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# Are Social Networks a Double-Edged Sword? A Case Study of Defense Contractors

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## Author Biographies

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# ABSTRACT[1]

Utilizing a survey of defense contractors in the New England region, this study explores the effect of social networks on business performance—measured by annual employment growth and market diversification—during a time when defense spending in the United States was contracting. In contrast to prevailing literature focusing on entrepreneurial firms, this study offers insights on how social networks function in defense contractors, which tend to be mature firms. The main conclusion is that having more network connections is associated with faster short-term employment growth (from 2014 to 2015) for defense contractors, but there is a limit to that benefit. The analysis also shows that social networks do not aid market diversification for defense contractors. This poses an interesting challenge for defense contractors, as they need to balance the priorities of short-term growth and long-term success.

*Keywords*: social network, business performance, employment growth, market diversification

Firms that produce goods and services for the Department of Defense (DoD) play an important role in the U.S. economy. Not only do they provide crucial capacity to ensure national security, but they also support millions of jobs around the country. In fiscal year (FY) 2016,[2] for example, the total defense budget was $585 billion (in 2011 constant dollars), accounting for 3.1% of gross domestic product (Office of the Under Secretary of Defense, 2015).

Defense spending affects national and regional economies in multiple ways. Payroll for military and civilian personnel benefit businesses around military bases, installations, and government agencies when individuals spend their income at local firms such as restaurants and retail stores. The DoD also procures goods and services through defense contracts that support a significant workforce in many industries (Fuller, 2012).

Some defense contractors rely on one customer—the DoD – for a significant portion of their revenues. These businesses deriving a large share of their revenues from defense contracts face significant policy or political risks such as changes in administrations or budget priorities. Consequently, fluctuations in the federal budget can severely impact DoD-dependent businesses (Fuller, 2012).

The past two decades have been marked by a sharp buildup in defense spending followed by a decline. On the heels of the September 11, 2001 terrorist attacks and the war efforts in Afghanistan and Iraq in the early 2000s, defense spending rose from $316 billion in FY2001 to $691 billion in FY2010 (Office of the Under Secretary of Defense, 2015). Since then, defense spending has steadily declined due, in part, to the drawdown in overseas military presence. In addition, the economic recession from 2007 to 2009, the most severe one since the Great

Depression, precipitated a ballooning federal deficit that ultimately required spending reductions for all agencies in the federal government through the Budget Control Act (BCA) of 2011.

From FY2010 through FY2016, defense spending fell by 15%, from $691 billion to $585 billion, creating a challenging environment for defense contractors (Office of the Under Secretary of Defense, 2015).[3] When our study started in 2015, the expectation was that defense spending would continue to decline into the foreseeable future. Consequently, market diversification was expected to be a strategy to assist long-term growth of defense contractors (Bishop, 1995), and defense-intensive communities were interested in transitioning toward an economy less dependent on defense.

The Office of Economic Adjustment (OEA), Department of Defense, provided defense industry adjustment (DIA) technical assistance to defense-intensive states and communities to help diversify their economies.[4] In New England, efforts were made to use this grant to connect defense contractors with key players in the fields of education, research and development, venture capital, and government with a goal of helping those businesses diversify and grow.

This study is the result of efforts to understand whether social networks play a role in assisting defense contractors improve their business performance. Much of the existing literature on social networks focuses primarily on entrepreneurial firms and not mature firms that typify many defense contractors. Moreover, there is limited research on the relationship between social networks and market diversification.

This analysis is based on a survey of the defense contractors concentrated in the New England states of Massachusetts, New Hampshire, Connecticut, Rhodes Island, Vermont, and Maine. The focus of the survey, however, was firms in Massachusetts. The purpose of the study

was to answer the question of whether defense contractors could utilize social networks to improve their business performance, promote growth, and diversify.

**Social Networks and Business Performance**

Economic research on social networks has a long history that started well before the advent of the Internet and social media. Traditionally, networks are defined as a specific set of connections among a certain number of individuals or organizations (Lechner, Dowling, & Welpe, 2006). The theoretical foundation of social network research can be found at the intersection of economics, sociology, and organizational management. The common theme of this literature is that actors in the economic systems (such as firms or individuals) are not isolated or separate identities, but are connected actors (Grabher & Stark, 1997; Uzzi, 1996 , 1999).

Utilizing the concept of evolutionary economics to study post-socialist economic transition in Eastern Europe, Grabher and Stark (1997) proposed that the actual unit of entrepreneurship is not isolated individuals, but social networks that link firms and actors. Thus, ignoring social networks may reduce organizational diversity and affect success of the transition.

Similarly, the theory of social embeddedness proposes that "economic transactions become embedded in social relations that differentially affect the allocation and valuation of resources" (Uzzi, 1999). These are the mechanisms through which network ties can affect behavior and business outcomes: information transfer and joint problem-solving arrangements (Uzzi, 1996). Networks can facilitate private information exchanges, which are not public in the market place, giving participants some advantage. Network ties also allow joint problem-solving arrangements that enable actors to coordinate different functions. Burt (2004) demonstrates the difference between private and group benefits, and shows that brokerage between groups

provides a vision of options otherwise unseen that becomes social capital for individuals that can lead to positive performance evaluations and promotions. Those are private gains for individuals connecting different groups; a mechanism for those gains to affect business performance was not provided.

At regional levels, Safford (2004) has investigated the role of networks and social capital in economic development. By comparing and contrasting Allentown, Pennsylvania and Youngstown, Ohio—two cities that faced acute economic crisis in the late 1970s and early 1980s—the study addressed how the configuration of economic and civic relationships (social network) affected collective actions, thus influencing trajectories of economic change.

While many of the above studies utilized case study approaches focusing on the network effect for a single firm, industry, or region, a large volume of research implements an econometric approach aiming to quantify the impact of network effects. Much of the research concerns the roles of social networks in small and entrepreneurial firms, due to the perception that social networks involve personal connections and might be less influential in mature and well-established firms (Watson, 2007). More mature firms may be less dependent on social networks because they have developed more structured ways to acquire capital, knowledge, and resources for business development. For entrepreneurial firms, an entrepreneur's personal and social networks can potentially be their most important strategic resource, and entrepreneurs can obtain capital, knowledge, and services important to their enterprise development, thus improving firm performance (Lechner & Dowling , 2003).

For entrepreneurial firms, business performance is defined in various ways, including business survival, length of time to reach profitability, sales, and employment growth. In a study

based on interviews with 53 small- and medium-sized firms in Finland, Kalm (2012) defined business performance as revenue and employment growth. The study shows that increasing network interactions is positively associated with both revenue and employment growth. Hayter (2015) explored the factors associated with the performance of university spin-offs with a sample of such enterprises in New York. The author defined business performance as the size of employment, and concluded that the success of a spin-off is dependent on both the size and types of the entrepreneurs' social networks. Watson (2007) investigated the role of networks in firms' survival rate and revenue growth. Based on a longitudinal database in Australia, the study found a significant positive relationship between networking and both firm survival and revenue growth.

Research on the size of social networks yields mixed results. Witt (2004) found that larger networks are typically more beneficial for entrepreneurial firms. But Lechner and Dowling (2003) concluded that an entrepreneurial firm's ability to utilize its networks may grow with size, but it will eventually reach a maximum level. Therefore, too large of a network will ultimately limit its effect. Similar results of diminishing benefits as network size increases beyond a certain level were also observed by Hayter (2015) and Watson (2007), implying an inversed U-shaped relationship between network size and business performance. However, Qian and Kemelgor (2013) suggested that the effect of networks is largely negative toward firm performance measured as sales growth.

