PERFORMANCE ANALYSIS OF ENTREPRENEURSHIP POLICY: WHICH BUSINESS INCUBATORS GENERATE THE HIGHEST LEVELS OF ECONOMIC PERFORMANCE?

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ABSTRACT

Business incubators, organizations created to help small and young firms become stable and profitable, are a mainstay of economic development programs. This study looks at how the incubation process and the attributes of incubators affect the performance of their clients during and after incubation. Results reveal that some types of incubators achieve greater success and that success often varies on whether the entrepreneur is a woman or minority.

INTRODUCTION

Since the 1980s, cities have seized on promoting entrepreneurship as a way of inciting growth. This interest in entrepreneurship at the local level is reflected in the explosive growth of US business incubators, which is 100 times larger today than in 1980. Incubators—organizations that provide subsidized space and management support to new ventures—have grown quickly due to beliefs that they have the ability to select and nurture good business ideas that will reap greater economic development.

To date, however, little systematic knowledge exists about how the selection of a new venture into an incubator affects its competitiveness in the external environment. This is an important scholarly omission because the logic of evolutionary theory can call into question the benefits of business incubators (Aldrich, 1999). As this theory explains, processes of selection and retention occur at two levels—internally within organizations and externally in the environment. While internal selection protects organizations from the pressures of the external environment, it can also stymie their ability to adapt to a competitive external environment. Hence, while incubation might insulate a firm from competitive forces of the external environment and increase survival, incubation could also weaken the firm's ability to compete post-incubation.

To explore how incubation affects firms' competitiveness in the external environment this study looks at the performance of incubated firms, during and post incubation while controlling for idiosyncratic differences among types of incubators and their practices. Because the incubator industry encompasses a diverse set of models, which vary according to whether the incubator operates as for-profit or nonprofit, type of specialization, and collaboration among others, this study looks at how these and other incubator attributes affect the performance of incubated firms.

THEORIZING WHY TRAITS MATTER

Nonprofit and For-Profit Incubators

Since its beginning, the business incubator industry has been divided between nonprofit and for-profit incubators. In fact, the Batavia Industrial Center, the first incubator in the United States, has operated successfully as a for-profit organization from its beginning. Today the incubation industry is primarily dominated by nonprofit incubators due to high levels of state and local public...
funding. Nevertheless, 10 percent of incubators operate as for-profit entities and this type of incubator has continued to grow since the 1990s due to interest from venture capital firms (Finer & Holberton, 2002).

Given the bifurcation of incubators into for-profit and nonprofit entities, the question remains which model generates higher long-term business performance. According to public management scholars, one would expect nonprofit incubators to perform at lower levels due to goals that are more-complex, contradictory, and hard-to-measure (Lan & Rainey, 1992). This outcome is plausible if one assumes that the single priority of for-profit incubators is to generate a return on investment for their investors, while nonprofit incubators might seek to achieve one or all of the following: stimulate job creation, stimulate redevelopment of a neighborhood, or increase the number of women and minority entrepreneurs. While for-profit incubators might not withstand long-term losses, nonprofit incubators may not need to worry about their financial backing because public funders might tolerate subsidizing operations.

Another perspective on how the performance of nonprofit and for-profit incubators might differ comes from scholars who study the economic and sociological reasons why the nonprofit sector exists. For example, DiMaggio and Anheier (1990) argue that consumer demand leads to the creation of nonprofits when a donor is buying services for an unknown third party, the beneficiaries of the service are unable to assess service quality, a fee cannot be traced to a specific unit of service, or the service is too complex that consumers cannot evaluate its quality. In other words, once can expect for-profits to predominate industries where the “non-contractible quality” of a good is not valued by consumers (Glaeser & Shleifer, 2001). Hence, when the quality of a service is important to the consumer but evaluation of quality is difficult to assess and define, consumers should favor nonprofit service providers. Because being a nonprofit suggests to consumers that the organization cares less about pecuniary rewards and more about quality, consumers will prefer a nonprofit service provider as opposed to a for-profit provider (Glaeser et al., 2001). Based on this logic, small businesses that seek high quality services would be more inclined to pursue incubation in a nonprofit incubator. Therefore, one would expect tenants of nonprofit incubators to outperform tenants of for-profit incubators because tenants of nonprofit incubators might scrutinize an incubator’s service offerings more carefully before entering incubation.

