EVALUATING TECHNOLOGY BUSINESS INCUBATOR AS A TOOL OF GOVERNMENT INTERVENTION: PUBLIC VS PRIVATE

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
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Mixed results from empirical studies concerning the effectiveness of Technology business incubators (TBI) raise questions of the role of local government as a legitimate sponsor of incubators. In response to the current debate on the role of government in incubator program, this study undertakes a comparative evaluation to assess the differences both in selection of inputs and in outcomes between public and private technology incubators.

The primary question examined through this research is whether publicly funded technology business incubators could be substituted by private ones. The following questions guide this assessment. 1) What are the implications of public engagement in incubator program 2) Are there any significant differences between them in the level of performance? 3) What are the major differences that might lead incubators to succeed or fail? 4) How should public incubators be guided to promote better performance?

Using case study methodology, this research studies exemplar incubators of different sponsorship types to observe roles of public engagement for different sponsorships. Using National Establishment Time Series (NETS) data base, this research then conducts two-group comparison to exam whether performances of TBIs differ by sponsorships, in terms of sales, wages and employment.

By synthesizing findings of the case studies and quantitative findings of performance of client companies, this research concludes, that public resources may play important roles for operation of TBIs in the US. In regards to the differences in the inputs, the differences in the status and capacity of the resources provided to each sponsor may drive the differences in services and strategies. Based on the findings about primary performance, none of the two sponsorships dominates in terms of efficiency, while several differences are observed. These findings altogether imply that the old fashioned private-public framework might not be appropriate for this subject. An alternative perspective may be that the roles of public TBIs may need to be diversified. The public sector may find an active role in utilizing large-scale capital. It also means that the public sector may step back from operating tasks, as the private sector may respond to the market dynamics more effectively.

CHAPTER 1
INTRODUCTION

Background

Technology Business Incubator

Technology business incubators (TBI) have gained a wide attention as a potential strategy of local economic development planning that aims to nurture technology startups as engines of economic prosperity, due to following reasons. Young firms tend to show high mortality rate. Particularly high-tech start-ups are more intensely experiencing that problem because of the combination of their capital-intensive nature and their slow profit return. In other words, a bulk of capital is required to be invested during the pre-production stage, also known as a stage of research and development (R&D), and it tends to take a long time to make up that initial investment. The local capital lenders, however, complain about difficulties with investing large scale capital to such a risky item. From local government's perspective, this risky situation is considered as impediment that hinders the potential prosperity of the local economy (David N. Allen & Richard McCluskey, 1990; Bøllingtoft & Ulhøi, 2005; Colombo & Delmastro, 2002; R. Smilor & Gill, 1986). To response this situation, TBIs nurture targeted technology startups during their fledgling period when they are most fragile (Hamdani, 2006). Government intervention is initially justified in that these young potential companies suffer from poor survival rates (Eisinger, 1988). In this respect, business incubators include physical infrastructure as an essential provision to offset fixed costs. Yet primary role of the incubator is to provide client with monitoring and business assistance (Hackett & Dilts, 2004a).

Snapshot of Business Incubator of the US

Primarily business incubators were the instrument of urban renewal and community development. Then in the 1970s, the incubator industry became a tool for commercialization of

university research and technologies (Hamdani, 2006). The movement to establish innovation centers was initiated by support of US national Science Foundation. After this, universities became more enthusiastic in operating incubator facility as a means of technology commercialization (Hamdani, 2006). In this period, one of the major issues arising from activities related with technology development was controlling spillover effect. Knowledge spillover refers a production of non-appropriable knowledge. Once knowledge generation activity is regarded as non-appropriable, firms are discouraged to invest in innovative activities, such as R&D. This occurs due to failures in protection of outcomes of research and technology generated by innovating agents, such as New Technology Based Firm (NTBF) (Kaiser, 2002). The Bayh-Dole Act in 1980 was an approach by congress to reduce such risk of engaging in research activity and commercializing the outputs of federally funded research (Hamdani, 2006) . This enabled business incubators to serve as tool of urban revitalization, a means of technology transfer and commercialization.

The majority of business incubators are managed by non-profit organizations. There are also for-profit incubators that target creation of returns to shareholders. Technology business incubators comprises of about 40 percent of all incubators. The remaining 54 percent of incubators serves business from all industries. This type is commonly called mixed-use. In terms of geography, about half of all incubators operate in urban areas (Knopp, 2007). Thirty-one percent of North American business incubators are publicly sponsored. Incubators served by government entities cosntitute 21 percent of the total. NBIA also reports 8 percent of incubators as being sponsored by more than one sponsor (Knopp, 2007).

Issues of TBI as an Economic Development Program

Economic development policy geared toward promoting employment growth through the innovative economy often requires strong justification for two reasons. First, policies to target

employment growth and innovation are expensive (Bartik, 1990). Also, job growth and innovation can take place without external help. For these characteristics, government intervention for economic development is justified only when 'market failure' is explicitly perceived (i.e., a situation when the market economy alone fails to maximize efficiency). Similarly, a careful approach is always suggested when a government program is likely to distort market mechanisms, since public programs tend to be less efficient than private actors. In this sense, delicate choice of action is critical to make a public program successful (Bartik, 1990; Gruber, 2005). Therefore, a good policy evaluation is generally an answer to the question; "why should government act the way it does," unless it is to be a pure economic analysis.

Revisiting the primary inquiry of policy study, this study particularly investigates the relationship between government intervention and the efficiency of technology business incubators (TBI) in the US context. Efficiency is indicated by the performance levels of tenant and graduate firms, and they are compared by the types of sponsorship.

Direction of This Study

To fulfill the primary goal of this study that examines different level of performance compared to sponsorship, a cross-program comparative evaluation has been utilized. The cross-program evaluation method is defined as a framework that compares program performance of multiple groups by analyzing level of performance of 'incubatees' divided by the types of sponsorship. Most of the existing studies employ a quasi-experimental method that compares the level of performance between a control group, 'incubatees' and a compared group, 'non-incubatees', to shows the effectiveness of programs. The framework of existing evaluation studies as 'control group vs comparable group' compares incubatees and independent startups, the framework of this study is 'control group A vs control group B' that compares incubatees of group A and incubatees of group B.

The remainder of this chapter discusses the rationale for this study. The characteristics of TBI are explored as a tool of government intervention. Discussion about issues that have gained attention from existing studies will serve as a conceptual platform for the discussion of the research question of this study. The following section explains the structure of this research and addresses sub-questions that relate to the primary question that is, the relationship between sponsorship and program efficiency.

TBI as a Tool of Government Intervention: Market Failure Approach

Business incubators (BI) are widely accepted as a tool of government intervention, due to the popular consensus that the success of small business requires external help and the capital market does not provide a patient investment (Jenssen & Havnes, 2002; Rice, 1992). As previously noted, government intervention is a way in which public authority comes into play where market mechanism fails (Hackett & Dilts, 2004a; Jenssen & Havnes, 2002). The term, "market failure" refers to a situation in which aggregated economic exchange of independent market agents end up failing to maximize the utility of public resources (Eisinger, 1988). In order to remedy such situation, public resources are often invested to adjust the imbalance of supply and demand in a way to optimize utility. In the case of high-tech markets, a major symptom of market failure is a high rate of early drop out of high-tech startups which otherwise could bring economic prosperity to a region.

High Mortality Rate of High-Tech Startups

A high rate of early dropout among small firms generally indicates a lack of managerial skills and access to capital, instead of being a special character of high-tech startups. Eisinger attributes this problem to rational, risk-averse behavior and some imperfections in the market (Eisinger, 1988). In particular, high-tech start-ups are more intensely experiencing the problem because of the combination of their capital-intensive nature and their slow profit return. In other

words, a bulk of capital is required to be invested during the pre-production stage, also known as a stage of research and development (R&D), and it tends to take a long time to make up that initial investment. The local capital lenders, however, complain about difficulties with investing large scale capital to such a risky item. Not surprisingly, venture companies are typically young and new to local bankers. Unknown young companies are a type of company least favored by bankers. Conceptually speaking, capital demand exceeds the capacity of capital supply.

From local government's perspective, this risky situation is considered as an impediments that hinders the potential prosperity of the local economy (David N. Allen & Richard McCluskey, 1990; Bøllingtoft & Ulhøi, 2005; Colombo & Delmastro, 2002; R. Smilor & Gill, 1986). In general, small businesses are well known as job generators (Stam, Suddle, Hessels, & Stel, 2007). High-tech startups are usually expected to have even greater potential to generate new jobs and become innovative leaders in local and regional economies (Malecki, 1991). Potential positive externality is assumed as probable, including increased income. Government intervention is justified in that these young potential companies suffer from poor survival rates (Eisinger, 1988). A government intervenes using public resources to remedy the market failure and to build a patient, nurturing environment in which those young firms can survive and grow (Allen & Rahman, 1985; Malecki, 1991). In this given situation, TBIs undertake particular roles to reach the goal of bolstering local economies and channeling government resources to help the potential economic agents.

Origins of TBIs

In general, TBIs are an effort to enhance innovation and entrepreneurship to respond the challenge. Historically, university-affiliated innovation centers came as a first type, developed by National Science Foundation (NSF) in 1973 (Campbell & Allen, 1987). They started as an experimental program "to enhance entrepreneurship education, development of new technologies

in existing companies, and the establishment and nurturing of new businesses" (Campbell and Allen 1987, p.180-181). Although the NSF has no direct role in the development of incubators, the model is still being adopted and replicated.

Small business incubators coordinated by university-sponsored Master of Business Administration (MBA) teams provide managerial services and advice, rental space, and office supplies. The service also includes networking opportunities, access to local venture capital, and links to research activities that are only available in a university setting. The Technology Park (TP) or Science Park (SP) is the most popular models. Technology business incubators are, in many cases, services included in an SP package (Tamásy, 2007). In summary, as an intervention tool, business incubation services provide a package of real estate-based services, managerial and strategic advisement, technical assistance networks, and new, early-stage capitalization mechanisms. (Campbell & Allen, 1987; Sherman, 1999) In this way, SBI programs aim to achieve efficiency as well as a high rate of survival among young firms.

Like some public services, such as public health care, business incubator programs are provided in coordinated public-private partnerships. Partnership is a way to combine advanced management skills from the private sector “with the risk bearing capacity and resource of the public sector” (Eisinger 1988, p.22).

