companies having defense-related knowledge spillovers are more likely to obtain investment capital.

H3b: High-tech companies having defense-related knowledge spillovers are more likely to demonstrate better performance.

2. Methodology

The research sample consisted of the team members of 200 young high-tech firms who had completed a detailed questionnaire. The research population was obtained from a list of all the firms in technological industries established in Israel between 1990 and 1998 (prepared by BDI -Business Data Information). All the 950 technological companies which were included in the list were approached; 26% of them were not accessible for lack of correct contact information. Of the remaining 800 firms, 35% completed a questionnaire and returned it by fax. Of the 279 questionnaires received, 200 were fully completed and 79 were partially completed. The sample consisted of entrepreneurs drawn from many high tech sectors, such as electronics, software, medical equipment, communication, etc. We collected annual sales data for 150 of the 200 firms, and data on capital investments for only 126.

Data were collected by the Interdisciplinary Center for Technological Analysis and Forecasting at Tel-Aviv University at the end of 1998. In order to assure the randomality of the research sample, we compared the distribution of the whole population of firms in the BDI list (800 firms) with that of the firms in the research sample (200 firms). In both distributions the dominant industry was software, followed by communications. Comparing the number of employees in the sample and in the population of firms in BDI list, it was found that the average number of employees in the sample was larger (33.4 vs 28.5 employees). The sample firms were also on average a bit older than those in the full list of firms, though the difference was less than one year on average.

We performed summary information from the entire set of 200 respondents. We further analyzed a sub-set of the population that provided performance data ($n = 150$) using both correlations and OLS regression.

2.1. *The questionnaire*

The questionnaire consisted of several parts: (1) The characteristics of the team of entrepreneurs;

(2) The firm's characteristics; (3) The linkages with the military and defense system; (4) The venture's performance. Due to the difficulties in obtaining reliable data on the performance of start-ups, researchers have emphasized the importance of using several measures of performance (Kuratko and Hodgetts, 1995; Cooper, Gimeno-Gascon and Woo, 1994). We also examined the characteristics of the founding team, including their human capital assets and characteristics of the firm that have been previously examined with regard to their impact on performance (e.g., Chandler and Hanks, 1993), though they are not at the focus of this study.

2.2. *The variables*

Our dependent variables are (1) firms' acquisition of financial capital and (2) firms' annual gross sales. The independent variables are their linkages to the defense system. We also incorporated in our examination control variables: firm age and size (number of employees) that are known to influence the firm performance.

2.2.1. *Dependent variables*

(1) *Size of accumulated financial capital invested in the company* was based on four categories ranging from 1 – up to 4 (1 – One millon U.S$ to 4 = above $4 million) Category medians were used in the regression analysis.

Types of financing that the company received: (1) startup capital; (2) venture capital; (3) private investors; (4) capital raised on the stock market (Yes/no for each of these items).

(2) *Annual gross sales* as a performance measure were determined from 7 categories ranging from 1 – no sales yet to more than 51 M$. Category medians were used in the regression analysis. We requested expected annual estimates for the year of the study. As the questionnaire was completed in November, we were satisfied that the firms would have a relatively informative basis to estimate their current annual gross sales. Thus, the main measure chosen to analyze performance was anticipated annual sales.

2.2.2. *Independent variables: linkages with the defense system*:

2.2.2.1. *Social capital variables*

Team of founding entrepreneurs – Number of entrepreneurs who established the company

Length of military service: Number of years of military service of the entrepreneurs – 5 categories: (1) did not serve; (2) served up to 3 years; (3) 4–6 years; (4) 7–10 years; (5) served more than 11 years.

Military officer rank of at least one of the founding entrepreneurs (yes/no).

Responses to the question "Whether the linkage of the entrepreneurs with the military and defense system helped the firm" in each of the following four areas: (1) Locating good staff. (2) Locating customers for the firm products. (3) Locating suppliers. (4) Project management experience. Responses were given on a 5-point Likert scale ranging from 1– not at all to 5 – to a great extent.

2.2.2.2. *Signaling variables*

Engagement in R&D during military service of at least one of the founding entrepreneurs (Yes/no).

Service in special prestigious professional units of at least one of the founding entrepreneurs (Yes/no).

Company a supplier to the military defense system (yes/no).

Product developed for defense sector (yes/no).

2.2.2.3. *Spillover variables*

Ideas for new products derived from the military defense system: Responses were given on a 5-point Likert scale ranging from 1 – not at all to 5 – to a great extent.