The preceding discussion centers on two issues, how does the profit motive affect the operations of incubators and how does information asymmetry affect the sorting of firms into nonprofit as opposed to for-profit incubators. According to descriptive studies of the incubator industry, we do know that the profit motive affects operations. Mainly for-profit incubators are tied to venture capitalists who seek to obtain an equity share in start-ups that are expected to grow quickly and speed-up the time it generally takes a business to reach profitability (Halkides, 2001; Zedtwitz & Grimaldi, 2006). These differences play out in operations where for-profit incubators are considered to take on a more hands-on approach to the management of tenants than nonprofit incubators (Finer et al., 2002). In contrast, nonprofit incubators tend to distinguish themselves most in regards to their tenant selection. Accounts of nonprofit incubators emphasize how they tend to target tenants facing socioeconomic challenges, businesses with longer time horizons for profitability, and those with limited markets (Halkides, 2001). In essence, descriptions of for-profit incubators tend to signal that they are less patient of tenants with low or poor economic performance in contrast to nonprofit incubators, which have a practice of selecting tenants with high odds of low or poor performance.
Hypothesis 1: Tenants of for-profit incubators will perform at higher levels than tenants of nonprofit incubators.

University Incubators

The Knowledge Spillover Theory of Entrepreneurship (knowledge spillover theory) by Audretsch, Keilbach, & Lehmann (2006) offers several lenses through which to probe the relationship between economic development and factors that foster entrepreneurship. This theory identifies two phenomena that affect levels of entrepreneurship and subsequently economic development: knowledge spillovers and entrepreneurship barriers (Audretsch et al., 2006).

Knowledge spillovers occur when uncommercialized scientific knowledge is appropriated and exploited by entrepreneurs. The theory states that a gap exists between available knowledge and economically exploitable knowledge due to underinvestment in the selection and identification of opportunities for commercializing knowledge. Because knowledge is difficult to codify and transmit, its economic value is best exploited when information is transmitted through frequent and repeated face-to-face interaction (Audretsch et al., 2006). The difficulty of transmitting knowledge and learning its economic applications makes location a key variable in understanding differences in entrepreneurial growth. Those firms and entrepreneurs that reside closest to sources of knowledge are poised to learn its economic merits first.

In order to help their faculties and students commercialize new research and patented inventions, many universities sponsor and establish their own incubators. These incubators work closely with the university’s technology transfer office to help faculty commercialize research. Based on the importance of knowledge spillovers to entrepreneurship and the practice of incubation within universities, one key control variable in this study will be whether an incubator is created and sponsored by a university or institution of higher education. An assumption based on knowledge spillover theory is that incubators that are part of universities would hold an advantage over other types of incubators in first learning about important economically valuable knowledge and in getting the technical expertise to commercialize it.

Past research on university incubators has shown that their tenants enjoy several advantages in terms of accessing research, human capital, and technological resources (Rothaermel & Thursby, 2005b). In a study of 79 firms incubated by Georgia Tech University, Rothaermel & Thursby (2005a; 2005b) found that those firms holding a Georgia Tech technology license were less likely to fail. In addition, they also found that firms which citing and Georgia Tech’s university research were more likely to receive higher levels of venture capital. While their study spanned the height of the dot.com economic cycle 1998-2003, their findings and methods show that firms in university incubators that actively exploit local knowledge resources are most successful.

Hypothesis 2: Firms incubated in university incubators will have higher levels of performance than firms incubated by incubators not sponsored by a university.

Network Externalities

It is argued that networks allow entrepreneurs to discover opportunities, test ideas, and garner resources to form businesses (Lee et al., 2001). The advantages of collaboration within networks include knowledge-sharing, access to complementary skills, and economies of scale (Ahuja, 2000). The benefits of networks to the spurring of entrepreneurship include higher outputs of innovations and faster firm growth (Ahuja, 2000). Evidence of this phenomenon is research
showing scientists are located near the firms they advise when they are transferring knowledge but not when providing other types of services (Audretsch et al., 2006).

Networks also facilitate clustering, the agglomeration of industries, which is known to result in innovation, cooperation, and competition (Enright, 2003). Clusters assist entrepreneurial development because they allow firms to share risks and rewards of R&D, share tacit knowledge, and lower transaction costs when collaborating (Enright, 2003). These aspects of a strong business climate also create stronger linkages between large and small businesses. R&D findings from collaborative research between firms or networks of scientists often lead to new start-ups when corporations and the producers of scientific research are unwilling to assume the risk of marketing a new technology. Successful clustering enables economic growth through the creation and diffusion of opportunities for new ventures and enhances the survival of small businesses through increased competition (Enright, 2003).