Business incubators are often affiliated with universities to promote the effective management of public investment in technology. Phelps and Brockman (1992) found that most states limit their own roles as investors and let local institutions, universities, or colleges operate the incubators. Possible models of TBIs include partnerships with public investment and private management, and vice versa (Paul Westhead & Batstone, 1998)

General Roles of TBI

TBIs are external actors that work with the market, firms, and venture capitals with an aim to help young companies survive and succeed (Rice, 1992). Mian puts emphasis on the role of 'networking' business, capital and social inputs (Mian, 1996). Soetano and Geehuizen (2005) also view incubators as 'intermediary agents' and state that for TBIs favorable conditions are created in which firms and non-corporate institutions interact (Soetanto & Geenhuizen, 2005). Second, TBIs play a role in coordinating actions in positive directions or in discouraging any negative outcomes to be produced to enhance formation of young firms, which also means that TBIs are a tool to encourage creations of university based spin-offs (Löfsten & Lindelöf, 2001, 2005; Tamásy, 2007).

Third, TBis change circumstance to encourage all participants to collaborate and eventually to succeed (Sherman, 1999). Improving access to venture capital is considered as an important service that incubators provide. Through this service, each party finds an available provider and customer. In addition, Smilor and Gill (1986) finds roles to leverage talent, to accelerate the development of new firms, and to commercialize advanced technology.

The tasks of the TBI reflect its demand-side approach, mostly real estate based programs, including the provision of affordable rent, shared office space and office supplies, managerial advice and legal consultation, and fostering networking between firms within the facility and within the local economy (Lo¨fsten & Lindelo¨f, 2005; Löfsten & Lindelöf, 2002; Mian, 1996). Provision of essential resources and services reflect progressive activism, which stimulates positive externalities and deter any unnecessary waste due to possible outcomes of trial and error.

A Tool of Technology-Based Economic Development (TED)

As one program of small business oriented policies, the TBI intends not only to remedy, but also to lead local economic growth as a desirable strategy of local economic development

(LED) (Esisinger 1988). Programs driven by TED policy are legitimately supported since TED is accepted a mode of establishing linkages between technology and innovation and new industrial and economic growth (Phillips, 2003). Economic competitiveness is likely to be achieved through innovative activities (Schumpeter, 1934; Paul Westhead & Batstone, 1998). According to Schumpeter (1934), long term economic development is achieved through leapfrog innovation in advanced technology (Phillips, 2003; Schumpeter, 1934, 1939, 1942). Relying on Schumpeter, Phillips (2003) contends that industry learns to adapt to continuously challenging market conditions by implementing new innovations into products and processes, especially in a market situation in which technology plays a crucial role. Appreciating the value of knowledge, the regional economic development practitioners chose to direct their efforts towards building knowledge-based economic structure for territorial innovation (Malecki, 1997). In an effort to achieve this paramount goal, a variety of new concepts were introduced, including: innovative milieu (Aydalot, 1986), the science park (Löfsten & Lindelöf, 2003b), and new industrial spaces (Soetanto & Geenhuizen, 2005). Incubators are touted as the most effective engines that invigorates the competitiveness of the local economy (Phillips, 2003).

Phillips (2003) noted, competitiveness is the "ability of an industry to produce qualitatively differentiated products and respond quickly to market changes." Rothwell and Zegveld find, in concert, that an innovative economy is an engine for a country to leverage their economic competitiveness in the international economy (Rothwell & Zegveld, 1981). In other words, high-tech firms are found driving leap frog innovations based on unconventional technical approaches. In short, new public intervention oriented toward technology-based firms (NTBF) are a popular choice since it is a strategic choice of LED (Colombo & Delmastro, 2002).

Evaluating TBI in Policy Context

Levels of Policy

An evaluation study requires a thorough understanding the scope in which the subject policy is structured. Hughes (1991) contends that a research framework for both policy evaluation and analysis should systematically consider the 'organization's structure of the agencies involved, the internal pressures of competing policy objectives and the feasibility of designing (Hughes, 1991, p. 911)'. These aspects are often defined by a program's range and scope, which are established by the policy agency.

Therefore, misguided evaluation study may only provide mistuned implications. For instance, evaluation of one 'program' may have impact on national policy, but the implication would be fairly limited. Rather, such a program evaluation study may change program guideline that local government should follow.

This is a reason that understanding the level of policy is critical. According to Hughes (1991), there are four broad levels in the policy field. 'National policy' is the first level, which is established by central government. Then, the second level is 'strategies' involving broad approaches to development. Diverse priorities and sectoral balance are examples of strategies. The third level is 'policies' that provide conceptual targets of the given 'strategy'. Forth level is 'programs'. The program is a set of detailed action to achieve the targets of a corresponding policy with more practical measurement. At this step, allocation of financial and staff resources are coordinated based on the agency's strategy and priorities. Conceptually speaking, TBI is a program which is structured in a strategy that targets building an innovative economy.

Evaluation Study in Policy Context

Another aspect of an evaluation study for policy is that it should reflects policy context, rather than remain as providing management implication, which can be relatively neutral about

the political context that has in fact a greater influence on technology policy. Here, a primary concern of the evaluation study is to test whether a program works or not. Quasi-experimental method is effective in showing the difference between a group under control of policy, and the other group that is free from policy influence.

Although effectiveness is a one of the important issues of evaluation study, a program evaluation only highlights effectiveness would be limited in serving the needs of public agency that should make a wise choice among many options. In other words, effectiveness is important, but not the only concern of public agency. They also concern discriminating which program serves the stated goal better than alternative options. An agency may be misdirected if an evaluation study disregards this political economy by only highlighting the efficiency of one program. In this sense, following four critical issues should be addressed for an evaluation study to be well structured in a policy context.

- when the government should intervene in the economy
- how the government may intervene
- the effect of intervention on the economy
- why government chooses to intervene in the way it does

In regards to the above mentioned critical four issues, Hughes (1991) abstracted and reformulated these issues in a more conceptual manner. According to Hughes, a desirable evaluation study should include the following four aspects.

- the ability to compare actual performance against target performance;
- the ability to compare similar departments and programs;
- the ability to highlight key issues and areas of interest;
- the identification of trends over time and the development of specific norms or targets (Jackson & Palmer, 1989)

Hughes continues to suggest that the study framework should include performance measures “which provide ex-post evaluation but with discrimination among effects” (Hughes

1991, p. 911). The framework should thus provide guidance on policy amendments 'that will increase the effectiveness of policies (Hughes 1991, p. 911) '. In short, a meaningful evaluation can be produced when program objectives and allocation of resources, usually categorized in programs, are addressed in relations to each other.

Problems of TBI Evaluation in Policy Context

Most incubator studies in the existing literature test the effectiveness of TBI by investigating the differences in performance between control group, the tenant firms and comparable group, non-tenant firms. This framework, named 'program vs non-program', has the potential to describe the actual target performance. Here, the target performance is the effectiveness of the incubator program, indicated by the level of performance of tenant firms. Also most of these studies coordinates relatively well between program objectives and performance measurement.

Recall that policies are implemented under the pressure of competing objectives and alternative programs. The existing framework, which only highlights the fruits of the program, is likely to fail to provide referential insight about which program performs better among given active options. As previously mentioned, 'program vs. non-program' framework only measures the effectiveness of a policy, which, for the purpose of this discussion, is TED. According to Hughes, this framework is useful only for addressing the 'third level' of LED. Pertinent issues included in the fourth level of LED, including programs that involve financial and staff resources, still remain unaddressed since different programs are not compared within the framework. Consequently, if an agency solely relies on this framework, differentiating the different efficiency of different programs would be nearly impossible. Resource allocation and staffing strategies are likely to become arbitrary.

Legitimacy of Government Intervention

In regards to the incubator issue, theorist and empirical researchers have focused on issues centering around the legitimacy of a policy program and the potential effects of local resources on developing an innovative economy. Any type of public resource allocation, aiming to give economic agents incentives, involves the intervention of public agencies, venture capitalist, and higher education institutions (HEI). These interventions aim to provide environmental infrastructure that nurtures economic agents who are less likely to survive and grow if there is no external help (Flynn, 1993). From the public agents' perspective, this intervention provides valuable resources that the private agents could not have accessed otherwise (Flynn, 1993). In this way, the utility of those resources is expected to be maximized.

The question here is the degree to which government could intervene in the market as the 'invisible hand', which is believed to be the best agent for maximizing the utility of limited resources. Is it legitimate for a government to determine the candidacy of market agents? How does a government know who is going to be a winner? Does it even work? (Flynn, 1993) These are the questions asked by market advocates who are suspicious of the role of government intervention in general, and of intervention in incubators.

Pessimism on direct intervention of public sector has been deeply rooted in neo-liberal economic perspective that uncritically champions market capitalism as a single principle that determines who should participate and who should survive, and to what degree. It further supports non-interventionism that asserts laissez-faire and free market as preconditions that are necessary for economies to function productively. The underling philosophy of this position is that market price is determined by equilibrium between demand and supply.

Influenced by this perspective, government has long been generally considered as an ineffective producer. This perspective has also been evolving as skepticism on public

organization. According to this perspective, government is less knowledgeable (i.e. less effective) in information acquisition than market agents. Measures of supply and demand based on government decisions fails to reflect actual market conditions for lack of accurate information. Government may not know where to increase investments and where to withdraw investments. Also, neo-liberalism contends that government tends to be sluggish in responding quickly to changing market conditions. In contrast to market agents, who are mostly interested in making profits, government works with multiple stakeholders who do not share a common goal. Driven by multifaceted goals and norms government actions may guide the economy in an undesirable direction. Finally, this perspective introduces size of public agent being large as one of the factors that hamper effective performance. It claims that such a large organization also hinders prompt decision-making. Because of this, government intervention and regulation often cause a distortion of market mechanism. In sum, conventional economic theory is deeply suspicious of the roles of government in the economy. It states that government more often than not fails as economic agents and only has a negative impact on economy. This implication stems from such perception that government is less knowledgeable, less adaptable, and less efficient than market agents.

Based upon empirical study, the public sector does not necessarily show significant difference in efficiency compared to private agents (Atkinson & Halvorsen, 1986; Borger, Kerstens, W.Moesen, & Vanneste, 1994; Levie, 1993). Some indicate economies of scale as an affective variable, rather than the ownership (Christoffersen, Paldam, & urtz, 2007). Theories also provide rationale behind such empirical findings. Focusing on economic development in conventional economic theories, government intervention is conditionally justified when it offsets market failure. Market failure is conceived when private market fails to achieve

‘economic efficiency’. In such a situation, net social benefits do not result. When a negative externality occurs, such as toxic chemicals releases into a river from a factory, a government can legitimately intervene to mitigate the problem. When a positive externality is conceived, but market fails to realize the benefits, a government can legitimately intervene to maximize utility. In other words, when a good is considered as non-rival and non-excludable, intervention by the public sector is justified in that it may enhance productivity and efficiency in making business out of such goods (Musgrave & Muscrave, 1973). Fortunately, there seems to be a sound consensus to technology business incubator is an appropriate form of public intervention.