In addition to network size, research has analyzed different types of networks and their roles in start-up firms. In a study of venture-capital-backed entrepreneurial firms in Germany, Lechner et al., (2006) suggested that different types of networks play various roles in firm performance, which are defined as total sales and the speed to reach profitability. In particular,

they found a significant and positive relationship between reputational networks and the time a business reaches profitability.

Another theme of social network research is the importance of geographic dimensions of networks. Some studies claim that local networks are more beneficial to entrepreneurial firms, as knowledge spillover occurs more frequently within geographically bounded or localized networks. This localized knowledge network has long been used to explain the sustained entrepreneurial success of California's Silicon Valley (Saxenian, 1996). However, Hayter (2015), in a study of university spin-offs, concluded that extra regional networks of nonacademic contacts—including investors and researchers from other companies—give academic entrepreneurs access to a broader base of knowledge and other resources important to business success. Similarly, Patton and Kenney (2005) also highlighted the importance of extra regional entrepreneurship networks, especially in the biotechnology industry, as firms are increasingly sourcing ideas internationally.

The literature review suggests that significant empirical research has been completed on the relationships between social networks and the performance of entrepreneurial firms. There appears to be less extensive empirical research related to the role of social networks in established and mature firms (Watson, 2007). For mature firms, the central role of the business is not survival but maintaining profitability, which implies sustained employment growth. It needs to be examined whether social networks matter for those firms.

Mature firms also have different strategic goals than entrepreneurial firms, which necessitates new measures of business performance. For defense contractors who expect a long-term decline in defense spending, one of the key strategic priorities is to reduce their reliance on

defense contracts and increase their share in the civilian markets (Bishop, 1995). More broadly, studies have found that diversified R&D-intensive firms are more profitable than undiversified firms (Chiang, 2010). Further, in a study of all types of firms, Pandya and Rao (1998) have found that diversified firms show better performance in terms of risk and return than undiversified firms. In this context, market diversification could be crucial to reduce risks and achieve sustained growth during a period of declining defense spending. It is essential to understand if social networks support diversification efforts in this context.

The contribution of this study of defense contractors in New England is to provide an analysis of the roles social networks play in defense-related firms, which are dominated by mature firms. We use two indicators of business performance. One is the commonly used measure of employment growth, and the other is the diversification of markets, which has received little attention in the existing literature.

## Survey and Data Collection

### *Survey Design and Implementation*

The findings of this study are based on a survey implemented in late 2015 through early 2016. The survey was designed to gather data on the status of defense contractors in New England and to identify their associated social networks.[5]

A survey is the most appropriate tool for collecting data on social networks because secondary data sources are not available regarding network types and sizes. Therefore, almost all studies on social networks utilize surveys or interviews to gather network data (Lechner et al., 2006; Qian & Kemelgor, 2013). In our study, all the information on social networks and

business performance is self-reported. Previous research has given support to the reliability and validity of self-reported business measures, especially when secondary data sources are unavailable (Lechner et al., 2006).

The survey population includes defense-related businesses with addresses in New England with a federal defense contract from 2013 to 2015. The vast majority of contacts were obtained from the defense contractors listed in the USASpending.gov (U.S. Department of Treasury, 2016) federal spending database. In addition, about 1,110 contacts were obtained from the Donahue Institute, University of Massachusetts-Boston. Combining these two sources, we compiled a list with 26,105 businesses contacts, representing 11,200 unique businesses. For some businesses, multiple contact emails of executives were obtained and surveys were sent to all contacts to boost the response rate. After the survey was completed, we examined the responses and removed any duplicate businesses.

The email survey was launched in September 2015. Multiple reminders were sent until the close of the survey in January 2016. Ultimately, 181 responses were collected. This represents a response rate of 1.5%. Although this sample may be considered small, it is not uncommon in studies on social networks, many of which are based on samples of fewer than 100 respondents (see Hayter, 2015; Kalm, 2012; Lechner et al., 2006; and Qian & Kemelgor 2013). Business surveys are notoriously difficult to conduct, especially for well-established firms, due to confidentiality concerns, busy executives, or imprecise contact information. In addition, businesses are more hesitant to answer questions regarding business revenue and profit than questions on location, firm age, and employment, which also affected our choice of business performance measures.

Despite the relatively low response rate, the validity of the statistical analysis is not a concern. When population is sufficiently large, as is the case in this study, the key to determine the statistical significance of coefficient estimation and hypothesis testing is the absolute number of the sample size not the response rate, as long as the sample is representative of the population (Moore, McCabe, & Craig, 2015).

***Representativeness of Sample***

To evaluate whether the survey sample is representative of the overall population, we compared firm characteristics in both the population and sample on the industry composition, as industry can drive business performance and an unbalanced sample could bias the study results

The top two industries in both the sample and the population are the same—professional and business services (PBS) and manufacturing (Figure 1). Thirty-seven percent of respondents are classified as PBS, compared with 33% in the population. Also, 30% of surveyed businesses are manufacturers, compared with 34% in the population. Respondents in other industries account for less than 10% in both the population and sample. For a sample with 181 respondents, the margin of error for proportional variables is about 7%. The differences of the sample and population percentages for all industries are within the margin of error. As a result, we conclude that the industry mix of the sample is not statistically different from the population.

(Figure 1 Here)

Furthermore, the industry pattern in our sample is consistent with other literature on defense contractors, as PBS and manufacturing industries typically obtain the most DoD contracts (Fuller, 2012). While previous studies on social networks focused on high-tech firms (Qian & Kemelgor, 2013; Hayter, 2015), a high concentration of manufacturing and professional

and service businesses in our sample provides a different industry context to study the role of social networks in business performance.

***Profile of Surveyed Businesses***

Businesses of all sizes are represented in our survey. A total of 34.7% of the responding businesses had 10 or fewer employees, whereas 30.7% of businesses had more than 10 but less than 50 employees. In addition, 12.5% of businesses had more than 50 but less than 100 employees and 22.1% had more than 100 employees. On average, the responding businesses had 129.9 employees, much larger than the national and Massachusetts averages of 16.0 and 17.8 employees per establishment, respectively (U.S. Census, 2016).[6] The size of responding firms to our survey is significantly larger than in the existing literature where entrepreneurial firms dominate the studies of social networks.

In this analysis, we define small business as those with 50 employees or less, and 65.4% of our sample are small businesses. This definition is consistent with that used by the World Bank and Organisation for Economic Cooperation and Development (OECD), which classified firms with 10 employees or less as microbusinesses, and those with employment between 11 and 50 as small businesses (Gal, Criscuolo, & Menon, 2014).[7]

(Table 1 Here)

Defense contractors responding to our survey are dominated by mature businesses. While different factors define a mature business, a common measure is the age of the business. For example, the OECD classifies businesses less than 2 years old as startups, between 2 and 5 years old as young businesses, and those over 5 years old as mature (Gal et al., 2014).

Based on the OECD definition, more than 90% of businesses in our sample are mature and more than 80% have been in existence for more than 10 years. Consequently, very few young businesses are in our sample of defense contractors. With the average business tenure in our sample being 28.3 years, it is a sharp contrast to the prior literature focusing on entrepreneurial or start-up firms.

Regarding growth, 40.2% of responding businesses experienced an increase in employment from 2014 to 2015. No change in employment was reported by 44.4% of respondents and employment declined for 15.4% of the businesses responding. On average, employment in responding businesses grew 2.2% for the year, slightly faster than the national average of 2.0% during the same period (Bureau of Labor Statistics, 2016).

In terms of market diversification, responding businesses derived an average of 22% of their sales from DoD. Of responding firms, 25.5% obtained more than half of their annual sales from DoD contracts, showing heavy dependence on one customer.