Acquiring knowledge and expertise in the relevant technologies from the MDS: Responses to Likert scale ranging from 1 – not at all to 5 – to a great extent.

Product derived from military technology: 1 – not at all 2 – partially 3 – to a great extent).

2.2.3. *Control Variables*

2.2.3.1. *The characteristics of the business*

Age of the venture

Firm size measured by the current number of employees.

Registered patents owned by the company (yes / no).

2.2.3.2. *Human capital and demographic*
We included the following variables to study factors relating to both human capital and demographic characteristics of our population:
Educational level of the entrepreneurs
Professional area of the entrepreneurs; Previous experience in establishing a startup; Previous industrial experience of the entrepreneurs; Entrepreneurs' age.

2.3. *Descriptive statistics*

Summary characteristics for all the firms responding are in Appendix 1. Most of the sample firms were software enterprises (about 38%), communications enterprises (21%). The remaining firms were in the medical equipment sector (12%) and in electronics and components (11%) and others (17%). Most of them (about 40%) were 4 up to six years old, and only about a quarter (24%) of them were 1 up to three years old. 25% were 7 up to 9 years old, and 11% were more than 10 years old. Most of the firms were already at the initial sales stage or the full sales stage (over 70%), and only about a quarter of them were still at the R&D stage. The average number of employees per firm was 28.2, and the median was 17. Summary characteristic for the entrepreneurs are in Appendix 3.

3. Findings

Linkages with the military and defense systems are presented in Table I. It shows that in more than half of the firms there are entrepreneurs who served more than 3 years in the army (which is the compulsory service, into which actually everyone is conscripted at age eighteen). In 57% of the firms there are entrepreneurs with the rank of officer. In close to one-third of the firms there are entrepreneurs who engaged in R&D during their military service. In 17% of them there are entrepreneurs who carried out their military service within the framework of elite academic programs for especially talented recruits. In 27% of the founding teams of the firms there are entrepreneurs with previous experience in the defense sector.

3.1. *Organizational linkage of the enterprises*

The contribution of military service to the technological infrastructure of young high-tech firms on which entrepreneurs are prepared to speak openly[1], is limited. Only 9% of the firms acknowledged that their products were based on military technology, the remaining 91% answering "not at all", in response to the direct question "To what extent is the product based on military technology?". However, Table II shows that 20% of the entrepreneurs noted that their relationship with the military

TABLE I
The Entrepreneurs' military service characteristics

	% in sample	N of firms
Length of entrepreneurs' military service[a]		
Did not serve	14.6	29
Up to 3 years	63.6	126
4–6 years	33.8	67
7–10 years	10.6	21
11 and more years	8.6	17
Military rank		
% of ventures in which at least one of the entrepreneurs was an officer	56.8	108
% of ventures in which at least one of the entrepreneurs served in R&D in the army	32.8	65
% of ventures in which at least one of the entrepreneurs served in elite academic units in the army	16.7	33

[a]The total percentages is higher than 100%, because the question related to several entrepreneurs in the company.

TABLE II
Perceived contribution of the linkage of the entrepreneurs to the military and the defense system

Area of contribution	Not at all	Partially	To a great extent
Coming up with ideas for new products	84.7	8.3	7.0
Achieving relevant technological knowledge	80.1	9.0	10.9
Achieving know-how of project management	80.8	9.6	9.6
Locating staff	81.4	11.5	7.1
Locating suppliers	86.5	7.7	5.8
Locating customers	89.1	5.8	5.1

helped them, to a certain extent, acquire relevant technological knowledge. The relationship of the entrepreneurs to the military and the defense system also helped 15% of the firms to come up with ideas for new products and to recruit human resources (19% of the firms). Beyond that, 24% of the firms are suppliers to the defense system.

Next, we examine the sources and character of finance for the new ventures (See Appendix 2). The most common form of financing was from private investors (about 70%); 27% of the firms were financed by venture capital funds and only 9% of them raised capital on the stock market. Twenty-eight percent of the firms received no support whatsoever from governmental aid programs. About 40% received R&D support grants from the Office of the Chief Scientist at the Ministry of Industry and Trade, 27% were supported by the overseas marketing fund, 18% obtained help under the Law for Encouraging Capital Investments, and only 8% received help within the framework of the governmental incubator program. 11% received funding from the Bird Fund – a high visibility fund sponsored mutually by the US and Israeli governments.