In this context, supporters and critics both agree that an incubation program is only justified when it makes an increase in ‘net benefits in social welfare’(Flynn, 1993). More specifically, due to the difficulty in measuring incubators’ impact on ‘net social welfare’, indirect measurement is used to evaluate program performance. Growth rate in employment, sales, and survival rates are examples of indirect measurements. They may be regarded as ‘direct’ in terms of the impact of incubation service, but considered ‘indirect’ because they only arbitrarily indicate the degree of impact on ‘net welfare’, which is the ultimate target the program aims to achieve. The focus of this argument is that it is not conclusive whether technology incubators generate a positive impact on net welfare.

Public Intervention in Technology Policy

Generally speaking, government intervention in technology policy has diverged from two modern economic theories. This primary theoretical diversion typically emulates one that has been applied to the discussion of roles of government in industrialization (Heijs, 2003). On one hand, broad support for non-interventionism, laissez-faire (Smith, 1776), has been in place. Although, a role of government has been attributed as a force to stimulate and expedite industrialization.

The importance of this dispute lies in the fact that government intervention always implies allocation of limited financial resources and strategic approaches to maximize utilities of the resources. Furthermore, justification of a certain financial policy depends on the 'effectiveness' of a program. It seems that general principles of evaluation criteria apply to this particular policy.

In the same line of reasoning, the incubator program, as a particular program of LED, only could be justified when 'net social welfare' increases (Heijs, 2003), while the difficulty of calculating 'net social welfare' is another issue. As Georghiou (Georghiou, 2002) notes , public intervention is justified when 'additionality' is observed. Additionality is defined as achievement or improvement attributed to policy effect. Input side additionality is reflected by an increase in R&D investment. This input side additionality is, however, only a necessary condition that is expected to draw innovation, not necessarily a sufficient condition that guarantees actual 'return' of public investment. Observation of the output side additionality, which is technological and commercial additionality, would mean the 'effectiveness' of the intervention. Lalkaka (2003) observes potential positive aspects of TBIs as following.

- Creation of jobs at reasonable net $ public subsidy
- Taxes paid by corporations & workers per net $
- Reduces gestation and costs of entering market
- Enhances chances of success (2 to 4 times)
- Income, sales, exports generated for community
- Disadvantaged regions and groups empowered
- Client satisfaction at services, costs saved, time
- Sponsor satisfaction at return on investment
- Promote climate for innovation & entrepreneurship

In short, government financing in technology development is one of the issues in which the same economic theory may be applied in the following different ways. First TED implies a government intervention on the private market. As justified by market failure theory, public intervention in incubator business appears to be inevitable (Allen & Rahman, 1985; Bartik, 1990;

Malecki, 1991). Second, it entails public investment, using tax dollars. Therefore, a subsequent question is which way can one maximize utility using limited resources, i.e., tax dollars. Third, program 'effectiveness' is one of the most important evaluation criteria. The bottom line is that inviting public agents to the private market is justified when such an intervention first creates an 'incentive' for private agents to participate in the game more aggressively and when it generates a solid benefit to the communities which bear the cost for the intervention.

Criticism on the Public TBIs

Critics of incubation programs severely hammer the legitimacy of the program, as a waste of money and as a failure in making significant differences in its recipients' level of performance. Incubator programs are perceived as an unproductive policy approach that is driven and fed by political delusion (Tamásy, 2007). Based on the same logic applied to criticisms of general technology policies, Tamásy (2007) calls for a withdrawal of public intervention because technology incubators are not as effective in creating positive externalities as expected. Instead, she suggests roles of private management without public funds. She reports that German technology incubators fail to promote a sustainable high-tech economy because the number of sponsored firms is too small and even decreasing. In addition, the potential of the incubated firms appear to be poor since most of them do not show satisfactory levels of technological sophistication (Tamásy, 2007). In this case, about 20 percent of the companies were not even newly founded; they were an average of two years old when they were incepted to the facilities (Tamásy, 2007). Also, the incubator did not appear to provide potential entrepreneurs with motivation (Tamásy, 2007). Nearly all of the founders indicated that they would have started their business even if there was no incubation service available. The report indicated also that the availability of incubation services does not even attract quality firms from outside. It may be attributed to the immobility of firm founders, which is usually associated with local resources

and knowledge that the founders have already acquired from previous work experience (Tamásy, 2007).

Empirically speaking, however, no significant difference is substantiated between types of incubator sponsorship. There are private incubators, which are for-profit entities. As evidenced by the NBIA report (2003), public, not-for profit incubators were not outperformed. Can we conclude, then, that there is a justification for dismissing public intervention? Such findings imply that sponsorship may not be the one that solely determines the effectiveness and efficiency of incubator program. The bottom line is that failure in observing significant differences of what is inside may enhance the credibility of comparative evaluation.

It may be true that the performance of incubation programs failed to make a difference compared to those companies without incubator services. Also, it is true that the incubators are under governmental influence. Nevertheless, there is still not enough empirical and analytical evidence that the performance of public incubators is poorer than private ones. For now, the only legitimate implication is incubator programs may be an illusion, regardless of type of sponsorship. They are in a dichotomous world where only two groups of firms exist. One is under the influence of an incubator and the other is outside the garden. Critics are mistakenly inviting private incubators to their world as saviors. However, they are more like inexperienced aliens than saviors.

Conclusion and Summary

The purpose of this research study is to investigate the relationship between sponsorship and the performance of TBIs. The efficiency of incubators by sponsorship will be compared in multiple dimensions that are prevalently employed in diverse incubator evaluation studies. A major strategy of this study is to minimize the chances of making biased assumptions is to utilize diverse methodologies so that each of them can address shortcomings of each other. Absolute

numbers and figures will be still used as references even though their potential drawbacks are fully acknowledged. Absolute values are still important for policy agencies as the most commonly used tool for illustrating program effectiveness and efficiency, due to its intuitive nature, which effectively highlights subtle differences that may not be outstanding by absolute figures only.

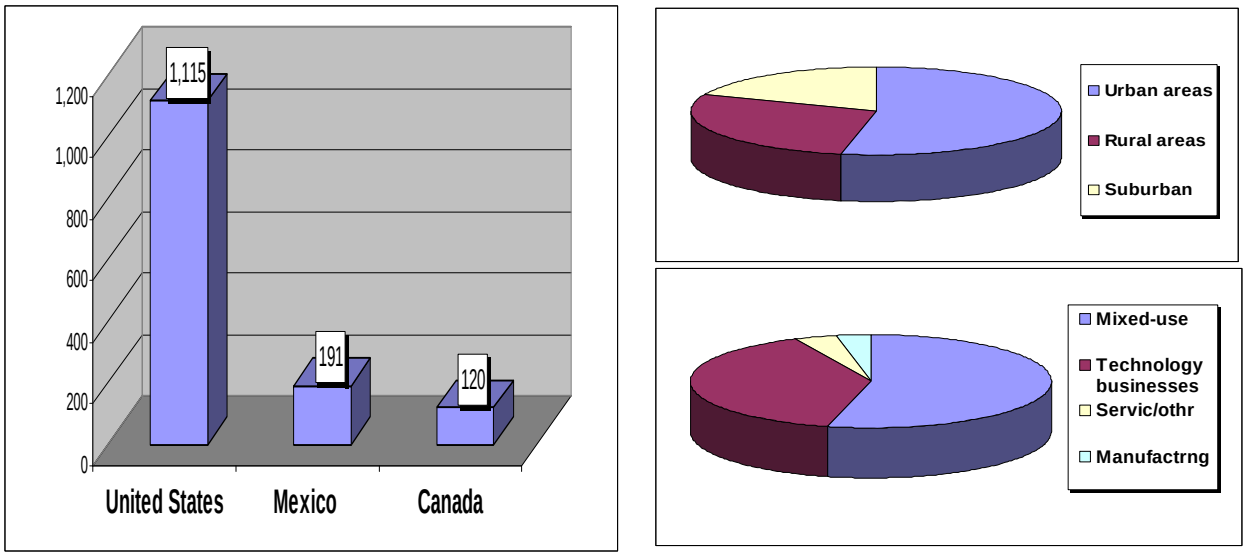

Figure 1-1. Snapshots of technology business incubator

CHAPTER 2
LITERATURE REVIEW

Introduction

As evaluation makes significant progress in incubator studies, major debates are formed around several topics. A major approach for discussing effectiveness of TBIs is to measure the productivity of the output compared to the input of a policy program. Studies focusing on the attributes of input analyze different arrays of services which different incubators provide. The effectiveness of inputs and outcomes have played an important role in the discussion of whether incubators are actually good enough to serve their original purpose: delivering economic prosperity to local or regional economies. Literature considering input attributes is important for establishing a theoretical platform for the justification of this study's primary independent variable, the type of sponsorship.

This literature review discusses the implications of existing studies for each topic in order to enrich understanding of operating mechanism of TBIs. This chapter is structured in two parts. The first section briefly explores existing studies concerning the relationship between sponsorship and the performance of the incubator. The second section is then dedicated to the different approaches and arguments of evaluation issues. This section also explores the subtopics related to the 'effectiveness' of incubator services. The studies are generally in favor of the conventional expectations which favor the effectives of incubator services, but several points are suggested as either unclear or questionable. Existing studies are explored as samples of each approach. Limitations and utilities will be briefly mentioned to build a methodological platform of this study.

Taxonomies of TBIs by Sponsorship

Several authors discussed the taxonomies of the incubators. Mian (1994) questions whether sponsorship generates any difference in incubator performance. He conducted an extensive exploration of procedural characteristics of university sponsored technology incubators (USTI). Although his study does not compare the level of performance, the work is one of a few studies which conducted a comparative analysis over different program sponsorships. Three state university-sponsored and three private university-sponsored facilities are compared. Thriteen Key dimensions are explored to measure practices and performance. They include their origins and objectives, organizational design, governance and policy guidance, tenant performance review procedures, funding sources, targeted technologies, tenant entrepreneurs' personal traits, impact on tenant firms, strategic operational policies, services, and their value-added services for the client firms. Extensive interviews were conducted and survey research was supplemented. Survey data was collected from 47 respondents out of 150 contacts during 1991 and updated near the end of 1993. The conclusions were unexpected. There seems to be no significant difference in performance regardless of public or private university sponsorship. The author thus infers that regardless of the types of sponsorship, USTI in the US context has almost the same implication to the local or regional community. The conclusion is notable because it finds that almost all USTI articulate 'not-for-profit' objectives in accordance, but both sponsorships are found to still be effective in drawing private investment. This conclusion still, however, appears to be premature or incomplete since it only 'implies' a positive consequence of the community activities motivated by the incubator, but consequences in enhancing performance of startups itself has not been empirically established.