***Profile of Business Network***

Responding businesses are interconnected. In this study, a connection is defined as personal contacts of respondents who are influential in their businesses. We first mapped the organizations where those contacts belong. In Figure 2, each white dot represents a survey respondent and each gray dot represents one of the organizations with which they are connected through professional or personal contacts. The size of the gray dot indicates the number of respondents associated with the organization. Some of those organizations, such as the Small Business Association of New England and regional chambers of commerce, are also linked to other businesses, forming a large interconnected network. Thirty-eight firms in our sample are in

a broader interconnected network (within the dotted line), which means they share one or more common connections with other firms.

(Figure 2 Here)

On average, respondents reported that they had 4.5 contacts that were instrumental in their business operations. A total of 38.7% of survey respondents reported no such contacts, whereas 33.7% stated that they had 1 to 5 influential business contacts, 16.0% had 6 to10 contacts, and 11.6% had more than 11 such contacts.[8]

(Table 2 Here)

The most popular connections for defense contractors are those in the private sector, where 43.6% of responding businesses had such contacts. This is followed by connections in government, colleges/universities, and research and development, where 29.3% of responding businesses had such connections. A total of 23.2% of businesses had connections with DoD or other defense contractors. Very few responding businesses reported network connections in the financial sector. The reason could be that since many respondents are mature businesses, start-up capital is not a concern. This is another key difference with prior social network studies that focus on entrepreneurial firms, for which access to capital, especially venture capital, is crucial.

## Model Specification

### *Measurement for Business Performance*

In theory, firms maximize profits. In research of nonpublicly traded firms, however, profits are rarely used as a measure of performance because of the sensitive nature of the information and concerns about response rates (Watson, 2007). Instead, empirical literature

focuses more on total revenue (sales) or employment as the most common measures for firm performance (Kalm, 2012). Many studies on social networks use employment and employment growth as measures of firm performance (Kalm, 2012; Hayter, 2015) when revenue data are not available. In the profit maximization framework, expanding profit is generally associated with increased employment as firms add employees to meet additional demand to the point where marginal revenue equals marginal cost.

Thus, in our survey we focus on employment growth rather than revenue or profit to maximize our response rate. We also chose employment growth to measure performance because policy makers tend to focus more on creating job opportunities than business profitability. Using this measure can generate policy suggestions for growing the regional employment base.

For defense contractors, market diversification is a common focus for their sustained success (Bishop, 1995). While market diversification may not enter short-term profit maximization considerations, it is a way for a firm to insulate itself from the influence of one or a few important customers and reduce future revenue volatility. As a result, we also examined whether networks have effects on firm diversification as an indicator for long-term success. Combined, these two measures of business performance—employment growth and market diversification—reflect the strategic goals of short-term and long-term business growth for defense contractors.

***Model Specification***

To quantify the effect of social networks on business performance, we employed an econometric model expressed as follows:

(1) $Business\ Performances\ (BP) = f(NS, NS^2, NL, NT, FC, IND)$

In the above model, *f(x)* represents a linear functional form. The dependent variables are two measures of business performance (BP) for defense contractors: employment growth and market diversification. Employment growth is defined as the percentage change in firm-level employment from 2014 to 2015. Market diversification is defined as the percentage of a firm's revenue that is not related to DoD contracts in 2015. A high percentage of this measure implies less reliance on DoD contracts and a high degree of market diversification. Due to the limitation of the survey, this study is only able to examine short-term employment growth.

The key independent variables are different characteristics of social networks, such as network size, connection types, and network location. Network size (NS) is defined as the number of self-reported influential personal contracts for each respondent. For businesses not reporting such connections, their network size is set to 0.

While prior research has shown that social networks are typically beneficial for business (Witt, 2004), some studies also found too large of a network may have a negative effect (Watson, 2007). To test the hypothesis of an optimal network size, this model includes the squared terms of network size ($NS^2$). If the coefficient estimate of NS is positive but that of $NS^2$ is negative, we can conclude that there is an optimal network size, and that the benefit of social networks first increases with network size but eventually declines as more connections are added.

Another dimension of social networks is geography or network locations (NL). Studies have shown mixed results on the advantages of localized networks in relation to global networks (Hayter, 2015; Patton and Kenney, 2005; Saxenian, 1996 ). In our survey, we classify social networks into three geographical categories:

1. Only in-state connections,

2. Only out-of-state connections, and
3. Both in-state and out-of-state connections.

Two dummy variables are included in the model to represent network locations. The first is the in-state dummy, with a value of 1 implying a firm's network contains only in-state connections and a value of zero otherwise. The second is the out-of-state dummy, with a value of 1 implying a firm's network has only out-of-state connections and a value of zero otherwise.

Studies have also found that different connection types matter (Lechner et al., 2006). To test this hypothesis, we tested a model with several variables representing the number of connections in the following six different types (NT):

1. Colleges and universities or research and development
2. Government, public sector, or politicians
3. DoD or defense contractors
4. Financial sector, including venture capital
5. Private businesses
6. Other connections

Another variable of interest is whether the firm is in an interconnected network versus an isolated network. As Figure 2 shows, 38 firms in our sample are in a broader interconnected network (within the dotted line), which means they share one or more common connections with other firms and they are connected with dozens of other organizations through shared connections. On the other hand, many firms have isolated connections. To test whether being in a central network makes a difference, we created a separate regression for two subsamples—those firms in the central network and those with only isolated connections.

Outside the key variables of interest related to a firm's network, we also include the following firm characteristics (FC) control variables that may affect business performance: firm size, measured by the current employment and firm tenure, measured by the number of years that a firm is in businesses (Watson, 2007).

Finally, three industry dummy variables (IND) are included, for businesses in manufacturing, professional and business services, or health care, which are the three largest industries in our sample. The industry dummy variables can capture the industry-specific factors affecting firm performance that are not explicitly modeled, such as industry trends and technological change specific to a sector. Table 3 presents the descriptive statistics of the dependent and independent variables.

(Table 3 Here)

***Specification Tests***

Several tests were run to ensure that the model specification and estimating method are justified. First, multicollinearity among independent variables is not a serious concern in the model estimation. The variable inflation factor (VIF) for each independent variable was calculated to test multicollinearity. Although there is no deterministic criterion for VIF, a rule of thumb is that a VIF value greater than 5 for an independent variable indicates possible high correlation between it and other independent variables. All independent variables have VIF less than 2, except for network size (NS) and the squared terms of the network size ($NS^2$). However, to analyze whether there is an optimal size of social network, both variables must be included. This is typical practice in the literature on social networks where both variables are included despite possible correlation (Hayter 2015; Qian & Kemelgor 2013; Watson 2007).

In a cross-sectional model, heteroskedasticity is a concern as well. $\chi^2$ statistics for heteroskedasticity for various specifications of employment growth models ranged from 25.52 to 117.68 with a *p* value between 0.12 and 0.95. Similarly, $\chi^2$ statistics for heteroskedasticity for market diversification models ranged from 30.89 to 127.67 with a *p* value between 0.14 and 0.83 (Tables 5 and 6). These tests imply that we cannot reject the hypothesis of the homogeneity of error terms at the 95% significance level. The specification tests indicate that the ordinary lease squares (OLS) method is appropriate to estimate the model.[9]

There will be little concern regarding the simultaneity between network connections and firm performance. It is possible that high performing firms are better in forming network connections, thus resulting in simultaneity concern.[10] While this concern is valid in abstract, the survey design is specific about the direction of influence. When asking about social contacts, the survey asked responders to "[t]hink carefully about your personal contacts that have been most instrumental in the growth and support of your business." This question suggests that when businesses responded to the survey, they reported connections that are influential in their businesses, not just any personal or business contacts, nor those contacts gained due to business growth.[11]

**Results Discussion**

We ran the various regressions to examine the effects of networks on business performances. First, we utilized the full sample but excluded network types (NT) to serve as the core model for our results discussion (model 1). We do this because there may exist some correlations between overall network size and different network types. The effect of network

types was examined in an expanded model (model 2). In addition, using the specification of the core model, we ran separate regressions on the following five subgroups:

1. Small firms with 50 employees or less (model 3)
2. Medium or large firms with more than 50 employees (model 4)
3. Firms with primary business locations in New England (model 5)
4. Firms within a central network (model 6)
5. Firms with isolated connections (model 7)[12]

Since the sample size is relatively small, we chose to only use data from the survey and did not collect additional data from secondary sources to boost $R^2$.