According to the knowledge spillover theory, a network market failure occurs when a region with a population of entrepreneurial firms and individuals fails to develop geographic, intersectoral linkages (Audretsch et al., 2006). Because networks enable collaboration and the diffusion of knowledge and ideas, entrepreneurial firms and individuals can benefit from the processes that networks enable. These processes—collaborative R&D and finding and sorting economically valuable knowledge—help firms and individuals innovate and remain competitive through the transformation and application of scientific research in the production of a new good, improvement in quality of a current good, the use of a more efficient method of production, the opening of a new market for an available good or service, the discovery and ownership of a new supply of raw materials, the restructuring of an industry (Schumpeter, 1934).

In the context of business incubation, it has been shown that economic development attracts the interest of diverse stakeholders in the community. Cox et al. (1991) revealed that the typical participant in community development policy meetings include representatives from the Chamber of Commerce, city and county governments, banks, development authorities, media, real estate development, and colleges and universities. Indeed many incubators often host not only for-profit tenants but also nonprofit business associations and economic development agencies, which facilitate the transfer of business skills and information to for-profit tenants.

Qualitative research on business incubators has shown that tenants view networking as an important benefit of incubation (Aernoudt, 2004). Thus far, the literature on networks within incubators focuses on inter-firm collaboration among for-profit tenants and documents how tenants build business and informal mentoring relationships of mutual benefit (Bollingtoft & Ulhoi, 2005). However, the aspect of how an incubator’s economic development and business services network affects tenant performance has not been studied. It has been posited that an incubator acts as node point for its tenants that can easily foster relationships with business services and consultants (McAdam et al., 2006). Tenants with weak networks—having few ties and weak ties with others—can compensate for their lack of beneficial business relationships by using their incubator’s network (Peters et al., 2004). The use of an incubator’s network creates a formal process through which a tenant can quickly be embedded into a beneficial business network that can help increase survival and business performance.

**Hypothesis 3:** Tenants of incubators with a higher number of nonprofit economic development networks will demonstrate higher levels of economic performance than tenants of incubators with a lower number of nonprofit economic development networks.
METHODOLOGY

The Unit of Analysis

Changes in the activities, ownership, and legal form of new businesses complicate their longitudinal observation (Davidsson and Wiklund, 2006). In order to reduce potential threats to generalization due to the changing nature of firms as they evolve from their nascent stage, to incorporation and beyond, this study looks at firms post-incorporation. This choice eliminates several empirical and theoretical challenges because observations of firms begins at their founding stage when their identity and public data becomes available. Limiting the unit of analysis to this subpopulation eliminates new ventures stalled in the idea stage and those led by the self-employed (Davidsson & Wiklund, 2006).

Business Incubator Data

The scholar collected a panel of business incubator data consisting of 2,100 business incubators, which have operated in approximately 2,300 establishments. The panel includes information on all known addresses of the incubator, its incorporation as a nonprofit organization, and its affiliation with an institution of higher education. The population of business incubators was assembled through membership rosters of the National Business Incubation Association and 23 state associations of business incubators and lists of economic development resource from 50 state governments. Also, two rosters from the University of Central Florida Business Incubation Program were obtained. Due to concerns that the incubator population might overrepresent “successful” and “younger” incubators, an additional search using the National Establishment Time-Series Database (NETS) was conducted. This search yielded 130 additional incubators.

Data on each incubator was gathered and verified using six methods. First, the incubator’s name, physical address, contact information, nonprofit status, university affiliation, industry focus, and year of birth were researched using the search engine Google (www.google.com). A second search was conducted using the Internet Archive (www.archive.org) which stores over 150 billion screen shots of web pages dating back to 1996. More specific searches on incorporation were conducted using the master file database of the National Center for Charitable Statistics (NCCS), a clearinghouse of data on the U.S. nonprofit sector. In cases where the incubator was thought to operate as a for-profit corporation, the researcher used the D&B Million Dollar Database published by Dun & Bradstreet along with LexisNexis Academic.

Finally, in the cases where the above methods did not generate a full set of incubator demographic data, the researcher proceeded to survey all incubators over e-mail. The questionnaire asked the incubator to verify its last known address and provide its founding date. Thus, the scholar was able to develop an Incubator Master List that contained one observation per incubator address with variables for birth, death, nonprofit/for-profit incorporation, affiliation with an institution of higher education, and type of specialization.