Another shortcoming of this study is that the study excluded "for-profit incubators", which might impose some different directions in their program, thus it may affect the performance of

the startups. Since all USTIs are categorized as ‘non-profit’, the conclusion in favor of indifference might be biased from the beginning by the misleading classification. The inference drawn by this study, although seemingly attempting to tackle the public/private partnership issue, appears to suffer from its overgeneralization of the classification of USTIs’ sponsorships. For the purpose of making a more distinctive comparison on the effect of private and public sponsorship, alternatively, a comparison between for-profit and non-profit would be more relevant.

Since the given findings reject the mentioned difference, this study might be an anomaly of the general theory that admits different effects of different sponsorships. Enriching empirical study is still meaningful for testing the theory in application to incubation research, if it conducts an investigation of the relationship between such partnership and the level of performance. Mian revisited this study in his later works and drew a positive implication on incubation performance. These works will be discussed later.

Sherman (1999) presented an additional study on the same subject of Mian. Dealing with the sponsorship issue, Sherman conducted a performance based evaluation: a ‘pro’ incubation study that affirms positive changes in the graduate’s performance. The primary purpose of this study was to examine the extent to which business incubators are effective in improving survival rates of startup businesses. Three methods of study were used. Using a quasi-experimental method, the study compares outside firms (comparable group) with the clients (treated group)commencing the use of incubators between 1991 and 1996. From a national sample, a total of 49 incubation programs provided a list of clients and graduate companies. Finally, the sample consisted of 126 companies who returned the questionnaires. The macro-economic model was also used to calculate the economic impact of the incubators. Twenty-three firms

were chosen from 4 incubators. It included 2 technology incubators and 2 mixed-use incubators. The third methodology is called 'stake holder analysis', primarily relying on survey research methodology that measured the stake holders' perceived value of the business incubator.

This study contributed to enriching supportive insights by illustrating the positive economic impact of the TBI program. Although it widened the horizon of evaluation study by using three methodological applications, the study largely reiterates the points that have already been made by existing supportive studies. It successfully reassures the effectiveness of the incubator, but is still unable to measure the influence of different sponsorships.

The major difference between the above two representative works dealing with taxonomies of incubation programs is that first one focused on the differences of input by investigating service provisions, whereas the other work viewed the same issue from multiple angles. In response to debates about sponsorship, Tamásy (2007) questions the legitimacy of public investment in incubation programs. Thereby, she suggests the withdrawal of public intervention and allowing private actors to deal with the issues.

Tamásy claims that the incubator program is created based on a political foundation, but that the actual effect of the program is either exaggerated or not empirically substantiated. She reviewed empirical studies and highlighted the ineffectiveness of the program. Empirical studies conducted in major three countries, the United States, New Zealand, and Germany, are explored as evidences of the negligible effectiveness. According to Tamásy's review, literature converges on the point that the incubation program is either ineffective or the effectiveness is offset by the operating costs of the program. Employment generating power is questionable. Survival and growth rate is only marginally improved by the incubation program. Typical optimism supported by major organizations, such as the NBIA are criticized as misguiding reports, based

on either dismissible figures that do not base any statistical significance, or the significance is misleadingly represented. The conclusion is that the public role, in especially the technology business incubation program, should withdraw its financial commitment since this public expenditure fails to serve public interest. Suggestions are made for calling for the role of private agents to handle this issue.

These reports are couched in a logical structure that public intervention on the technology business incubation program is only justified when the investment, through the program, serves to effectively deliver the desired goal. It introduces a series of articles that shed suspicious light on the effectiveness of business incubators. The conclusion inviting private agents as major providers, however, appears to be premature for two reasons. First, although the report stands on a fairly logical structure that focuses on the 'effectiveness' of the incubation program, it is not comprehensive enough. It does not account for the significance of the 'market failure' phenomenon, which is the primary reason that the private party is not motivated to play a role in this venue. Obviously, as long as a risky image of technology startups persists, expecting private actor's involvement is naive. Second, the report does not provide any empirical evidence that private agents do their job better than public agents. There is no theoretical or empirical ground to support the roles of private agents, especially when only the 'effectiveness' of a program is focused on. In addition, the report does not provide any reason for its distrust causing the arguments made in favor of the 'effectiveness' of the incubation program. In sum, the report suffers from an unbalanced perspective, seemingly because the report does not stand on its own empirical research, whereas it was a valuable attempt that calls forth deliberation on roles of public and private agents in incubation program.

Effectiveness of Technology Business Incubators

The definition of 'effectiveness' for the existing studies refers to whether an incubator could enhance the performance of the startups. Since the performance of the startups is considered as a consequence of incubator service, the effectiveness of incubators is examined using indirect measurements. The performances of startup companies are regarded as proxies that may reflect how well an incubator does its job.

Overall, the findings appear to be mixed. In accordance with the affirmative works in the previous section, the potential benefits of incubation services are supported, but its validity is questioned. However, the studies mostly provide empirical evidences in favor of improved survival rate, growth rate, and the innovative activity in terms of patent generation. Indicators include the 'survival rate', the 'growth rate' in terms of employment size and sales revenue, and the 'innovative activities' of the firms that received incubator services. Higher survival rate implies that incubators have helped the firms 'survive' the fledgling period that is hazardous for young high-tech firms. Growth rate in employment and sales revenue indicates incubators' contribute to the local and regional economy, primarily serving the political needs that seek research backups for continuous revenue support for the incubation program. Innovative activities, often indicated by the number of patents made by the startup firms, are considered as an important criterion that indicates effectiveness of an incubator. The following studies are the examples of individual attention on each subtopics of the effectiveness issue.

Mian (1996) analyzed value-added contributions of UTBI to tenant firms. The typical incubator services and university related services were analyzed using the same sample that he himself used for his previously mentioned work. The author found a positive impact of UTBI on the performance of tenant firms. But as it focused only on the physical supplies and infrastructures, it failed in appreciating the value of intangible value-added services, such as

psychological supports, managerial intervention, and miscellaneous activities including seminars, meetings, and mentoring with local entrepreneur activists. This limitation may open up a possibility for a future research on the relationship between tenant performance and those attributes unaccounted for. Also, the survey-based measurement may suggest another bias related to the positions of each participant. Service recipients are usually appreciative of the providers. Although cross-program comparison is absent in this study, this study not only contributes to enriching general understanding of incubators, but also provides a set of bench marks from which policy implication could be drawn for future development of incubation.

Mian's emphasis on the roles of universities on incubation performance continues and even becomes explicit in his later work: "Assessing and managing the university technology business incubator: an integrative framework" (Mian, 1997). In this work, using the same data set employed in the previous works, an integrative framework is employed to conduct a comparative evaluation study. The study compares and evaluates the level of performance of different programs that shared the similar core objectives, while the comparison was not based on the different sponsorships. Three performance dimensions are analyzed: (1) program sustainability and growth; (2) tenant firm's survival and growth; and (3) contributions to the sponsoring university's mission. General growth in revenue and employment was again found as being positive affectedduring the incubation periods. A general positive impact was observed in all dimensions tested together in the integrative methodological framework.

Colombo and Delmastro (2002) conducted another comparative evaluation with an aim to answer the same question: whether TBI contributes to the formation of NTBFs and their growth. A sample of 45 Italian independent NTBFs was compared with a similar group that is consisted of a matched sample of 45 similar off-incubator firms. The result appears to confirm the

conventional optimism for the incubation program. Incubated firms are found to have been positively influenced by the program in terms of post-entry growth based on the number of employees. Although innovative activities are only marginally different, the report indicates that incubated firms are more cooperative with other units located in the facility and university than off-incubator firms. Output measures also indicates that the on-incubator firms show better survival and growth rate.

Siegel and Westhead (2003) tested a sub-issue: the common belief which expects a positive influence on 'innovative activities' related to research and development, instead of conducting comprehensive evaluation. Using the conventional quasi-experimental research methods, this study compares the research performance of firms located in the university science park, and firms that are located outside of science parks. In conclusion, this study reaffirms the positive influence of the incubation program with stating slightly higher research productivity from park-located firms than those firms located outside the park

In terms of its methodological shortcoming, using data collected in 1992, this study indicates its limitedness due to its count-oriented analysis. While considering the number of patents, it may dismiss the different qualitative significance of individual patents. It suggests as a remedy to conduct a productivity-oriented analysis, measuring the actual size of revenue, created by technology innovation.

Among the sub-issues of 'effectiveness', another interesting study was done by Westhead and Storey (1994) on the conditions related to the geographic location of the firms. The critical feature they suggested was the collaboration with universities based on the theory that assumes linkages between knowledge and productivity. For instance Appold (1991) finds a tendency that industrial research laboratories cluster in large urban areas with a good university.

Lo¨fsten and Lindelo¨f (2002) conducted research on the difference of SP firms and out-of-Park firms in establishing such links, especially for those firms called New Technology-Based Firms (NTBFs) in Sweden. Differences are found in three areas: sales, employment, and profitability. Generally speaking, the study reaffirms the positive impacts of SP on NTBFs in sales and employment, as found in their previous work (Löfsten & Lindelöf, 2001), but was not able to make sure its role in increasing 'profitability'. Extending the previous study, the major purpose of this study was to identify any added-value of SPs to NTBF, distinguished by other firms outside SP. The research compared the level of the formal linkages bridging among on-site-NTBFs and those for off-park-NTBFs. Their findings showed that firms located in SPs are more effective in establishing formal linkages with universities than those outside SPs. However, the NTBF in SPs were found to not have so much different in channeling the advantage to making profit. Thus, effectiveness of incubator programs on improving profitability remains unanswered, in this study. In their later study, also looking at the question of whether incubation service is effective in stimulating innovative activity'(Löfsten & Lindelöf, 2003b), they found no significant difference in profitability between the NTBFs on and off park firms. A question raised by this study concerns the gap between the high level of collaboration among firms and high profitability.

Recalling the theoretical foundation of the incubator program, 'innovation' is one of the important goals for university affiliated incubators to deliver. Based on the 'agglomeration effect', firms tend to be better off when they are located closely to each other so that they can easily collaborate. Technology based economic development is a strategy that aims to build a nurturing circumstance for many companies to find an attractive place to work together in the targeted neighborhood, eventually for them to construct a leap frog development of technology.

Two hypothetical reasons support the argument that incubators would generate the agglomeration effect. First, firms would take advantage by locating closely with other firms in SPs since they can easily work together. Second, incubation facility serves as a node that transforms pure knowledge and technology generated by affiliated universities to commercial products; young and small companies take the role (P. Westhead & Storey, 1994)

In regards to the first hypothesis, collaboration among the on-site NTBF is a critical assumption. While the previous study by Lo¨fsten and Lindelo¨f (2002) found a higher formal linkage among on-site-firms, the level of collaboration may not have been very high. It may be due to weak informal linkage, through which 'tacit knowledge' is transferred. One explanation is that on-site-NTBFs have little motivation to collaborate due to the heterogeneous character of the tenants (Löfsten & Lindelöf, 2005). The wide range of specialty deters development of collaborative relationships. The agglomeration effect may be only found for those with shared interests, while this proposition is still empirically untested. Second, in regards to the 'spill-over effect' of universities, interaction between on-site-NTBFs and the universities are usually found to be generally low, while the level of interaction is slightly higher than the relation with off-site-NTBFs (Macdonald, 1987b; Massey, Quintas, & Wield, 1992). The fact that NTBFs have only limited access to the academic resources may be one of the reasons for this.