***Employment Growth Models***

Table 4 lists the regression results for employment growth for models 1 to 7. The core model explains 33% of the variation in employment growth. Since this model is mostly concerned with the role of social networks in business performance, a low $R^2$ does not prevent meaningful discussion in this arena.

(Table 4 Here)

*Control Variables*

For control variables, the results from the core model show that firm employment and tenure have important influences on firm-level employment growth. The coefficient estimate of firm employment (FE) is positive and significant at the 95% confidence level, indicating that larger defense contractors grew faster in 2015. This is different than previous network studies such as Watson (2007), who found firm size has no effect on employment growth. The possible

explanation is that in recent years of declining defense spending, larger firms may have better resources to weather the DoD budget cut than smaller firms, resulting in a positive association between firm size and growth.[13] Alternatively, larger firms may choose to bring work in-house and reduce their use of subcontractors. Our results also show that for the subsamples with small firms (model 3), the coefficient estimate for firm size is not significant, but is positive and significant for firms with employment larger than 50 (model 4).

Results from the core model show that firm tenure has a negative and significant effect on employment growth, which is consistent with Watson (2007), who also found that younger firms experienced faster employment growth in his study of the effect of social networks on business performance. Of six other models with different specifications and sample sizes, coefficients are significant at the 95% confidence level for two models (models 2 and 4), and are significant at the 90% confidence level for one model (model 5).

For industry dummy variables, coefficient estimates for the two largest sectors—manufacturing, and professional and business services—are all positive and significant at the 95% significant level for the core model (model 1). Coefficient estimates for the health care dummy is marginally significant. Industry dummy variables represent factors affecting firm employment growth that are not specifically modeled. The positive coefficients mean that there are other factors promoting employment growth in those three industries. As noted previously, the industry mix of the sample is consistent with overall defense contractors, so there is little concern that an unbalanced industry composition may have biased the results.[14]

*Network Size*

In terms of network size (NS), the first key result of our models is that network connections are beneficial for firm employment growth for defense contractors. The coefficients for the core model (model 1), expanded model (model 2), and five subsample models (models 3-7) are all positive. Three of the estimates are significant at the 95% level and three are significant at the 90% level. Only in model 2, with extended network types, the coefficient estimate is not significant due to possible correlation with variables representing network types. In model 2, different network types may collectively capture some of the positive effect of social networks, making the coefficient for network size smaller and insignificant (*p* value of 0.12). Overall, the positive impact of network size is rather robust. That conclusion is similar to the literature on entrepreneurial firms (Witt, 2004).

While the network size (NS) has a positive and significant effect, the squared term of the network size ($NS^2$) has a negative and significant effect on firm-level employment growth. The coefficients for the core model (model 1), expanded model (model 2), and five subsample models (models 3-7) are all negative. Three of the estimates are significant at the 95% confidence level (models 1, 2, and 4) and four are significant at the 90% confidence level (models 3, 5, 6, and 7)**.** The negative second-order effect suggests that when the size of a social network is small, increasing the number of connections is associated with faster employment growth. But when the network size is sufficiently large, the negative effect of a big network will emerge, and having more connections will dampen employment growth.

In terms of magnitude of the impact, the marginal effect varies based on the current network size. Using the core model as an example, if the network size increases from 0 to 1, it can boost one-year employment growth by 2.0 percentage points. In other words, for a company with 100 employees, having one network connection could mean 2.0 more jobs; however, the

marginal benefit is declining. If the current network size is one, having one more connection will boost growth by 1.7 percentage points. Further, if the current network size is five, having one more connection will boost growth by 1.1 percentage point.

Based on the magnitude of the coefficient estimates, we estimate that the optimal network size is 9.2—this is where the positive effect of networks reaches the peak and the marginal effect of network is zero. Below this optimal size, adding more connections will provide additional growth stimulus. When the number of network connections is larger than 9.2 but smaller than 18.4, the overall effect of network connections is still positive but declining in magnitude, thus suboptimal. When the network size exceeds 18.4, the effect of the network size becomes negative.

Our results are similar to those observed by Watson (2007) and Hayter (2015 ), who found that network size exhibits an inverse U-shaped effect and there is an optimal size of social networks for business growth. This pattern can be explained as follows. When firms start to build a network, the first few connections may provide crucial knowledge or resources to help them grow, such as opportunities to respond to requests for proposals (RFPs) or to partner with firms to create new products and services. As more connections are added to the network, a significant amount of energy for business owners and executives will be devoted to pursuing new ventures as well as maintaining the networks through meetings and communications. These activities take time and energy away from activities that bring in immediate revenue. More importantly, with larger networks, these connections may provide redundant, inconsistent, or conflicting information and may result in opportunities that are not pursued after committing significant time to the potential venture.

In the two subsamples with small firms (model 3) and medium or larger firms (model 4), the results hold, except that two of the four coefficients are significant at the 90% confidence level and the other two are significant at the 95% confidence level. The corresponding optimal network size for smaller firms is around 11.2, but for medium and larger firms is 7.2. Medium and larger firms may prefer smaller networks because they are able to leverage internal resources and experts and have less needs for outside contacts.

*Network Location and Types*

Our model found mixed results regarding the effect of network location on employment growth. We tested two dummy variables to capture the geographic dimension of social networks (in-state-only dummy and out-state-only dummy). In the core model, the firms with in-state-only networks appear to be associated with lower employment growth rates, while the coefficient for out-state-only networks is not significant. The coefficients for other models show similar patterns, albeit with different degrees of significance. These results may suggest that having both in-state and out-state contacts could be beneficial, but the results are not conclusive. More likely, the physical location of a network has at most a weak association with employment growth for defense contractors. Telecommunication and the ubiquity of Internet access have made communications almost instantaneous, as firms can draw contacts anywhere to benefit their businesses. This contradicts earlier studies such as Saxenian (1996), who observed that a localized network is beneficial for start-up firms, or Patton and Kenney (2005), who found that globalized networks are more helpful. Those studies are more than a decade old, and were completed before advancements in the Internet, mobile devices, and social media software dramatically increased the speed and frequency of communications and information sharing.

While some studies have concluded that network types are important (Lechner et al., 2006), we find that none of the different categories of connection types (NT variables in model 2) have statistically significant correlations with firm-level employment growth. The results suggest that while the overall collective effect of social networks is positive, the model cannot pinpoint a particular network type that is the most beneficial. The reason could be that each connection type may help employment growth in different ways, but those different effects are not statistically strong in their own rights. Compared with the regression results from the core model, the coefficient estimate for network size in model 2 is smaller, while coefficients for $NS^2$ are essentially the same. This implies that the six variables representing different network types capture some positive effect of having a network, rendering a smaller coefficient estimate for network size (NS).

*Central Network*

To see whether the effect of social network differs for firms in the central network versus firms with isolated connections, we ran regressions for two subsamples—those firms connected in the central network (model 6) and those whose connections are not (model 7). Firms reporting zero connections were excluded from both regressions.

For both models, due to smaller sample size and low degrees of freedom, all coefficients for network size and squared terms of network size are significant at the 90% confidence level, not the 95% confidence level as we hoped. The signs of coefficient estimate suggest that there is a positive network effect, but there is a limit to the positive effect, which is consistent with the conclusion from the core model.