Firm Level Data

The National Establishment Time-Series Database is a longitudinal dataset of over 36.5 million business establishments that tracks their business name, address, birth, relocations, industry, employment, annual sales, and legal status on an annual basis beginning in 1990 (Walls, 2009). This database relies on the Data Universal Numbering System (DUNS) utilized by the marketing and business information firm Dun & Bradstreet (D&B). D&B defines business establishments as
a “business or industrial unit at a single physical location that produces or distributes goods or performs services” (Neumark et al., 2005). The business establishments followed by D&B are identified through over 100 million telephone surveys, legal and court filings, news services, public utilities, all U.S. Secretaries of State government registries, company filings, and the U.S. Postal Service. Using a query, which matched the physical addresses of incubators with the physical addresses of over 36.5 million businesses in the NETS, a data extract—“NETS Full”—of 38,000 establishments was pulled. This assumes that from 1990 to 2008, each one of these 38,000 establishments shared the same address at some point with an incubator.

In order to capture the relocation patterns of both businesses and incubators, a second “NETS Moves” dataset detailing the historical record of where firms and incubators have been established was pulled. The NETS Moves dataset made it possible to determine the year when incubators and firms moved into an establishment and when they moved out or expanded.

Data Merging and Manipulation

Assembly of the final dataset required two significant matching and merging steps, which reduced the initial sample of 38,000 potentially incubated firms to approximately 20,000. First, the Incubator Master List was matched with the NETS Moves and the NETS Full datasets using the DUNS number. This allowed the author to generate a complete Incubator Master List of all the known addresses for each incubator, which contained time-series information that made it possible to determine the periods in which the incubator operated at each site.

To identify the incubated firms among the NETS Full dataset, two matches and mergers were required. Using address information, the Incubator Master List was matched and merged first with the NETS Moves dataset to identify firms, which operated in an incubator site at some point prior to 2008. Then the Incubator Master List was matched and merged using address information with the NETS Full dataset to identify all businesses whose last known address was an address belonging to an incubator. Both sets of potentially incubated firms from the NETS Moves and NETS Full datasets were appended to yield a reduced dataset of 32,711 businesses.

Because many incubators operate in multi-tenant facilities such as large office parks and university buildings, several data cleaning procedures were used to eliminate firms that likely were not incubated. First, all businesses incorporated as nonprofits and falling under SIC codes for government were dropped because they are not candidates for incubation by definition. Then all firms, which had existed for longer than five years at the time that their associated incubator was born, were dropped because it is assumed that incubators focus on helping young and new firms primarily. In addition, firms with an initial employment of over 100 and those determined to be large corporations were dropped. Finally, all firms, which emerged after an incubator had ceased operations or moved out of a location, were dropped. This resulted in a reduced dataset of 20,266 firms that were co-located with an incubator and likely to have been tenants of the incubator.

To assess further the accuracy of the address matching process in identifying all former and current tenants of business incubators, a data audit was conducted. A random sample of 40 incubators and their matched tenants (approximately 5,000 firms in total) was pulled from the remaining dataset. The researcher then surveyed all of these incubators by e-mail asking their managers to report which of the listed firms, were or were not their past or current tenants. The results revealed that 75% of the identified incubated firms were indeed current or former tenants.

DEPENDENT VARIABLES
Sales Growth. Much of the literature on firm growth has relied on Gibrat’s Law, a proportional growth model that asserts that an increase in firm size over a time period is proportional to its initial size. The general log form for modeling Gibrat’s Law is \( \log S(t+1) = \log S(t) + \varepsilon \), where \( S \) represents size and \( \varepsilon \) represents the proportional rate of growth. The literature on Gibrat’s Law defines growth as the log difference in size: \( \text{Growth}_{i,t} = \log(\text{SIZE}_{i,t}) - \log(\text{SIZE}_{i,t-1}) \) (Coad, 2007). In keeping with the literature in this area of research, this study measures growth as the log difference, too. Thus, sales growth is the log difference between annual sales at time \( t \) and sales at time \( t-1 \). Note that annual sales figures were first adjusted to 2008 dollars based on the consumer price index before they were log transformed.

Employment Growth. The employment growth measure is based on annual total employment reported by the firms in the study. These measures were first log transformed and then differenced to estimate employment growth on an annual basis.

Firm Failure. The third measure of performance in the study is firm failure. The NETS database reports the first year and the last year in which an establishment is active. To be active the establishment needs to report either sales or employment. This measure is a dummy variable where 1 indicates firm failure if the last year of activity reported by the business is not 2008.