However, this unexpected low level of interaction does not appear to hinder growth of on-site-firms. As indicated by previous studies, sales and employment growth are indeed found higher from on-park NTBFs than outside firms. Backed by Link and Scott (2006), the NTBFs located in the university affiliated SPs shows a better survival and growth rate, as proved in other studies. They found that the number of universities formally affiliate with the park is positively linked to faster growth. Also, company location being closer to the park is found to be effective

for firm productivity, echoing the existing studies (Audretsch & Feldman, 1996; Feldman & Audretsch, 1999; Henderson, Kuncoro, & Turner, 1995). This finding should not be interpreted as university managed parks being more effective, since they also found that parks managed by private organizations drive a faster growth rate than the park operated by universities. One of the findings of this study to note here is that technology focused incubators show a faster growth rate, especially in the information technology industry, than parks without a technology focus. The other interesting finding is that slower growth is reported from SPs than with incubators, when compared to the SPs without incubators. Also university ownership, whether the university is private or public, does not show any statistical significance in influencing on the firm performance. Reaffirming that park formation does increase efficiency of innovative activity, the study concludes that closer proximity, private operation, and a technology-focused strategy are three elements that make a difference for the firm performance.

As noted by Link and Scott (2006), the agglomeration effect may be found on a site if one serves a narrower target businesses, such as the bio-tech industry or information technology, so that the companies can find a stronger incentive to collaborate. The other reason that high-tech incubators show a weaker agglomeration effect may be the characteristic of their market being global rather local (Löfsten & Lindelöf, 2003a). Obviously, world-wide, long distance trade range dismisses the significance of physical distance from one central market, which was assumed to affect location pattern for certain traditional industries. The conventional location theory rests on the notion that distance based variations in industrial locations are affected based on the characteristics of products and foods for each industry. In this logical structure, delivery cost, determined by distance, was an influential factor that affects the decisions of a location of a company. This variable may not be a strong determinant to the high-tech industry as it was to

the traditional industries (Markusen, 1986). Also, a formal linkage, found more with on site NTBFs, may not have such a meaningful significance since the trust based collaborations tend to work better through informal relations, which is used as channels for exchanging 'tacit knowledge'. These findings all look for an explanation of location strategy's effect on NTBF from the agglomeration effect and those from collaborating with other firms. The following study on the other hand focuses on a positive effect that companies expect by locating in the incubator facilities. The next study highlights the significance of collaboration with universities, as opposed to collaboration with other tenant firms. It also confirms that access to new customers has little significance for startups of a high-tech industry.

Ferguson's primary hypothesis is that value-added services would have a positive effect on incubators provided to tenant firms (Ferguson & Olofsson, 2004). To test this hypothesis, he conducted research comparing on and off park NTBFs to show possible difference. Among 66 firms that were studied, 30 on park firms and 36 off park firms were grouped together to be compared. One interesting finding of this research was that location advantage occured only when cooperative relationships between universities and firms are established. Other advantages expected from locating in SPs, such as better access to new customers, were found to be little associated with changing firms' performance in regard to growth both in employment and sales. However, this research falls short in addressing the university services in detail; whether firms' productivity is affected by research collaboration with faculty members or access to lab facility remains unspecified.

Again, this research does not take into consideration one important causal factor for agglomeration effects: 'cooperation' among the tenant firms. While the focus is different, it would be appropriate if the study looked into how cooperation among tenant firms was

significant in connection with other variables. In addition, this finding conflicts with other research that suggests that cooperative relationships between universities and tenant firms are, in reality, rarely found. This may imply that the small amount of incubators which contribute to the growth of NTBFs is attributed to the difficulties for incubators to maintain cooperative relationships with universities.

In general, this study reaffirms the effectiveness of incubator services in improving 'survival rate' of young firms, while it reserves its position on the effectiveness of incubators in improving growth in sales and employment. In other words, incubators are effectively helping young firms to penetrate the hazardous fledgling period that usually suffocates most of the NTBFs, but meanwhile it may not necessarily deliver prosperity to those firms. Additionally, this research interestingly points out that the needs of on-park-NTBFs appear to be met, even though the range of needs are wider than those of off-park-NTBFs.

The most recent study by Squicciarini (2008) employs econometric modeling methods as a way to calculate the marginal effect of incubation programs on tenants' innovative activities. The comparative framework is the same as those typically used in the other studies, comparing science park firms and out-of park firms. Forty-eight science park firms were observed to measure the influence of SPs on their patenting activities, using a data set collected between 2002 and 2003. The study tests a primary hypothesis that NTBFs in a successful park with accomplishing innovation-supporting tasks would be better off in patenting performance after joining the SPs than the matching firms outside SPs. The study compared the temporal dynamics of tenant firms and outside firms to show if there is any difference created by SPs. It indicates that tenants demonstrate relatively better performance, keeping a higher patenting rate during their life cycle after they register their first patent. Based on the findings, the analysis suggests a

positive impact of science parks on innovative performance of tenant companies. In general, this study reaffirms the optimistic view that incubation programs help tenant firms perform.

Another report conducted by the National Business Incubation Association (NBIA, 2003) was a comprehensive investigation that attempted to figure out a set of service items to improve tenant outcomes. Primary and secondary outcomes were regressed with the diverse services provided by incubators categorized as the 'best-in-class'. Interestingly, no predictive relations were found to be significant as factors that yielded better performance. Only 'adjacency' to a major institution, such as university or research centers, is found as a common aspect shared by those best-performing incubators. Based on the regression analyses, none of the incubator services and assistances were found to be significant in enhancing 'primary outcomes', i.e. growth in employment and sales. Incubator assistance, however, was found to somewhat positively contribute to firms attracting external research grants and acquiring intellectual property. The report attributes this low predictive power to perhaps a small number of incubator samples. Besides, the individualized needs of clients were assumed as one of the possible reasons that one big trend has not emerged significantly.

This report is an interesting attempt in that it focuses on the relationship between a list of assistances of incubators and the level of performance. However, the major drawback of this report lies in, as indicated by author, the lack of consideration of other factors, including a larger context, such as location effect. Also, factors of firm resources, such as CEO's experience or firm sizes, are largely disrespected, which are perhaps one of the most important factors that predetermine the quality of outcomes. Another interesting remark on the lower predictive relationship between incubator services and primary outcomes is that primary outcomes may be way beyond the incubator's reach and it may have more of an impact in a larger context. The

role of the incubator may be redefined as a leveraging agent, but with more limited goals, focused on 'secondary outcomes' such as helping firms to acquire more intellectual properties, which is a precursor to the 'real' business outcomes. This redefinition may serve as a topical platform on which more realistic evaluation criteria could be conceptualized.

Especially regarding other factors that might affect business performance of client forms, Westhead (1997) conducted a comparative evaluation using the same framework: 'program vs non program'. However, the subject of this study is science parks in the UK, not incubators. One hundred eighty-three SP companies participated in interviews, and were compared with 101 non SP organizations. A unique contribution of this study is that performance was compared within groups with similar characteristics: industry, ownership type of the organization, age, and location of the organization. Geographic variation is also taken into consideration. It also uniquely pays attention on ownership type. The conclusion was, as stated by the author, somewhat unexpected in that he fails to support the positive impact of science parks on the performance of tenant firms in improving investments in R&D and improving degrees of technology diffusion. There was no statistically significant difference in the number of patents or applications between science parks and off-park firms. Performance in software copyright and application also does not show any improvement from client firms. A number of new products and services were virtually observed at the same level.

Another study that failed to find program effectiveness, by Chan et al (2005), conducted multiple case studies and ranked 9 value-added services of SP, using the business development data of six technology startups in Hong Kong SP. To capture the incubator effect throughout different stages of venture development processes, this study suggests new formation on the evaluative framework. In-depth interviews followed and analyzed the development processes of

participating companies and the impact of incubators on the tenant performance. This report provided insightful illustrations which highlight the contribution of incubators: the different roles for different stages of firm development process. However, it also remains as an anecdotal, descriptive study, illustrating how firms are motivated, even detailed with educational experience during the founder's life time that might have motivated firm foundation. It concludes with presenting the ranked significance of added-value incubator services. It also subconsciously studies the impacts of the founders' upbringing to be a business frontier, the relevance of which is questioned. Subject-oriented assessment methodology is also open to criticism in the sense that beneficiaries of public services tend to feel obliged to be appreciative rather than to be objective. Also, no comparative reference has been found to have further biased service assessments. Based on subject-orient assessment methodology, free or affordable rental provision is 'viewed' as the most significant contributing factor. An interesting trait of this study is in that it differentiates incubator services from other programs, such as subsidy-oriented, or tax incentive programs. Another interesting point is that the contribution of incubators in encouraging networking and clustering is found to be insignificant, which is also empirically backed by Acs et al (1992; Acs, Audretsch, & Feldman, 1994). It is indeed interesting that this finding opens the question on the incubator's role as a 'technological hub', which is one of the fundamental philosophies justifying public investment through the creation of incubation programs (Colombo & Delmastro, 2002). This finding is a reaffirmation of Macdonald (1987a), who questioned the cluster effect and the roles of the incubator as an 'information hub' based on the same premise. The overall stance of Chan et al (2005), however, is rather reserved rather than advocating or challenging, in that it balances some contributive role of the incubator, while criticizing existing perspectives.

Discussion

The question that remains to be answered in whether or not TBIs work. TBIs may have a moderate impact on job generation and on the multiplier effect than do incubators dedicated for general small businesses. Direct impact on employment tends to be limited since the operation of technology businesses does not rely on many employees. Indirect employment growth, however, may be fairly expected. Even in terms of sales growth, policy makers should note that some businesses take a long time to start making profits: the magnitude of the program's impact may vary by business sectors. Biotech startups are examples of businesses that move slowly. Finally, TBIs do help survival and growth of young high-tech startups, but usually those incubators in metropolitan areas tend to succeed better in an agglomeration economy. All of the findings discussed in this section are summarized in the Table 2-1

Table 2-1. Realistic prospects of TBI

	Expected	Evidenced
Job creation	At reasonable rate	Unlikely
Taxes	By corporations & workers	Maybe by corporation
Gestation and costs of entering market	Reduces	Maybe, vary by industry
Chance of success	Enhances	In terms of sales
Income, sales, exports	Generated for community	No evidence about income
Empowerment	Disadvantaged regions and groups	Unlikely, agglomeration advantage is essential and skill-dependent
Client satisfaction	At services, costs saved, time	Likely but nothing to do with business outcomes
Sponsor satisfaction	At return on investment	Likely if it is for-profit, Public sector may be disappointed at poor employment creation
Climate for innovation & entrepreneurship	Will produce	May create positive image to a region

CHAPTER 3
RESEARCH APPROACH

Research Framework

Research Question: How are They Different?