The coefficient estimate of network size (NS) for the central network model (model 6) is higher than that in the isolated model in model 7 (0.0390 as opposed to 0.0297). This suggests that each connection in the central network is more beneficial to firms with isolated connections. The optimal network size for firms in central networks is 9.3, smaller than 11.5 for firms in isolated networks. These results suggest that there could be some information exchange or feedback mechanism in the central network that generates additional benefits for defense firms. Each connection in the central network is more beneficial and firms in a central network need relatively fewer contacts to achieve maximum growth effects.

### ***Market Diversification Models***

Table 5 lists the regression results for market diversification for different model specifications. The regression results for the diversification models are weaker than those for employment growth model. The core model explains only 14% of the variation in employment growth, and only a few coefficient estimates are significant enough to generate meaningful insights.

(Table 5 Here)

#### *Control Variables*

For control variables, the core model (model 1) implies that only firm tenure is strongly associated with diversification of defense contractors. The result implies that mature firms, since they have been in the market for a long time, tend to be less reliant on DoD work than younger defense contractors. This may be because they have experienced the ups and downs of DoD work and have made efforts to diversify their businesses. Outside the core model, coefficient

estimates for firm tenure in five other models are positive and significant (models 2, 3, 5, 6, and 7).

While firm size appears to be positively correlated to employment growth, it does not have an effect on market diversification. In addition, none of the coefficient estimates of these industry dummy variables are significant.

*Network Size*

Our model shows that network size has an opposite effect on market diversification as employment growth. In the core model, the coefficient estimates suggest the network size (NS) has a negative and significant effect on market diversification, while the squared term of network size ($NS^2$) has a positive and significant effect. Combined, they suggest that when the social network size is small, increasing the number of connections does not help market diversification and more connections are associated with a higher concentration in defense work. But when the network size is sufficiently large, the positive effect will overtake the negative one, and adding more connections will help firms diversify. These results generally hold in the models with expanded network types (model 2) and New England firms (model 5). These effects also hold for small firms (model 3), but not medium and large firms (model 4).

In terms of the magnitude of the impact, the marginal effect varies based on the network size. Based on the core model, if network size increases from 0 to 1, it can increase the revenue share of defense contractors by 2.8 percentage points. If the current network size is 1, adding one more connection will increase defense revenue share by 2.4 percentage points. If the current network size is 5, adding one more connection will boost growth by 1.5 percentage points.

The core model indicates that two critical network sizes are 9.2 and 18.4. When network size is below 9.2, adding more connections reduces market diversification. When the social network is larger than 9.2 but less than 18.4, the effect of the network size is negative on diversification but declining. When the network size is larger than 18.4, additional network connections can benefit firms in diversification. The possible rationale for this pattern is that the first few connections (less than nine) for defense contractors may be used to acquire more defense work, promoting faster employment growth but reducing diversification. As firms accumulate more contacts, those connections may come from firms that are not defense contractors, thus helping defense contractors diversify.

*Network Location and Types*

Locations of networks do not seem to be strongly related to market diversification. This result simply implies that network locations are immaterial for defense contractors in today's business world. Telecommunication and the Internet have made interactions anywhere almost instantaneous.

Regarding network types, one specific type has a very distinctive effect. Connections in DoD or other defense contractors have a negative and significant effect on market diversification. For defense contractors, it appears DoD connections are effective in helping them gain more DoD work, resulting in less diversity.

*Central Network*

Comparing the regression results for businesses in the central network and those with only isolated connections, coefficient estimates are not significant enough to draw any conclusions. For firms in the central network, results show a negative first-order and positive

second-order effect. But only the coefficient estimate for squared terms is positive and significant at the 90% confidence level, implying connections in the centralized network may be beneficial for market diversification. Both coefficients on the isolated network models are not significant.

***Social Networks—A Double-Edged Sword?***

The effect of network size on market diversification is exactly the opposite of its effect on employment growth (Figure 3). Combined results show that adding more connections initially seems to bring more DoD work, resulting in more jobs but increasing reliance on DoD work. For faster short-term growth, it appears firms concentrate their efforts on their major customers and use their social networks to gain DoD contracts, even though the side effect is that it may decrease diversity.

(Figure 3 Here)

Therein lies the conflicting roles of social networks for defense contractors between short-term and long-term growth. For defense contractors, a social network may help achieve faster short-term employment growth, but increased reliance on the DoD exposes firms to higher risks that could impact long-term expansion, especially during cycles of defense budget cuts.

The conflicting roles could explain how New England defense contractors utilize their social networks. It is likely they leverage their social network contacts to obtain more defense businesses because of their familiarity with the federal government RFP process and ability to win contracts. Diversifying into civilian markets may require additional investments and research that the firms are hesitant to take on (Pandya & Rao, 1998). In the long run, however, this strategy would put them in a vulnerable position during a downturn in defense spending.

### *Policy Implications*

Our results imply that defense-intensive firms tend to focus on growth, not diversification, as it takes considerable resources and may not succeed (Pandya & Rao, 1998). Possible barriers for diversification includes lack of information of the new market, as well as financial resources needed to adapt their products to a civilian market. Policy makers should target these firms with programs that make it easier for them to find alternative markets. Virginia, for example, created a program to help its defense contractors find export opportunities for their products and services (Virginia Economic Development Partnership, 2013). In addition, some type of financial assistance for firm diversification in the areas of product adaptation and innovation, either from DoD Office of Economic Adjustment grants or from state and local governments, may be needed.

Due to the drive for short-term business growth, defense contractors tend to focus on cultivating defense-related connections that can have an immediate benefit and not the ones that may be beneficial over the longer run. Our results also show that connections in centralized networks tend to be beneficial to diversification. From this perspective, community leaders should create networking events that bring firms together in a central network. The efforts already underway in New England to build a broad-based network should help defense contractors leverage such networks to diversify. However, community leaders should be aware of the nonproductive effect of networks when they get too large. Consequently, networking events should be focused to facilitate deeper discussion of market and strategy instead of just meet-and-greet networking events.

Also, realizing that a wide range of connections are useful for diversification but businesses may not have time or energy to cultivate them, community leaders can serve the role of a resource or information depository and maintain a broad community asset map for defense contractors. Even if individual defense businesses do not directly maintain a large network of connections, resources can be made available by local governments or key influencers such as regional chambers of commerce or the Small Business Association of New England.

Community leaders not only can foster networking opportunities, they can also provide additional business and financial assistance that will promote market diversification. Research has found that increased public relations and marketing efforts can help attract new customers, but an individual defense contractor may lack resources or expertise to engage in such activities. Community leaders can form a marketing alliance that pools resources together. They can also utilize community social media presence to help defense contractors reach wider audiences.

Finally, from the broad perspective of regional development, policy makers and particularly economic developers in defense-dependent regions can focus on diversifying their regional industry base to guard against widespread economic decline during periods of defense downsizing. Indeed, the DoD Office of Economic Adjustment offers grants to help defense-dependent regions diversify their economy. These grants sometimes take the form of a diversification study that helps the region understand its reliance on defense-related jobs and how to become more resilient to potential reductions in defense spending (Association of Defense Communities, 2009).

**Conclusion**

In contrast to prevailing literature focusing on entrepreneurial firms, this study offers insights on how social networks function in mature businesses engaged in defense contracting. The main conclusion of this study is that more network connections are associated with faster short-term employment growth from 2014 to 2015 for defense contractors. But there is a limit to the benefit, as too many connections beyond an optimal size will negatively impact employment growth. The analysis also shows that social networks do not aid market diversification for defense contractors when network size is small. This poses a challenge for defense contractors as they need to balance the priorities of short-term expansion and diversification aiming to sustain long-term growth.