In close to 40% of the firms, more than 90% of the shares were still held by the founding entrepreneurs, and in only 30% of the firms were 30% or less of the shares still held by the founding entrepreneurs.

Table III shows a correlation matrix of the variables used in the study. The two performance measures were: annual gross sales, and size of accumulated capital invested in the company.

Table III reveals that the organizational linkage items were positively correlated with the investments: Thus, the items that ''the company is a supplier of the defense system'' and ''the product was developed for the defense sector'' were significantly and positively correlated with investments (0.23*, 0.24*). The item of ''the product derived from military technology'' was significantly and positively correlated with annual gross sales (0.18*). When we examine the personal linkage variables we find that investments were positively correlated with the item ''at least one of the founding team had military service in R&D'' (0.21*). Table III also shows that annual gross sales are correlated positively with age of venture (0.33**), number of employees (0.77***).

The main objective of the regression analyses was examine whether social capital, signaling, spillovers, and linkages with the military and defense system would retain their impact on the dependent variables, investment and annual sales, controlling for variables such as number of employees, age and team characteristics. The results of four regressions are presented in Table IV:

Two models were run with and without the control variable, firm size. We did this because size is arguably interact with both of the dependent variables, and we wanted to examine the relationships both with and without this as a control variable.

The first equation, including firm size, shows the regression of investment capital obtained has a statistically significant F of 2.85 and an adjusted R^2 of 0.25. Two variables in the equation provide statistically significant coefficients. Our individual defense related variable, having an entrepreneur who worked in military R&D previous to starting the venture, had a positive and significant coefficient in the model (0.25). Being a supplier of the defense sector was a significant predictor of obtaining capital, with a

TABLE III
Matrix of correlations of variables means, standard deviations, and correlation coefficients for High-Tech Israeli Startups

	Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Age of venture	4.9	3.3																		
2	Number of current employees	2.3	1.2	0.29**																	
3	Company has patents	1.4	0.49	0.11	−0.10																
4	Locating good staff	1.4	1.0	0.10	0.03	−0.09															
5	Locating customers	1.3	0.86	0.04	−0.08	−0.02	0.51**														
6	Locating suppliers	1.3	0.90	0.09	0.04	−0.03	0.66**	0.73**													
7	Project management experience	1.5	1.1	0.05	0.10	−0.06	0.70**	0.61**	0.59**												
8	Length of military service	0.31	0.46	0.03	0.03	−0.07	0.12	−0.01	−0.01	0.12											
9	Product derived from military technology	2.8	0.37	0.11	0.23***	0.07	0.40**	0.10*	0.23**	0.27**	0.01										
10	Company supplier of defense system	0.24	0.42	0.24*	0.01	0.25**	0.04	0.19*	0.34**	0.00	−0.4	0.04									
11	Product developed for defense sector	0.09	0.29	0.01	0.03	0.08	0.10	0.13	0.05	−0.02	0.03	0.04	0.24**								
12	Number of founding entrepreneurs	0.23	1.2	−0.07	−0.02	−0.00	0.04	−0.04	0.04	0.00	−0.40	0.06	−0.03	0.03							
13	Locating ideas for new products	1.40	1.00	0.12	−0.07	−0.07	0.40**	0.14	0.64**	0.57**	0.04	0.28**	0.26**	0.06	0.05						
14	At least one served in a profess. unit	0.18	0.38	−0.03	0.06	−0.21**	0.27**	0.12	0.06	0.35**	0.28**	0.05	−0.03	0.03	0.12	0.24**					

15 At least one had R&D military service	0.35	0.47	−0.6	0.05	0.01	0.19*	−0.01	0.06	0.25**	0.27**	0.07	−0.02	0.03	0.15*	0.16*	0.52**				
16 At least one of the founding team has the rank of officer	0.57	0.50	−0.04	0.11	−0.01	0.25**	0.14	0.22**	0.24**	0.43**	0.14	−0.04	0.00	0.20**	0.15	0.36**	0.36**			
17 Knowledge of relevant technology	1.5	1.2	0.03	−0.04	−0.06	0.70**	0.49**	0.60**	0.71**	0.15	0.37**	0.08	−0.00	0.03	0.66**	0.35**	0.27**	0.29**		
18 Expected Sales	3.7	6.9	0.33***	0.77**	−0.06	0.03	−0.06	0.03	0.04	−0.03	0.18*	0.15	0.02	0.05	−0.04	0.14	−0.00	0.10	−0.13	
19 Investment	8.5	13.4	0.13	0.43**	0.06	0.15	−0.09	0.10	0.06	−0.05	−0.11	0.23*	0.24**	0.13	−0.02	0.04	0.21*	0.02	0.08	0.21*