After acknowledging the inconclusive characteristics of the TBIs, the primary question of this study is how different forms of sponsorships actually affect the efficiency of TBIs. The research questions of this study responds to the existing pessimism on public sector that public intervention often results in lowering program efficiency. Why sponsorship is important? More often than not, sponsorship tends to create variation in organizations' objectives and services accordingly. Allen and Rahman (1985) found that services critical to small business development such as, business taxes, marketing, health and benefit packages, accounting and computing and information service are less likely to be available in incubators created by the public sectors than in those created by the private sectors. Also, they found that private sector incubators are more active in providing general business services (Allen & Rahman, 1985). These findings reaffirm the implication of different sponsorship, but they still need to be updated. Although the research is twenty years old, theoretically speaking, sponsorship is still regarded as a critical factor that changes the characteristics of organizations.

Potential difference may be found from service inputs and outcomes. Phillips (2003) contends that publicly-sponsored incubators are commonly concerned with increasing the number of jobs in the local and regional community, primarily aiming to making positive community economic impacts. While empirical studies fail to verify the widely accepted belief that small business incubators are job creators (Campbell & Allen, 1987), public sector TBI's prefer working with industries that have a high potential as job generators, accordingly, rather than industries likely to make higher sales revenue (Allen & Rahman, 1985). This is an example

of a case that organization's objective drives the operation of program. Alternatively, the private sector tends to target industries that are more likely to generate higher sales revenues to for-profit incubators.

The bottom line is that not enough studies have engaged in this discussion either reviewing differences of input aspects driven by sponsorships or productivities of outcomes drawn by them; hence, it is premature to make a conclusion. In addition, such observational studies tend to pay attention overtly on the service inputs provided by TBIs, while there are lots of other factors that affect business performance of the client companies. Consequently, they failed to address why some services are provided in some incubators. The only assumption is that the service profile is a result of choice decided by the manager's call. This position does not offer any logic that explains different managerial styles of different sponsorship. The only explanation is that internal differences, such as given objectives, are the only factors that make difference. In reality, many other aspects are different. As a consequence, most research treats incubator services as autonomous and independent, this may mislead all of the outcomes as fruits of incubator process. This perspective is illustrated in Figure 3-1. In this model, incubator recruits a group of potential companies that have different outfits. After they are incubated, they become more desirable drawn by the characteristics of incubator. So, if incubator drives the client companies to become red, the client companies becomes close to it. For instance, private incubators are usually limited in making large investment. They might also have difficulties earning respect from local innovators community while government agencies easily collaborate with them for their authoritative image. Most of all, as stated earlier, not many studies investigated difference in outcomes generated by TBIs with different sponsors.

An alternative approach of this study to study input side aspect is to look at factors that make TBI works, rather than focusing only on the individual services provisions of TBIs, and examine models that suit constraints and capacities given to TBIs of each sponsorship. As briefly introduced, there are three groups of factors that make TBIs work. Following section offers short reviews on the three perspectives that suggest different factors as ingredients of success of innovative economies. In short, this study questions how TBIs with different sponsorship are different, in terms of inputs and outcomes.

Focuses of Cost-Reduction Strategy

The first perspective is related with its cost reduction strategy. Recall that the role of an incubator is two fold, while they are both common strategies to cut the cost. First, an incubator contains the cost of failure by providing supplies, such as infrastructure, at an affordable rate (Hackett & Dilts, 2004b; Lalkaka, 2002). Second, an incubator is an agent to utilize resources and services to help client firms thrive. Therefore, the basic strategy of an incubation program is for incubators to bear the cost, otherwise NTBFs suffer in their beginning era (Knopp, 2007).

The primary rationale of this perspective on incubation business is that locating in the incubator facility may reduce production costs for NTBF in the fledgling period. This perspective explains roles of the incubator as a means to offset market failure of technology related industries. The original version of neoclassic economic theory is characterized as a conceptual framework that assumes economies to be static. Under the paradigm of the conventional economic perspective, microeconomics provides predictive insight, and individual participants are presumably able to make rational decisions, either based on calculation or experience. Utility maximization is achieved through optimization of cost and production. Cost reduction is one strategy through which rational individuals strive toward achieving the ultimate goal, maximizing profitability. One of the critical factors that determine cost effectiveness is

location. Rooted in market failure theory, traditional location theory is a good reference for understanding this strategy.

Traditional location theory, developed by Lösch (1954) and Weber (1929), views location decisions as consequences of reasonable decision making processes, using cost related on spatial variation, based on the delivery cost between major market and plant, and production cost determined by resource availability. The major market is where most consumers are aggregated. Production cost depends on the localized availability of resources. Location is determined as where the business maximizes the excess of gross profits over gross operating costs (Oakey & Cooper, 1989).

For high-tech industry, however, traditional location theory loses its relevance. The significance of consumer location is largely diminished since they are rather well dispersed, thus, central market assumptions may be inappropriate (Oakey & Cooper, 1989). Localized customers cannot be a proposition for high-tech industry; many customers are often from aboard (Oakey & Cooper, 1989). Also, distance-determined delivery cost loses the earlier relevance since products of high-tech industry tend to show high transportability due to its small size and high profitability (Oakey & Cooper, 1989).

Under the paradigm of conventional economic theory, location theory, in application to incubator research, is therefore transformed as a conceptual framework that focuses on cost-reduction advantages expected from moving in a facility that make available a series of unique provisions from which client firms can reduce net production cost. Therefore, the focus is on whether incubator services can exclusively channel those affordable services and resources, which means otherwise NTBFs expects those services that they are less likely to obtain. Couched in the paradigm of neo-classical economic location theory, researchers particularly

focus on “cost or availability of premises” (Sternberg, 1990), and service provisions with necessary business skills for NTBFs (Collinson & Gregson, 2003; Flynn, 1993).

This perspective is underlying the rationale of the real-east model of incubators. Based on this perspective, a critical task of incubators is necessarily providing a series of affordable infrastructure. Office space is offered as low as, or at the competitive level in comparison to the market rate, as a way of reducing fixed costs. Incubators also provide office supplies, furniture, shared conference rooms and even clerical services. From an incubator’s perspective, these services are provided to maximize cost reduction. From the clients’ viewpoint, they can expect advantages from moving in a specific facility, which is why incubators were used for this study, as opposed to a location. As illustrated in the Figure 3-2 the major task of TBI is to provide client companies with affordable services exclusively.

Of course, there are counterarguments on this view. Empirical studies state that NTBFs are willing to pay even higher rent if they can gain something more valuable by moving to a particular area (Saxenian, 1985). This includes “the image of a business with respect to scientific expertise (Tamásy, 2007)”, when a location has such image. Moving into a university incubator affiliated with a large research university is one of the cases. There is an argument suggesting that cost became a significant factor in the second stage, not for the companies in first stage, which are the subject of the incubation program (Schmenner, Huber, & Cook, 1987).

Focuses on the Intervention Mechanism

One chronic problem of NTBFs, in regards to incubator issues, is the old issue of liability of newness, alluded by Stinchcombe (1965), which refers to a general tendency of ‘high mortality’ of young companies. In reality, high-tech industry indeed reports a high rate of early drop out. As discussed earlier, to reduce mortality rates of NTBFs is among the many reason TBIs intervene in the private market. Based on the perspective of ecology theory, such

challenges are much more complicated and adverse due to a greater population density of the real world market (Carroll & Delacroix, 1982). This view, empirically substantiated later by Smilor and Feeser (1991), finds population as a challenging factor for new companies. It asserts that the intervention mechanism spoils young firms and, thereby, only results in weak firms that are less likely to survive in their later phase due to the challenges of a large number of competitors. In other words, spoiled firms will not be adaptive to handle such higher uncertainty generated by collective actions of a large number of competitors. TBIs, under hypothetical circumstance, only twist the natural market process when selection is determined by sponsored organization with deliberate care (Flynn, 1993). In a real world situation, higher population density implies greater uncertainty, which will easily suffocate ill-muscled incubated organizations.

The artificial selection bias of the intervention mechanism means the entire process of incubation is not limited as a literal reference of the selection process. In the incubator system, this intervention mechanism, however, can take place through three sub-sequences, as a series of nurturing processes of incubators. First, the initial intervention occurs through the selection process. Incubators intervene in markets by selecting participants through an admission process (R. G. Phillips, 2002) through which TBIs select most potential profiles. The rate of admission may supplement the intensity of the admission process. Intervention occurs through a monitoring process during their residency. The case studies, in the following chapter, provide comparable observations influenced by different organizational objectives imposed by the sponsorships.

Monitoring criteria and rigorousness may affect the direction and magnitude of client performance. Through monitor processes, the incubator provides formal and informal advice to

encourage firms to make progress. Conceptually speaking, monitoring processes serve as channels through which external information, guidance, and managerial pressure are offered. In this sense, it is reasonable to assume that more frequent monitoring may have a stronger impact, either stimulating or deterring the progress of clients, although generally it is assumed to be a stimulant. The type of monitor process may reflect the intensity of such procedures. A formal monitor that files progress records may legitimately imply that incubator managers put a greater effort into conducting monitoring tasks than other managers who do not. Besides the frequency and types of monitoring methods, the number of graduation criteria and graduation rate may reflect the intensity of intervention and of incubators on clients. Lastly, graduation criteria, as an intervention process, may have an impact on firm performances with the same reason for the monitoring process. As illustrated in the Figure 3-3, the TBIs are agents intervene market process through selecting, monitoring, and providing guidance, including imposing graduation criteria.

Focuses on Surrounding Resources

Finally, based on the perspective of the evolutionary theory of economics, the case studies discuss strategies to making use of surrounding resources that leverage innovative activities to emerge and spin. In terms of evolutionary theory, economic growth is the result of the co-evolution of technologies, firms, industry structures, supporting institutions, and governmental systems (Nelson, 2006). Evolutionary theory highlights the role of non-market institutions, such as universities, research organizations, and government programs. Also, the labor market, education system, financial institutions, and regulatory structures altogether shape the dynamism of innovative economies (Nelson, 2006).