CONTROL VARIABLES

Nonprofit incubators are represented by a dummy variable where 1 corresponds with incubators incorporated as nonprofits. As noted above nonprofit incubators were identified using several secondary data sources.

Network is a count variable that changes over time according to how many economic development, business associations, professional associations, and other nonprofits were found to be co-located with the business incubator on an annual basis.

University is a dummy variable that is coded 1 if the incubator is sponsored by a university or community college. The variable was derived from reviewing incubator websites and from industry codes from the NETS database.

Duration is a count of how many years a business has resided within an incubator. The variable is measured using the NETS Moves dataset that tracks the specific years in which a business moved in and out of an establishment. If a business is born in an incubator, duration begins in the first year that the business appears in the NETS until it fails or moves out of the incubator. If a business is born elsewhere, then duration begins when the business first moves into the incubator.

Post-duration is a variable that counts each year that a business has operated after graduating out of an incubator. This variable is constructed using the NETS Moves dataset that indicates the year when a business moves in or out of a particular location. The count increases annually until 2008 or the business fails.

Women Owned. Historically, women participation in new venture creation has been disproportional in comparison to men. For example, women make up 27% of business owners despite their larger participation in the workforce; they are 50% less likely to be involved in starting a new business at any point in time than men; and they make up only 34% of the self-
employed (Shane, 2008). Not only are women less involved in entrepreneurship, their businesses are also considered to underperform. There is much evidence pointing out that women owned businesses grow at a lower rate, employ fewer people, are less profitable, and fail more often than those owned by men (Fairlie & Robb, 2008). Explanations for why women businesses perform at lower levels than those of men point to factors like time devoted to housework and evidence that women devote less time and energy to their businesses than men (Hundley, 2001). Because the reasons why women and men start businesses appear to matter in how their firms perform in the aggregate, this study controls for the gender of the business owner with a dummy variable where 1 represents women-owned enterprises.

Minority-Owned. Just as women are underrepresented in entrepreneurial activities, so are minorities—specifically, African-Americans. While African-Americans are 78 percent more likely to be in the process of starting a business than whites, this interest does not translate in proportionally higher rates of business ownership and self-employment among this population (Shane, 2008). Studies show that lack of capital appears to be the main reason for low rates of entrepreneurship among African-Americans. Furthermore, business performance among African-Americans owned enterprises is markedly lower than those owned by white business owners. It has been shown that survival, average sales, and positive net profits are lower for black-owned businesses than white-owned businesses (Shane, 2008). Given that the ethnicity and race of the entrepreneur has been shown to affect business performance this study also considers minority status. The variable minority-owned is a dummy variable where 1 represents a business owned by an entrepreneur who is non-white.

Standard Control Variables. Apart from taking into account the above theoretically relevant variables, this study also controls for the following standard control variables. Lagged employment is a measure of firm size when the dependent variable is sales growth and lagged annual sales is a measure of firm size when the dependent variable is employment growth. Age of the firm and age of the incubator measured in years are measured. Eight two digit SIC industry dummy codes are also used to control for industry effects. The eight broad industries are agriculture, construction, manufacturing, transportation, wholesale trade, retail trade, finance, and services. Finally, year dummies are also included to control for overall economic trends.

ESTIMATION PROCEDURES

Sales and Employment Growth

Panel data analysis is often used for policy evaluation because it's been shown to reduce statistical bias due to omitted variables and unobserved, time-constant factors that affect the dependent variable and are correlated with explanatory variables (Wooldridge, 2006). However, in the case of dynamic growth models where a future value of growth is partially dependent on a current value of growth, it becomes important to adapt panel methods so that endogeneity and serial autocorrelation do not bias estimates and standard errors. This study estimates the following fixed effect dynamic model:

\[ y_{it} = \gamma_{1} y_{it-1} + (\beta_{2} npo_{j} + \beta_{3} network_{j} + \beta_{4} uni_{j} + \beta_{5} age_{j,i}) inc* x_{i,t} + (\beta_{6} npo_{j} + \beta_{7} network_{j} + \beta_{8} uni_{j} + \beta_{9} age_{j,i}) post_{inc}* x_{i,t} + \beta_{10} duration_{i,t} + \beta_{11} post\_duration_{i,t} + \beta_{12} age\_firm_{i,t} + \gamma_{t} + \alpha_{i} + \epsilon_{i,t} \]

In this model, \( y_{it} \) represents either sales or employment growth, which is lagged as an explanatory variable. Incubator characteristics are represented by the dummy variables—npo,
network, uni, and age— which are interacted with the firm variables women owned and minority owned and take into account whether the firm is in incubation or post-incubation. For example, the interaction of npo=1, incubation=1, and women-owned=1 represents the effect on performance when a women-owned business is being incubated by a nonprofit incubator. In contrast, the interaction of npo=1, post-incubation=1, and women-owned=1 represents the effect on performance for a women-owned business that has graduated from a nonprofit incubator. Duration represents the number of years that a firm has been incubated and post-duration represents the number of years elapsed after a graduated from an incubator. The rest of the variables are standard control variables.