Because our results are driven by a sample of defense contractors, it may not be appropriate to extrapolate some of the conclusions to firms in other industries without additional research. For example, the effect of social networks on diversification may be unique for defense contractors. Because firms in our study have DoD as a main customer, efforts are devoted to maintaining DoD-related connections to increase DoD work. Thus, we do not see that networks help diversify their markets initially. It does not imply the same results will hold for other businesses that do not rely on one or two major customers. Further research on nondefense contractors is necessary to understand whether the negative effect of social networks on market diversification is more generic, or only unique to defense contractors.

Another limitation of this study is that long-term effects of social networks cannot be modeled explicitly. Since we are using a business survey to collect data, we limit our survey questions on information in the past 12 months from the time of the survey to ensure reliable data were reported. We used market diversification as a proxy for long-term success, but it is not a direct measure of long-term employment or revenue growth. Future research in the area, either

using secondary data of historic employment and revenue, or conducting additional survey several years in the future, may help determining the long-term effect of social networks. In addition, future research can investigate the timing between business acquiring contacts and starting to benefit from those ties, and whether network ties have temporary or long-lasting influences on businesses.

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## Figures

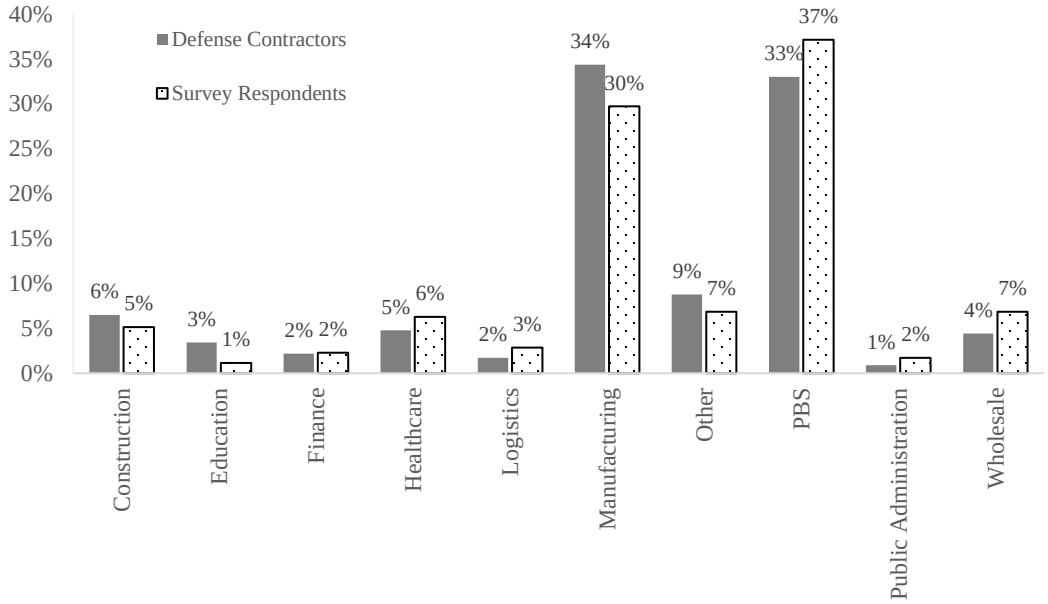


*Figure 1: Distribution of Firms by Major Sector*

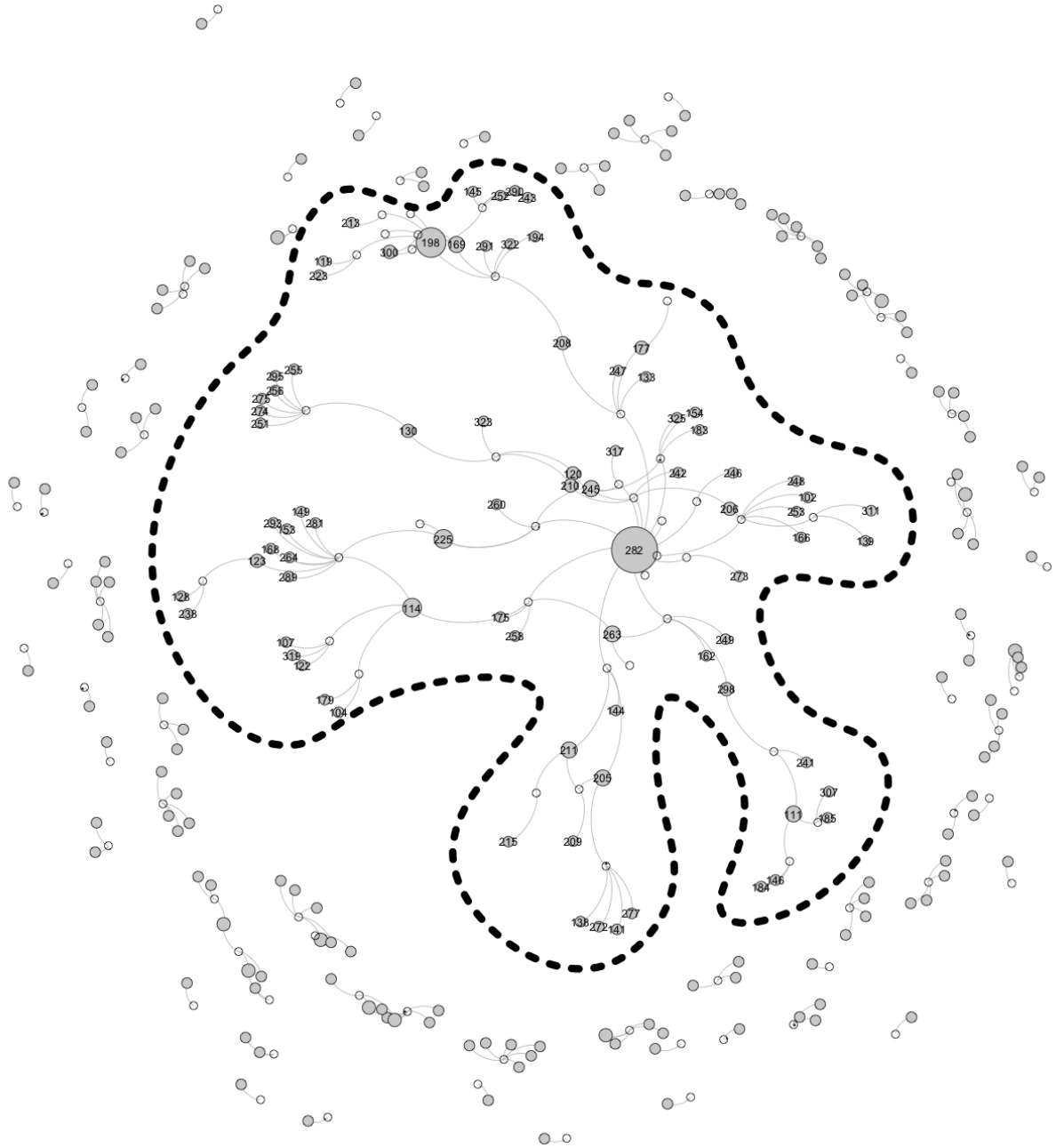


*Figure 2: Interconnections Among Individual Business Networks*

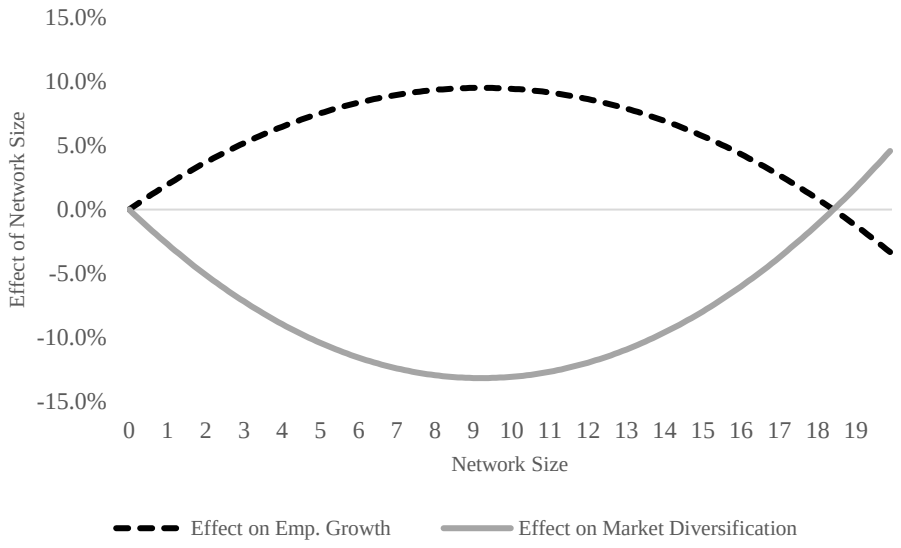


*Figure 3: Effect of Network Size on Employment Growth and Market Diversification*