Especially for the companies at the first phase, by the time second stage expansion is reached, infrastructure is the most influential factor on organizational survival, along with

sponsoring organizations and availability of regional R&D capital (Flynn, 1993; Nelson, 2006). Surrounding resources include the availability of research laboratories, area wide technical expertise (Carlton, 1983), the availability of skilled labor, or existing businesses where informal social interaction could be formulated and operated (Collinson & Gregson, 2003). More importantly, in terms of structural perspective, innovative economy emerges where the synergistic effect of those resources is likely to be generated. Metropolitan areas, where the agglomeration effect is expected, or a university town might be strong candidates. A technology business incubator may take advantage of such neighborhood because such areas allow fluent exchange of tacit knowledge. For this reason, the agglomeration economy is often ranked as the most important success factor (Abetti, 2004). It is not surprising that NTBFs even prefer paying higher rent in exchange for locating in a metropolitan area over saving rent for locating in an unattractive area in a business sense, such as a rural area (Tamásy, 2007).

Another focal point under this paradigm is that surrounding resources also serve as sources to cut redundant expenditure. In regards to cost saving, one must see the strategies of incubators to cut costs related to human resources. NTBFs are operated, more often than not, by one or two technology or business experts. Sometimes, an NTBF enters the incubator only with a business idea that needs supportive technology. Obviously, businesses lacking managerial/technical expertise are highly likely to fail. Also, availability and cost of technical labor is one of the most important factors in location decisions for NTBFs (Premus, 1982).

Many times, technological development itself is an issue for NTBFs to solve. For such cases, one of the important roles of incubators is to introduce new technology or license existing technology. NTBFs take cost advantage from using already developed technologies and know-how by being a client of an incubator. Access to a university is important in this sense. It

includes access to library facilities, research facilities, student recruiting as research associates, and a positive image (Premus, 1982). Ferguson also supports university-associated image benefits as having positive impacts on growth and success (Ferguson & Olofsson, 2004). The Figure 3-4 illustrates surrounding factors of technology business incubators.

For this reason, community economic developers are often suggested to pay attention in addressing contextual and linkage issues (NBIA, 2003). The case studies focus on strategies that attempt to maximize external utilities, as its unit of analysis is the incubator rather than regional economic structure. One incubator might not be located in such an attractive area. This circumstance itself may hinder success of such an incubator. How could the incubator offset such disadvantage? Do different sponsorships have anything to do with such strategy?

Conceptual Framework

This study compares the input side aspects and the outcomes of the programs. Three groups of factors are examined as measurements of the input side measurement. The first group of factors is those related to cost-saving strategies. The second group of factors is related to an intervention mechanism that includes the selection criteria, the thoroughness of the monitoring activities, and the policies of graduation. The third group of factors includes strategies for establishing linkages with external resources; such as universities, research facilities, and governments. The major focus of the investigation of these factors is to highlight the different approaches that each incubator employs to make the program work, rather than showing the quantitative differences in it. Two reasons justify this rationale. First, quantifying individual services may not be appropriate since the size of the comparable sample is too small. It is very hard to find purely private for-profit and purely public non-profit technology incubators. Also, it is even harder to find two of them in the same location at which the influence of external factors can be controlled. Second, the quantitative aspects of individual services, such as the number of

social meetings and the number of fax machines, are by and large predetermined by incubator policy and capacity. A recent trend in the incubator business has been to provide cubicles which emulate the garage model because it is believed that this architectural style may enhance collaboration among client companies. On the other hand, in many cases public incubator programs work on the large-scale infrastructure, such as wet labs and large conference rooms. Presumably, such provision is made available because the public sector is able to utilize large-scale investment; which is also an option that private agents are likely to emulate. In this sense, comparing quantitative differences predetermined by different sponsorship may not generate meaningful inferences. Rather, an appropriate approach is to investigate the alternative strategies for each incubator in order to respond to the challenges that arise from the constraints that different sponsorships have predetermined.

In regards to the outcomes of incubators, the performance of tenant and graduate firms is a widely accepted indicator. Among many variables, this study examines the primary outcomes, such as employment, wages and sales revenue; rather than secondary outcomes such as intellectual property or financial improvement. Within this framework, incubator efficiency is measured from multiple angles so as to reflect the different objectives; the significance of these angles was elaborated upon in the previous section. The first approach is to measure indicators in aggregated forms by the types of sponsorship. The aggregated number of jobs, wages, and sales revenues will indicate the capacity for sponsorship. Aggregation may confuse the variation in capacity that may have been predetermined by the types of industry and the size of firms, which may have existed in effect even before the firms were incorporated into the programs. Nevertheless, this method can still be said to be justified, based on the premise that the level of performance of an incubator measured by aggregated business performance is a result that is

affected by a particular selection strategy of the incubator. In other words, when a research study measures the performance of a profile of client companies, all of the strategies and choices that the group of client companies employed could be considered to be dependent on the incubator's choice. Table 3-2 summarizes the conceptual framework of this study.

Taxonomy of Incubators

Only four major types of sponsorship of TBIs are observed from among a handful of studies (Kuratko & LaFollette, 1987; R. Smilor, 1987; Temali & Campbell, 1984) that used taxonomies to classify incubators based on their financial sponsorship. Although they appear to be useful as a template for this research, modification seems to be unavoidable, for data availability. The four types of sponsorship-based taxonomies reflect degrees of involvement of private and public agents: Publicly-sponsored, Nonprofit-sponsored, University-sponsored, and Privately-sponsored.

These classifications, however, may not be relevant for more recent incubation programs. Typical type of public incubator serves as non-profit organization. Recently more popular type of public incubator is a public-private partnership. Also, many non-profit organizations are founded by government but operation is delegated to an organization dedicated to this business. Such organizations are independent from government in operation of fund, but still their management is driven to deliver the public goals and objectives imposed by founding government. Even for-profit private organizations enter into the program as main operating organization. This type of 'partnership' seems to be a result of public sector's expectation of higher efficiency from delegating private for-profit organization as a program manager.

In sum, financial influence of founding sponsorship is in reality pretty much scrambled by such partnering strategies, thus lost magnitude of implications that it used to have. This research alternatively investigates two incubators of two radical extremes of sponsorship: private for-

profit vs. public non-profit. Hopefully, investigating these two radical examples would produce insightful inferences on the influence of different sponsorships.

Hypotheses

The major hypothesis of this study is that the input side aspects and outcome efficiency may vary between different types of sponsorship. The hypothesis statement is as follows:

- **H:** Government intervention may have an impact on the efficiency of TBI

To investigate the input side differences, sub-hypotheses are drawn based on the following three theories:

- **h1:** For the limited options allowed for private incubators, typical cost-reduction strategies, such as affordable rent, may be limited.
- **h2**: With higher flexibility, private incubators may prefer informal intervention activities.
- **h3:** Private incubators may have more difficulty taking advantage of local sources of knowledge, capital, and institutions than public incubators.

How the Cases were Selected

As previously mentioned, this study selected incubators from two extreme cases: a private for-profit incubator and a public non-profit incubator. To be a private for-profit incubator, requires being founded and managed by a private agent without any financial help from the public sector. Private non-profit incubators are excluded, accordingly. To be a public non-profit incubator, an incubator should be owned and founded by the government. In addition, the government agent drives most of the operations of the incubator. Also, TBIs founded by the government, but managed by a private agent, are excluded. Obviously, both incubators should serve NTBFs as opposed to mixed industries.

Based on the above criteria, to investigate the input side aspects, one for-profit incubator, and one public non-profit incubator were recruited from two different locations in Florida. Due to the limited number of client companies and data availability, quantitative research was done

with sample client companies from two other incubators which were both located in Rockville, Maryland. These TBIs also meet the criteria stated above. One advantage expected from analyzing incubators located in the same city is that factors related to economic geography are almost perfectly controlled.

Methodologies: Case studies and Group Comparisons

As discussed previously, the problem then arises as to how we address the efficiency issue. The case study method is relevant to explain how the different types of incubators are similar or different from each other. Indeed, the case study method may be the only eligible approach for the given conditions of incubators, as long as a bit of exaggeration is tolerated. In addition, the case study method is effective when the number of subjects is small (Yin, 1994). Methodologically speaking, measuring the correlation association between elements of incubator service provisions and client performance may be quite unrealistic. As indicated by the NBIA research team (2003), predictive relationships between service practice and performance outcome may be difficult to observe. They infer that such a low level of predictive relationship may be due to the individualized needs profile of technology businesses. Incubator services are offered as part of a packet of services, and the services are given in concert with surrounding conditions that usually define the business atmosphere of the area. In this type of case, experimentation on the relationship between service practice and results may distort the particular holistic dynamics that are created by concerted contextual conditions. These special characteristics may reinforce the relevance of case study methodology as an approach for incubator study (Yin, 1994).

To illustrate the possible differences imposed by sponsorship, the method should be referred to as a comparative case method. For this research, the comparative case study method is employed to achieve multiple goals. As mentioned, the first goal is to demonstrate differences

or similarities. In this sense, the main task of the case study is to discuss why such services and managerial fashions are chosen, and it would be appropriate to show these items. The aim is to discuss the meaning of using them as strategies to meet the individually defined objectives and the overall assigned mission; not to list names of services or to count the number of them. The method also explores the goals and objectives imposed by different types of sponsorship to explain how services and managerial strategies function to achieve them. Along the same line of reasoning, strategies to maximize the utilities of given resources are explored and explained based on the different theories of innovation process. The ultimate goal of the case studies in this research study is to present logical inferences on the predictive consequences of operational/organizational characteristics that are observed from each incubator; rather than present stochastic inferences based on repetitive patterns. This leads into the discussion in the next section of the methodological constraints of incubation study which actually add to the relevance of the case study method for incubator study.

Two group comparison methodologies were employed to compare the primary outcomes produced from two incubators. This study investigates both the business outcomes of the client companies, and the aggregation of these to the incubator. Data are gathered using three sources. Incubator managers were contacted and asked to provide list of client companies. Supplemental information about the clients is gathered from the websites of the companies and incubators. Finally, business record of employment and sales were provided by National Establishment Time-Series (NETS) database.

Using SPSS and supplemental applications, the Wilcoxon-Mann-Whitney tests (which use nonparametric statistics) were employed to test the statistical significance of the business outcomes of client companies, and also to cover the wide distribution. This method ranks the

data to test the hypothesis that two samples, with two different sizes, come from the same population; assuming they are similar in nature, when normality assumption is badly violated. Another advantage of this test is that the number of samples of the two groups need not be equal, which is the case in this study. Indicators related to growth in employment, wages, and sales are explored and tested. Detailed test hypotheses and test statistics are elaborated in the section that presents the findings.

In the following sections of case studies and group comparison, four subject incubators are named by codes. Capital letters will be combined to indicate sections and sponsorship. C will indicate 'Case study' and G will be used to indicate 'Group comparison'. Then P and G respectively indicate 'Private' and 'Government (instead of Public to avoid confusion with p of private). The private incubator in the case study will be called, hence, CP. CG indicates the Government (public) incubator in the case study. GP is the code of the private incubator in the group comparison, by the same logic. Finally, GG is given to the Government (public) incubator, a subject in the group study.