Estimation of the above autoregressive AR(1) model was conducted using the xtabond command in Stata 11 SE which uses a generalized method of moments estimator (StataCorp, 2009). This estimating procedure assumes no autocorrelation among \( \epsilon_{i,t} \), which can be tested using the estat abond command. In the reduced form equation, xtabond uses lags of the sequentially exogenous dependent variable as instruments for \( \Delta y_{i,t-1} \) and differences of the strictly exogenous explanatory variables as instruments for themselves. However, in the structural equation, xtabond estimates coefficients of the level model. Overidentifying restrictions can be assessed using estat sargan. One caveat of using xtabond is its assumption that \( E[\alpha_i \Delta y_{i,t}] = 0 \) in the reduced form equation (StataCorp, 2009). If the coefficient, \( \rho \), of \( \Delta y_{i,t-1} \) = 1, but in reality \( \rho \neq 1 \) in the reduced form equation, it implies that \( \Delta y_{i,t-1} \) is uncorrelated with any variable prior to \( t-2 \) (Wooldridge, 2002). In other words, there’s a problem with weak instruments which biases the use of instrumental variables methods. Furthermore, this scenario implies that IV methods cannot be used to test the \( H_0: \rho=1 \) (Wooldridge, 2002).

The use of the xtabond estimation method for the sales and employment growth models was deemed necessary after test for endogeneity of the lagged dependent variable and serial autocorrelation revealed biased results. Elimination of endogeneity concerns was attempted by use of an alternative growth rate calculation, various instruments, and alternative estimation procedures that are possible through Stata 11. The scholar decided to proceed with estimation using the xtabond command because of it simplifies elimination of autocorrelation through the use of first-differencing and use of all lagged levels of \( y \) when \( t \geq 2 \) as instruments (Wooldridge, 2002). The xtabond makes use of several orthogonality conditions that increase the efficiency of the GMM estimator (Wooldridge, 2002). The use of the GMM estimator through xtabond proved necessary due to a lack of alternative instruments which could have been used to successfully estimate the models using more traditional IV estimators.

Survival Analysis

Survival analysis is commonly used to study the occurrence of failure over time among subjects while controlling various treatments and demographic characteristics (Wooldridge, 2002). In this study, the Cox proportional hazard model which makes no assumption of the baseline hazard and five parametric models are estimated. Efficiency is a key difference between both types of models. While semiparametric models only take into account observations when failure occurs, parametric models take into account all observations which make it possible to account for time-varying covariates (Cleves, 2008). In addition, parametric hazard models require making assumptions about the baseline function. By estimating a semiparametric function like the Cox model and comparing results with parametric, one can assess whether results are consistent and then choose the most efficient functional form.

The functional form of the proportional hazards regression model is:
\[ h(t|x) = h_0(t) \exp(\beta x) \]

In this model, \( h_0(t) \) represents the baseline hazard which is left unparameterized in the Cox model. When one suspects that hazard, changes over time (i.e. increasing, decreasing, or both) then \( h_0(t) \) takes a functional form. Assuming a functional form of \( h_0(t) \) makes sense in this study since it is generally known that failure rates of start-up firms decreases over time (Shane, 2008). \( \beta \) represents the vector of coefficients that are to be estimated (Cleves, 2008).

**RESULTS**

**Hypothesis 1: Nonprofit Incubators**

Hypothesis 1 states that tenants of for-profit incubators will perform at higher levels than tenants of nonprofit incubators. The evidence from the three measures of performance point towards the rejection of this hypothesis. The strongest evidence of the hypothesis stems from the results of the Weibull model. The variable \( npo_x_{\text{post}} \) reveals that business that graduate from a nonprofit incubator have a 40% lower hazard than graduates of for-profit incubators. Furthermore, in the Weibull model, we can see that women owned businesses that are tenants of nonprofit incubators have higher levels of performance than similar businesses incubated in for-profit incubators. Women owned businesses incubated by nonprofit incubators have a 35% lower hazard rate than similar businesses incubated by for-profit incubators. Similarly, women owned businesses that graduate from nonprofit incubators have a 72% lower hazard rate than similar graduates of for-profit incubators.