**Table 1: Profile of Surveyed Businesses.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Primary location | Valid observations | Massachusetts | Other New England states | Other states | | | |
| | 168 | 47.60% | 23.80% | 28.60% | | | |
| Employment size | Valid observations | 1 | 2-10 | 11-50 | 51-100 | 101-500 | More than 500 |
| | 176 | 3.40% | 31.30% | 30.70% | 12.50% | 11.90% | 10.20% |
| Positions of responders | Valid observations | Owner | C-suite | Board member | Manager | Multiple roles | Other |
| | 174 | 33.30% | 10.90% | 1.10% | 30.50% | 15.50% | 8.60% |
| Age of businesses | Valid observations | Less than 1 year | 1-5 years | 5-10 years | 10-20 years | 20-50 years | More than 50 years |
| | 175 | 0.60% | 8.60% | 7.40% | 22.30% | 42.90% | 18.30% |
| Employment change | Valid observations | Decrease | Stay the same | Increase | | | |
| | 169 | 15.40% | 44.40% | 40.20% | | | |
| Percentage of DOD sales | Valid observations | 0%-5% | 5%-10% | 10%-25% | 25%-50% | 50%-75% | 75%-100% |
| | 106 | 34.00% | 18.90% | 15.10% | 6.60% | 11.30% | 14.20% |

**Table 2: Profile of Network Connections.**

| Size distribution of contacts | | Average number of connections | | % of respondents with connection types | |
|---|---|---|---|---|---|
| Valid observations | 181 | Valid observations | 175 | Valid observations | 181 |
| 0 | 38.7% | Construction | 3.1 | College/research and development | 29.3% |
| 1-5 | 33.7% | Education | 10.0 | Government | 29.3% |
| 6-10 | 16.0% | Finance | 0.3 | DoD related | 23.2% |
| 11-20 | 11.6% | Health care | 6.3 | Financial sector | 14.9% |
| | | Logistics | 2.4 | Private sector | 43.6% |
| | | Manufacturing | 3.2 | Other personal | 22.1% |
| | | Other | 2.7 | | |
| | | Professional & business services | 5.9 | | |
| | | Public administration | 8.7 | | |
| | | Wholesale | 4.0 | | |

**Table 3: Descriptive Statistics.**

| | | Valid data | Mean | Standard deviation | Minimum value | Maximum value |
|---|---|---|---|---|---|---|
| Business performance (BP) | Firm growth-employment growth | 167 | 5.6% | 19.9% | -66.7% | 100.0% |
| | Market diversity-nonDOD sales | 151 | 81.2% | 28.8% | 12.5% | 100.0% |
| Network size (NS) | Social network size | 181 | 4.54 | 5.92 | 0.00 | 20.00 |
| | Squared terms of network size | 181 | 55.46 | 113.30 | 0.00 | 400.00 |
| | Central network connection | 181 | 0.21 | 0.41 | 0.00 | 1.00 |
| Network location (NL) | Network location-in-state only | 181 | 0.12 | 0.33 | 0.00 | 1.00 |
| | Network location-out of state only | 181 | 0.29 | 0.45 | 0.00 | 1.00 |
| | Network location-both in- and out-state | 181 | 0.20 | 0.40 | 0.00 | 1.00 |
| Firm characteristics (FC) | Employment | 176 | 129.95 | 314.67 | 1.00 | 3500.00 |
| | Age of business | 175 | 28.30 | 15.41 | 0.50 | 50.00 |
| Industry dummy (IND) | Dummy PBS | 176 | 0.37 | 0.48 | 0.00 | 1.00 |
| | Dummy manufacturing | 176 | 0.30 | 0.46 | 0.00 | 1.00 |
| | Dummy health care | 181 | 0.06 | 0.24 | 0.00 | 1.00 |
| Network type (NT) | Network type-private business | 181 | 1.77 | 2.89 | 0.00 | 16.00 |
| | Network type-government | 181 | 0.76 | 1.67 | 0.00 | 11.00 |
| | Network type-college, research & development | 181 | 0.77 | 1.76 | 0.00 | 10.00 |
| | Network type-Department of Defense | 181 | 0.40 | 1.56 | 0.00 | 12.00 |
| | Network type-financial sector | 181 | 0.29 | 0.83 | 0.00 | 5.00 |
| | Network type-other connections | 181 | 0.82 | 3.00 | 0.00 | 35.00 |

**Table 4: Estimated Effects of Variables-Employment Growth.**

| | | Core model | | Add network type | | Small firms (Emp <= 50) | | Medium & large firms (Emp > 50) | | New England firms | | Central network | | Isolated network | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 6 | | Model 7 | |
| | Variable name | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value |
| | Intercept | 0.0327 | 0.41 | 0.0248 | 0.54 | 0.0541 | 0.25 | 0.0714 | 0.37 | 0.0326 | 0.50 | 0.0569 | 0.75 | -0.0702 | 0.47 |
| Network size (NS) | Social network size | 0.0206 | 0.01* | 0.0148 | 0.12 | 0.0183 | 0.04* | 0.0211 | 0.10** | 0.0159 | 0.05* | 0.0390 | 0.10** | 0.0297 | 0.07** |
| | Square terms | -0.0011 | 0.00* | -0.0011 | 0.01* | -0.0008 | 0.08** | -0.0015 | 0.03* | -0.0007 | 0.08** | -0.0021 | 0.07** | -0.0013 | 0.08** |
| Network location (NL) | Network location-in-state only | -0.0818 | 0.05* | -0.0945 | 0.03* | -0.0976 | 0.03* | 0.0435 | 0.65 | -0.0884 | 0.03* | 0.0054 | 0.97 | -0.0487 | 0.41 |
| | Network location - out of state only | -0.0180 | 0.58 | -0.0080 | 0.82 | -0.0790 | 0.04* | 0.1129 | 0.04* | -0.0589 | 0.12 | 0.0552 | 0.58 | -0.0125 | 0.80 |
| Firm characteristics (FC) | Employment | 0.0003 | <.0001* | 0.0003 | <.0001* | -0.0018 | 0.19 | 0.0004 | <.0001* | 0.0000 | 0.96 | 0.0004 | 0.12 | 0.0000 | 0.91 |
| | Age of business | -0.0032 | 0.00* | -0.0033 | 0.00* | -0.0015 | 0.18 | -0.0059 | 0.00* | -0.0021 | 0.07** | -0.0039 | 0.26 | -0.0021 | 0.15 |
| Industry dummy (IND) | Dummy PBS | 0.0739 | 0.03* | 0.0868 | 0.02* | 0.0424 | 0.27 | 0.1522 | 0.03* | 0.0597 | 0.13 | -0.0168 | 0.91 | 0.0815 | 0.12 |
| | Dummy manufacturing | 0.0827 | 0.02* | 0.0937 | 0.01* | 0.1306 | 0.00* | 0.0052 | 0.93 | 0.1002 | 0.01* | -0.0113 | 0.94 | 0.1327 | 0.02* |
| | Dummy health care | 0.0945 | 0.12 | 0.1096 | 0.08** | -0.0787 | 0.51 | 0.1430 | 0.05* | 0.0770 | 0.31 | 0.3685 | 0.42 | 0.1303 | 0.22 |
| Network type (NT) | Network type-private business | | | 0.0037 | 0.57 | | | | | | | | | | |
| | Network type-government | | | 0.0090 | 0.43 | | | | | | | | | | |
| | Network type-college, research & development | | | 0.0147 | 0.25 | | | | | | | | | | |
| | Network type-Department of Defense | | | -0.0038 | 0.74 | | | | | | | | | | |
| | Network type-financial sector | | | -0.0138 | 0.47 | | | | | | | | | | |
| | Network type-other connections | | | 0.0013 | 0.82 | | | | | | | | | | |
| Other statistics | Number of observations | 164 | | 164 | | 113 | | 51 | | 117 | | 35 | | 75 | |
| | *R*-Squared | 0.3304 | | 0.3488 | | 0.1983 | | 0.7005 | | 0.1427 | | 0.4602 | | 0.1629 | |
| | Chi-square for hetero | 28.98 | | 117.68 | | 25.52 | | 36.29 | | 29.73 | | 33.47 | | 52.92 | |
| | *p* value for X2 | 0.9498 | | 0.4911 | | 0.9635 | | 0.6380 | | 0.9381 | | 0.5895 | | 0.1204 | |