$^{**}p < 0.01$.
$^{*}p < 0.05$.

coefficient of 0.20. This finding suggests that Israeli firms active in defense related product development have good opportunities to obtain investment capital. The number of current employees (size) has a coefficient of 0.45. Other studies have also shown that larger firms are more likely to attract capital than smaller ones (Cooper and Daily, 1999). Thus, H1, suggesting that companies having linkages with the military and defense systems attain increased resources (in comparison with other companies that do not have defense- related linkages) is confirmed after controlling for company age and size.

In our next regression, we leave out the control for firm size. Three signaling variables provide positive coefficients: Producing a product for the defense sector was a very strong and significant predictor of obtaining capital, with a coefficient of 0.21. Also the variable "the company is a supplier of the MDS has coefficient of 0.20 at the significance level of 0.07. This finding suggests that Israeli firms active in defense related product development have good opportunities to obtain investment capital. The third signaling variable that provides a significant coefficient is having an entrepreneur who worked in Military R&D (0.26). This finding provides some support for H2a. The findings also reveal that the defense related linkages resulted in increased resources for start-ups, as indicated by the strong positive coefficient of having a product developed for the defense sector.

Next, we move on to annual sales as a dependent variable. The model examining the regression of annual sales has a statistically significant F of 13.2 and an adjusted R^2 of 0.65. In addition to the control variable of size of the firm, four variables have strong and statistically significant positive coefficients. One of our social capital variables, locating good staff, is significant with a coefficient of 0.24. This finding lends support for upholding H1b. Two signaling variables, the entrepreneur having had service in a prestigious military unit, provided a statistically significant and strong coefficient of 0.20 and being a supplier of the MDS provided a coefficient of 0.17. This is in line with H2b. Finally, one of our spillover variables, knowing relevant technology, provided a negative and

TABLE IV
OLS regressions – Standardized coefficients – Amount of investment capital, annual sales and linkages with the defense Industry

Variables	Investment capital		Amount of annual sales	
Control variables				
Age of venture	−0.009	0.127	0.060	0.283***
	(0.405)	(0.425)	(0.132)	(0.191)
Firm size (number of current -employees)	0.450***	–	0.739***	–
	(0.037)		(0.012)	
Firm has registered patents	0.047	−0.009	−0.008	−0.099
	(2.65)	(2.913)	(0.868)	(1.308)
Linkages of venture with the defense system				
Social capital variables				
Team of founding entrepreneurs	0.126	0.106	0.051	0.014
	(1.036)	(1.144)	(0.339)	(0.514)
Length of military service	−0.075	−0.090	−0.088	−0.113
	(2.988)	(3.302)	(0.976)	(1.483)
Military officer rank	−0.106	−0.063	0.064	0.134
	(3.003)	(3.307)	(0.981)	(1.485)
Locating good staff	0.144	0.008	0.237*	0.014
	(2.291)	(2.92)	(0.749)	(1.119)
Locating customers	−0.050	−0.153	−0.007	−0.177
	(2.451)	(2.678)	(0.801)	(1.203)
Locating suppliers	0.080	0.199	−0.110	0.085
	(2.488)	(2.714)	(0.813)	(1.219)
Project management experience	−0.121	0.081	−0.003	0.298**
	(1.907)	(2.21)	(0.623)	(0.908)
Signaling variables				
Entrepreneur worked in military R&D	0.247*	0.256*	−0.106	−0.091
	(3.127)	(3.457)	(1.022)	(1.552)
Service in prestigious academic military unit	−0.083	−0.062	0.203**	0.238**
	(4.012)	(4.432)	(1.311)	(1.990)
Product developed for military	0.158	0.212*	0.108	−0.020
	(4.295)	(4.709)	(1.403)	(2.115)
Supplier of military	0.198*	0.204†	0.173**	0.183†
	(3.275)	(3.621)	(1.070)	(1.626)
Spillover				
Knowing relevant technology	0.188	0.107	−0.338***	−.470**
	(1.891)	(2.078)	(0.618)	(.933)
Locating ideas for new products	1.61	−0.279	0.142	−0.052
	(2.095)	(2.284)	(0.685)	(1.026)
Product based on military technology	0.080	−0.034	−0.020	0.207**
	(3.777)	(4.041)	(1.234)	(1.815)
Adjusted R^2	0.247	0.79	0.649	0.190
F	2.849***	1.515	13.179***	2.639
Df	17	16	17	16
N	96	96	112	112
Constant	−12.413	0.79	−0.021	14.969
	(13.142)	(12.839)	(4.295)	(6.203)