The complementary relationship between nonprofit incubators and women owned businesses is also reflected in the sales growth results. The results show that women owned businesses incubated by nonprofit incubators have sales growth levels that are 16% higher than the sales growth levels of women owned businesses incubated by for-profit incubators. Furthermore, women owned businesses that graduate from nonprofit incubators have sales growth levels that are 31% higher than similar businesses that graduate from for-profit incubators. Overall, the results point towards a strong complimentary relationship where women owned businesses perform at markedly higher levels when they are incubated and graduate from nonprofit incubators as opposed to for-profit incubators.

Regarding the performance of minority owned businesses incubated by nonprofit incubators as opposed to for-profit incubators, the results are less conclusive but favor nonprofit incubators. The results provide evidence in support of the hypothesis in all three models. Minority owned firms incubated by nonprofit incubators are more likely to fail and have lower levels of sales and employment growth than their counterparts in for-profit incubators. However, there is stronger evidence against the hypothesis when minority owned firms graduate from a nonprofit incubator. The sales growth model shows that minority owned firms which graduate from nonprofit incubators have sales growth levels that are 400% higher than their counterparts who graduate from for-profit incubators.

**Hypothesis 2: University Incubators**

Hypothesis 2 reflects a test of the knowledge spillover theory of entrepreneurship. This hypothesis states that firms incubated in university incubators will have higher levels of
performance than incubators not affiliated and sponsored by a university due to benefits of being strongly associated with a knowledge producing institution.

Results based on all three measures are generally weak partly due to collinearity which led to the dropping of some of the university variables in all three models. Of the remaining university based variables which were estimated, none of them were significant in the sales and employment growth models.

The one finding in support of the hypothesis comes from the Weibull model which shows that businesses incubated by university incubators have a 27% lower hazard rate than other similar businesses while in incubation. However, findings against the hypothesis are much stronger. Results show that businesses that graduate from university incubators have hazard rate that is 95% higher than similar businesses not incubated in an university incubator. Further, evidence against the hypothesis is the finding that minority owned businesses that are incubated by university incubators have a hazard rate that is 114% higher than minority businesses not incubated in university incubators. Overall, this hypothesis is not well supported by the data.

**Hypothesis 3: Economic Development Networks**

Hypothesis 3 is a further test of the knowledge spillover theory of entrepreneurship, which asserts that locations with a high density of networks that support the transmission of tacit knowledge and information will have higher levels of entrepreneurship. In this study, this assertion assumes that networks that support business development are key. The hypothesis states that the greater the number of nonprofit economic development and business associations housed within business incubators, the higher the level of firm performance.

Generally, the results do not support this hypothesis based on the results from the Weibull model. This model shows that as the number of economic development associations increases in an incubator, the hazard rate increases by 3% when the firm is in incubation and by 10% when the firm graduates from the incubator. In other words, incubators, which host greater numbers of economic development peers, appear to face declining economies of scale in terms of the performance achieved by their tenants.

However, this general observation does not apply to minority owned businesses. For each additional economic development peer that establishes operations within an incubator, minority owned firms experience a reduction in their hazard rate of 9%. Furthermore, minority owned firms also benefit from growth in the economic development networks of incubators after they graduate. For each new member to a business incubator’s network, a minority owned graduate firm sees an increase of 16% in its sales growth levels.

**DISCUSSION & CONCLUSION**

For over 30 years, states and local governments across the U.S. have invested heavily in economic development projects with the hopes of creating new businesses, jobs, and wealth. Many of these policies have been designed and enacted without much rigorous study. The support given to the over 900 business incubators that make up the population and sample of this study are one example of many untested and unevaluated economic development programs.

The results of this study reveal that certain design features and practices of business incubators generate better economic outcomes than others do. For example, graduates of nonprofit incubators
have lower failure rates than graduates of for-profit incubators. More importantly, are the findings showing that economic performance of incubated firms varies according to the owner. For example, women and minority owned businesses appear to excel after graduating from a nonprofit incubator as opposed to their peers who graduate from for-profit incubators.