*Note*: * Significant at 95% confidence level, ** Significant at 90% confidence level

**Table 5: Estimated Effects of Variables-Market Diversity.**

| | | Core model | | Add network type | | Small firms (Emp <= 50) | | Medium & large firms (Emp > 50) | | New England firms | | Central network | | **Isolated network** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 6 | | Model 7 | |
| | Variable name | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value | Coefficient estimates | *p* value |
| | Intercept | 0.6913 | <.0001* | 0.7447 | <.0001* | 0.6367 | <.0001* | 0.8836 | <.0001* | 0.7650 | <.0001* | 0.1365 | 0.66 | 0.5186 | 0.00* |
| Network size (NS) | Social network size | -0.0286 | 0.03* | -0.0259 | 0.09** | -0.0414 | 0.02* | 0.0135 | 0.51 | -0.0229 | 0.11 | -0.0578 | 0.18 | 0.0015 | 0.96 |
| | Square terms | 0.0016 | 0.02* | 0.0016 | 0.02* | 0.0022 | 0.01* | -0.0006 | 0.59 | 0.0014 | 0.07** | 0.0035 | 0.09** | 0.0001 | 0.91 |
| Network location (NL) | NL-in-state only | 0.0498 | 0.49 | 0.0291 | 0.67 | 0.1095 | 0.20 | -0.1009 | 0.58 | 0.0710 | 0.34 | -0.0487 | 0.67 | 0.0441 | 0.66 |
| | NL-out of state only | -0.0181 | 0.74 | 0.0169 | 0.76 | 0.0871 | 0.22 | -0.2543 | 0.00* | 0.0574 | 0.39 | -0.0125 | 0.85 | -0.0003 | 1.00 |
| Firm characteristics (FC) | Employment | -0.0001 | 0.14 | -0.0001 | 0.36 | -0.0019 | 0.47 | 0.0000 | 0.62 | -0.0003 | 0.24 | 0.0000 | 0.66 | -0.0004 | 0.20 |
| | Age of business | 0.0059 | 0.00* | 0.0049 | 0.00* | 0.0074 | 0.00* | 0.0026 | 0.34 | 0.0055 | 0.01* | -0.0021 | 0.04* | 0.0077 | 0.00* |
| Industry dummy (IND) | Dummy PBS | -0.0007 | 0.99 | -0.0492 | 0.38 | 0.0400 | 0.59 | -0.1616 | 0.12 | -0.1043 | 0.15 | 0.0815 | 0.28 | 0.1307 | 0.15 |
| | Dummy manufacturing | 0.0414 | 0.51 | -0.0126 | 0.83 | 0.1054 | 0.20 | -0.0954 | 0.31 | -0.0302 | 0.68 | 0.1327 | 0.19 | 0.1014 | 0.29 |
| | Dummy health care | 0.1204 | 0.27 | 0.0998 | 0.33 | 0.2388 | 0.42 | 0.0047 | 0.97 | 0.1354 | 0.37 | 0.1303 | 0.63 | 0.2448 | 0.16 |
| Network type (NT) | NT-private business | | | 0.0110 | 0.29 | | | | | | | | | | |
| | NT-government | | | -0.0143 | 0.43 | | | | | | | | | | |
| | NT-college, research & development | | | -0.0106 | 0.59 | | | | | | | | | | |
| | NT-Department of Defense | | | -0.0605 | 0.00* | | | | | | | | | | |
| | NT-financial sector | | | 0.0026 | 0.94 | | | | | | | | | | |
| | NT-other connections | | | 0.0062 | 0.46 | | | | | | | | | | |
| Other statistics | Number of observations | 150 | | 150 | | 101 | | 49 | | 103 | | 31 | | 68 | |
| | *R*-Square | 0.1422 | | 0.3122 | | 0.2007 | | 0.2685 | | 0.1524 | | 0.3238 | | 0.2102 | |
| | Chi-square for hetero | 75.26 | | 127.67 | | 37.39 | | 41.69 | | 37.94 | | 30.89 | | 33.27 | |
| | *p* value for X2 | 0.2017 | | 0.1478 | | 0.6319 | | 0.3544 | | 0.6073 | | 0.4720 | | 0.8298 | |

*Note*: * Significant at 95% confidence level, ** Significant at 90% confidence level

**Notes**

[1] This study was prepared under contract with MassDevelopment with financial support from the Office of Economic Adjustment, Department of Defense. The content reflects the views of Chmura Economics & Analytics and does not necessarily reflect the view of the Office of Economic Adjustment or the Department of Defense.

[2] Fiscal year 2016 lasts from October 1, 2015 to September 30, 2016.

[3] FY2016 amount is the requested amount in the President's Budget.

[4] For more details, please see the OEA website at: https://www.oea.gov/how-we-do-it/defense-industry-adjustment/dia-technical-assistance.

[5] The survey instrument is available upon request.

[6] Source: Census Bureau, County Business Patterns for 2014. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

[7]The United States Small Business Administration (SBA) defines small businesses for the purpose of qualifying for federal programs. For manufacturing industries, the most frequent employment standard is 500 workers with many industries having an employment standard of over 1,000. We think this standard is too high.

[8] Our survey only asked businesses to report up to 20 network connections.

[9] Please note that we reported *p* value based on OLS regression. Huber-White robust standard errors were calculated in the process. While *p* value for certain coefficient estimates varied, it did not change the conclusion of the study. Robust standard errors can be reported if needed.

[10] The authors thank an anonymous referee for raising this concern.

[11] Our study does not attempt to examine the timing between business acquiring contacts and starting to benefit from them. It is possible that those contacts were obtained a long time ago or recently. The key point is that they collectively influenced the recent business performance.

[12] The authors thank an anonymous referee for this suggestion.

[13] Based on Office of Economic Adjustment, Department of Defense, "Defense Spending by State, FY2015," contract awards performed in Massachusetts fell from $13.0 billion in fiscal year (FY) 2009 to a low of $11.0 billion in FY2014, and then rose slightly to $11.2 billion in FY2015.

[14] The authors ran two separate regressions on the top two industries—manufacturing and professional and business services. Unfortunately, few conclusions can be made from this exercise due to the smaller sample size.