Standard errors are in parentheses.
†$p = 0.07$.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

statistically significant coefficient of 0.34. This suggests that H3b, stating that spillovers would lead to better performance, was not upheld.

Finally, we move to the last regression, where we leave the control of firm size out of the equation. Significant coefficients include the social capital variable of project management experience (0.30) and signaling variable service in prestigious unit (0.24). Spillover variables provide both a negative coefficient for the variable knowing relevant technology (−0.47) and a positive one for the variable "product based on military technology" (0.21). All in all, it appears that H3b, stating that spillovers will result in better performance, is not upheld, as it yielded mixed results.

In summary, the regression analyses revealed the importance of conventional controls such as age and size of firm (number of employees). Hypotheses identifying the importance of social capital on performance were upheld (H1b), but not on investment capital (H1a). The signaling variables appeared to be upheld (H2a, H2b) regarding both investment and performance. Only the spillover hypotheses failed to be largely confirmed regarding the attainment of investment capital (H3a) and had mixed results regarding performance (H3b) by this analysis.

4. Discussion

The focus in this study was to examine relationships between the different types of linkages, such as social capital, signaling, and spillovers of high-tech start-ups, to the Israeli military and defense system, and their resource acquisition and financial performance. Our hypotheses pointed to the importance of embedded defense related relations. Based on social capital and signaling theory, we expected to demonstrate the strength of associations, at both the individual and the organizational levels. We hypothesized that signaling theory would support firms with linkages to the military and defense system as attractive opportunities leading to greater investments. Our results generally confirmed this expectation. We found that firms who had products developed for the defense sector were more likely to get investment capital, and firms that were suppliers of the defense sector had higher sales. We also found that when the entrepreneur had either worked in military R&D, or served in an elite military unit, there were positive effects on investment and sales respectively. Social capital and signaling were found to lead to greater investment, as well as better performance.

Thus, at the organizational level, we found that firms that were producing products for the defense industry had much greater access to capital, and also had higher sales volume. This suggests that for the investors, including institutional investors, seeking high potential opportunities, the linkages of the firm with the military and defense system serve as a symbolic signal of promising performance. This signaling effect was found to be helpful for new technological start-ups that were not yet proven viable. These findings highlight the importance of creating a signaling effect for entrepreneurial firms to attract potential stakeholders (such as ventures capitalists and other sources of financing). Our findings also suggest that linkages with prestigious agents, such as the military and defense systems in Israel, may be used as a signaling mechanism for investors of the greater future potential of those high tech companies. Such linkages may assist entrepreneurial new high-tech firms to gain the support of potential financing sources, even in cases where they have not yet completed products. It is important to emphasize that these results were found after controlling for factors that have been found to contribute toward better performance and were previously examined in the literature as performance-related, such as size of the venture and the age of the venture.

The findings in this research are related to other studies that adopted signaling theory. Deutsch and Ross (2003) studied the signaling role of directors for entrepreneurial new firms, and pointed out that because a firm's reputation determines how willing others are to deal with the firm, cultivating the right reputation is an important activity. They show how superior entrepreneurial firms "rent" the reputation of prestigious outside directors to stand out in their attempt to attract stakeholders crucial for their survival. Also consistent with signaling theory, Certo et al. (2001) argued that high-value IPO

firms may seek mechanisms for communicating their high quality to potential investors.

Applying signaling theory to the Israeli case of linkages of new high tech companies with the MDS, does not necessarily predict improvement of human capital or greater future performance of firm. Rather, it points to the symbolic and social significance of obtaining such signaling linkages, that is, the legitimization and recognition provided for those involved in investment decisions. These findings may be related to Bourdieu (1986, 1996), who points out that capitals are fungible, in that various types of capital can be understood as assets that are subject to cycles, generate returns, are distributed, acquired and inherited. Equally, Bourdieu argued that there is accumulation, preservation (or depreciation), and transformation of the different types of capital (Bourdieu, 1987, p. 4).