This study theorized that nonprofit incubators would generate lower levels of economic performance than for-profit incubators due to more complex goals and the lack of a profit motive. The results do not support this view and instead suggest that either better suited entrepreneurs seek incubation at nonprofit incubators or that lack of a profit motive and secured funding allows nonprofit incubators to deliver higher quality services to their tenants. Because demographic characteristics of entrepreneurs affect the generated economic benefits of nonprofit incubators, future studies should look more closely at this relationship. In this study, the minority and women owned variables are self-reported. Hence, the data does not allow for the study of how entrepreneurs of different ethnic or racial groups fare while in incubation. This is necessary given that it has been shown that black and Asian owned businesses differ in their performance do to educational, social traits, and life experiences that are distinct among these two groups (Fairlie et al., 2008). Paying further attention to this concern is noteworthy given that many national, state, and local business development programs are targeted at women and ethnic and racial minorities.

Another important finding of this study centers on the effectiveness of university incubators in comparison to other types of incubators. The measures of firm survival reveal that firms incubated in university incubators tend to have higher hazard rates post-graduation. This finding reveals either that businesses incubated in university incubators are more risky ventures than businesses incubated elsewhere or that the quality of services offered by university incubators is lower than that offered by other types of incubators. If in fact, business incubators are places for testing the commercial viability of novel research then the findings are reasonable. However, if the results reflect lower quality of service among business incubators, then findings can perhaps be interpreted as reflecting that even in a university setting businesses are not able to access the adequate knowledge resources or that university incubators lack skills in identifying their research with the most commercial viability.

While the study sought to further understanding of the knowledge spillover effects of university incubators, these findings do not offer credible evidence to support this theory. Perhaps the results can be explained by a poor measure for knowledge spillovers. Other measures of knowledge spillovers within university incubators include license agreements, patents, research citations, and faculty involvement in the management or ownership of the firm (Rothaermel et al., 2005a, 2005b). For example, in a study of 79 firms incubated in a Georgia Tech University (GT) incubator, Rothaermel et al., 2005b found that firms with a GT faculty or staff member involved in senior management were incubated for longer than those firms without GT affiliated senior management. Rothaermel et al., 2005b also found that firms with a GT license experienced lower rates of failure. Because different measures of knowledge spillovers that are unique to university settings reveal relevant results that can inform the practices of university incubators, it is suggested that future studies should focus narrowly on samples of university incubators.

The results reflecting the effects of business development networks within business incubators have some interesting interpretations. First, it is curious that growth in these networks does not generate significant positive effects for all. The measure of this variable mostly represents nonprofit organizations created to support local business development in the region where a business incubator is located. One would expect that the proximity of incubated firms to these
business support organizations would have a strong positive effect overall; however, the results do not support this conclusion.

An explanation of the results of the network variables comes from social network theory. It is known that entrepreneurs generally seek and need knowledge to first identify promising business ideas and then to acquire the resources and expertise necessary to successfully launch the business (Aldrich, 1999). When entrepreneurs lack close relationships to sources of knowledge they can overcome this barrier by seeking brokers, people and organizations which can facilitate links between two individuals (Aldrich, 1999). In this study, business incubators and their co-located peers can be considered two types of brokers and perhaps even be redundant in their knowledge and external networks. Social network theory views homogenous networks, those with many redundant ties, as decreasing in value as the network grows. This is due to the assumption that in these networks there is less new information being transmitted, all new information quickly gets transmitted, and evaluation of new information is generally homogenous (Aldrich, 1999). Because the network variable essentially captures how many other business development peers are co-located with the incubator, it tests the redundant effects of business development services. However, while the findings show that growth in the business development networks of incubators, appear to hurt performance for most incubated businesses the effect is not similar for all types of entrepreneurs. Business development networks have a strong effect on the business performance of minority owned businesses. This unique finding can be interpreted as inferring that minority entrepreneurs absorb more valuable business management knowledge from these networks than other types of entrepreneurs.

Future research on the effect of networks on incubated businesses should look more closely at how networks affect the performance of businesses based on idiosyncratic differences of entrepreneurs. In addition, this research should also attempt to control for the network traits of entrepreneurs before their firms are incubated.

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StataCorp (Ed.) (2009). *College Station, TX: Stata Press Publication*.


Table 1: Regression Results

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<tr>
<th>Variable</th>
<th>Sales_Growth</th>
<th>Emp_Growth</th>
<th>Weibull</th>
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<td>-0.0060</td>
<td>0.3580***</td>
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<td>(0.0033)</td>
<td>(0.0087)</td>
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¹Results of control variables and insignificant variables are excluded from the table