Prior studies point to the strategic advantage accruing to teams formed among people who have already worked together in a previous organization, and who have existing relationships of trust and common experience (McGee et al., 1995). In this study we found that many of the entrepreneurial teams surveyed included members with past military background, either in military R&D, or in professional elite units. Although we could not demonstrate the precise relationships between different team members, they appeared to be embedded in their past social relationships in the military defense system.

This study demonstrated mixed effects from spillover linkages between military technology and firm performance, although we remain cautious regarding interpretation. In Israel, access to many formal and informal networks continues to be governed by military experience (Moskos and Wood, 1988). The results show that it is not the length of service, nor the military rank that have an impact on start up performance, but rather certain patterns of military service, primarily, service in a prestigious military unit and/or service in military R&D. Given the possible interrelationships between these networks, as well as the considerable flow of human capital into and out of Israeli hi-tech firms, it may be that knowledge spillovers are so pervasive and widely distributed as to be difficult to capture by a single organizational entity. Further, it may reflect the fact that the IDF makes no attempt to capture intellectual property developed under its auspices, and allows technology to freely diffuse into the marketplace.

4.1. *Limitations and suggestions for future research*

We believe that further examination regarding the embeddedness of Israeli high-tech firms to the defense system is warranted to better understand the implications of this relationship. We were unable to document extended network relations, network strength, or network frequency. Any of these measures may have yielded strong relationships with successful outcomes. Further study is thus necessary in order for us to understand the exact nature and extent of these relationships.

A further limitation regards our lack of longitudinal data. Entrepreneurship and performance are both essentially dynamic concepts, fundamentally concerned with producing change. This suggests that a measure of successful entrepreneurship needs to examine growth and therefore should incorporate a temporal dimension. As the data were gathered at one point of time and not over a period of time, they do not provide a longitudinal picture of the development of the firms in our sample. Future study would benefit from a longitudinal perspective in order to assess if linkages to the defense system affect performance as a firm develops. This study refers to high-tech firms as homogenous and does not examine industry differences. Greater specification by industry may yield different results regarding the importance, or lack, of military embeddedness for Israeli high-tech firms. Finally, comparing military to civilian linkages using a similar methodology would significantly improve our ability to comparatively assess our findings.

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Appendix

APPENDIX 1
Characteristics of the technological firms (percentages)

Firm characteristics	Number of firms	% of the sample
The industry		
Software	73	38.0
Communication	40	20.8
Electronics	22	11.5
Medical equipment	24	12.5
Other	33	17.2
Year of establishment		
1996–1998	48	24.2
1993–1995	78	39.4
1990–1992	50	25.3
1980–1989	22	11.1
Number of employees		
1–10	60	30.9
11–25	72	37.1
26+	62	32.0
Current business stage		
R&D stage	19	10.1
Before sales	31	16.3
Early sales	70	36.8
Sales	70	36.8

APPENDIX 2
Sources of finance of the ventures

Sources of finance	Number of firms	% of the sample
Seed money	52	26.3
Venture capital	54	27.3
Private investors (angels)	136	68.7
Initial offering	17	8.6
Obtaining governmental financial support		
Incubators	15	7.6
R&D grants	84	42.2
Bird Fund	22	11.1
Marketing fund	54	27.3
The Law for Encouraging Capital Investments	36	18.2
No governmental support	55	27.8

APPENDIX 3
Entrepreneurs' characteristics (percentages)[a]

Characteristics	Number of enterprises	Percent in sample
Number of entrepreneurs in the venture		
One	54	27.8
Two	79	40.7
Three and more	61	31.5
Academic degree		
Bachelor's	102	51.5
Master's	102	51.5
Doctoral	62	31.3
Non-academic	26	13.1
Professional area		
Engineering	115	58.1
Life sciences	11	5.6
Sciences	46	23.2
Management	36	18.2
Other	19	9.6
Programming	21	10.6
Other	19	9.6
Age		
20–39	59	30.6
40–45	91	47.2
45+	43	22.3
Previous occupation/job		
Management	78	39.4
R&D	126	63.6
Marketing	38	19.2
Financing	8	4.0
Other	29	14.6

[a]For some of the items there were multiple replies, thus they may add up to more than 100%.

Notes

[1] In certain cases, veterans may be prohibited from discussing any significant details of their military service.

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