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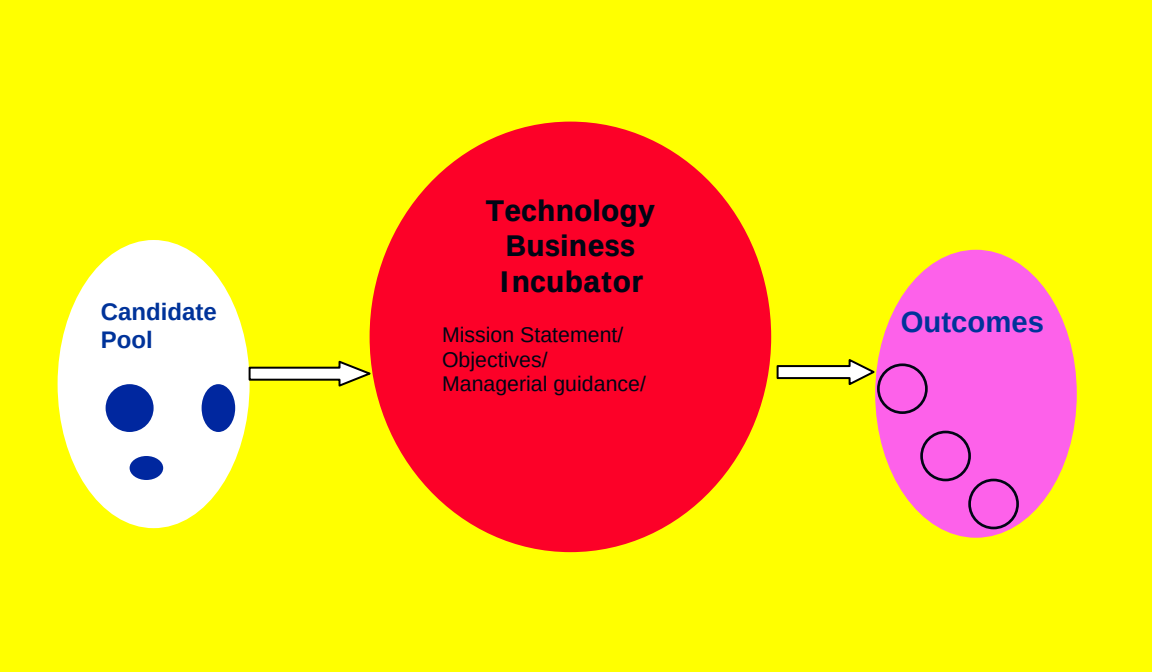

Figure 3-1. Generic model of incubation process

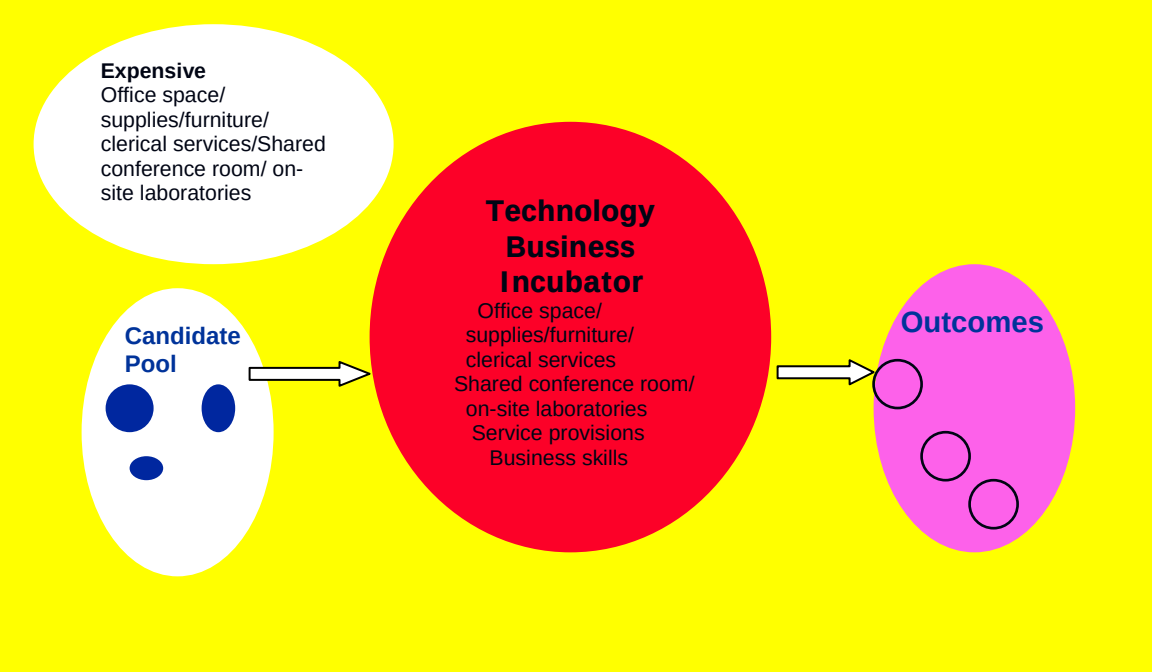

Figure 3-2. Incubator as a cost-reduction strategy

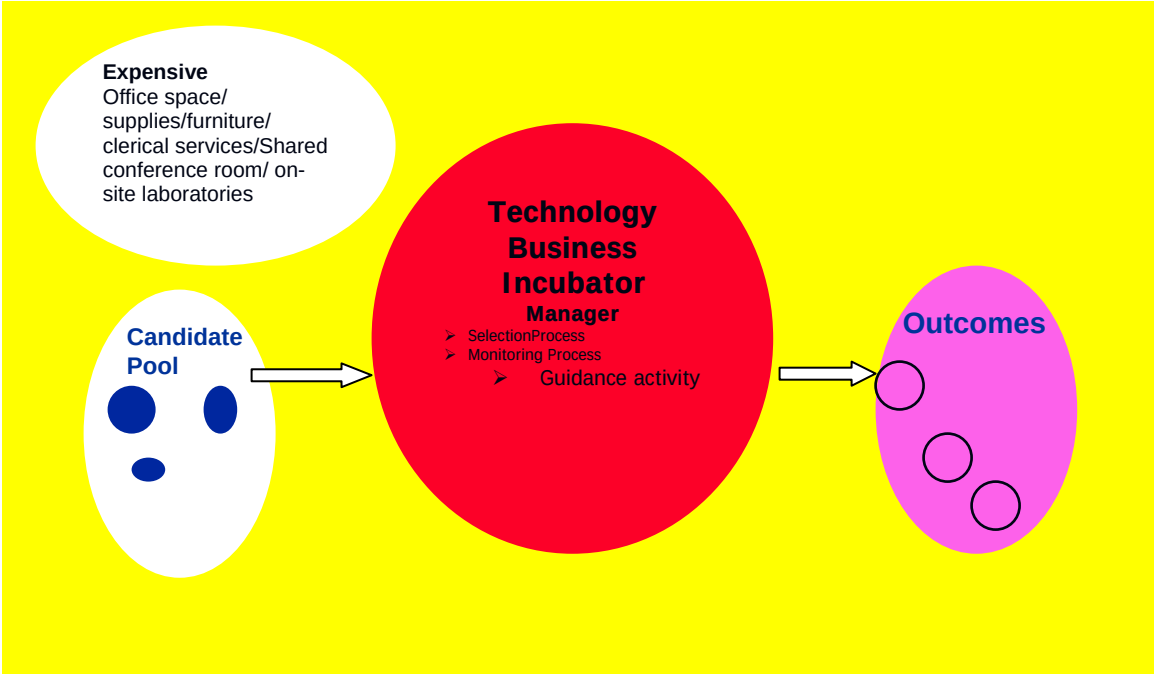

Figure 3-3. Intervention Mechanism of Incubators

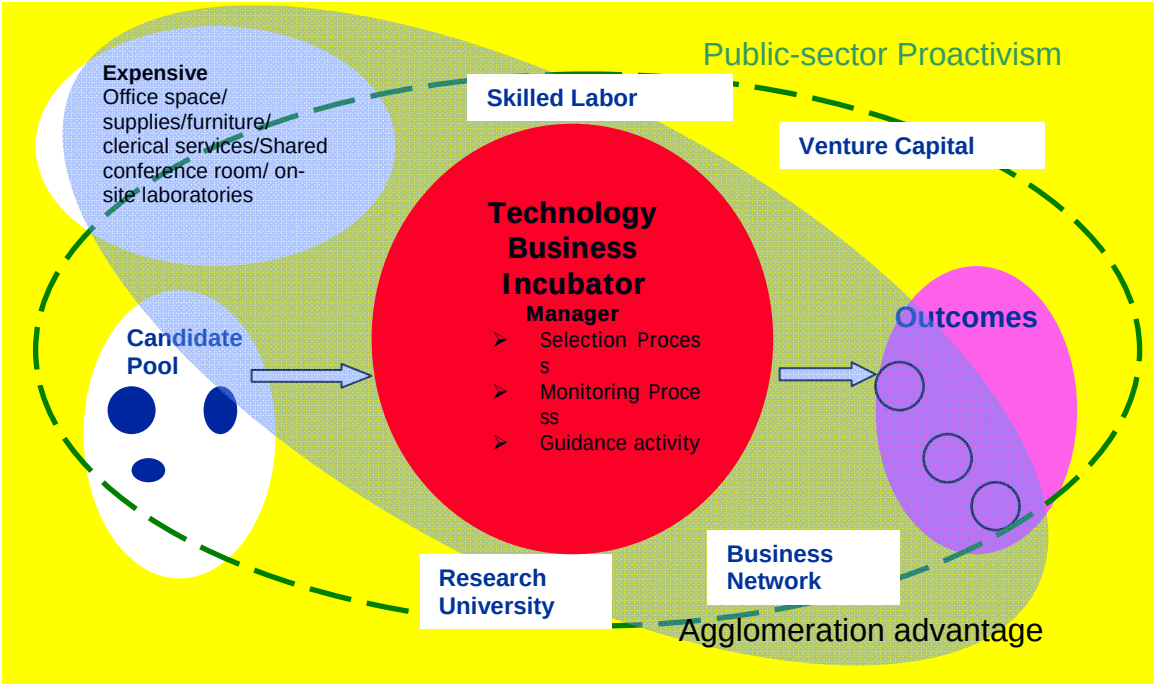

Figure 3-4. Surrounding Resources of TBIs

Table 3-1. Conceptual framework: measurement of input

Concepts	Categories	Indicators
Different Strategies Making the Incubator Work	Cost-reduction Strategy	Business model
		Rent
		Service fee
	Intervention Mechanism	Selection process
		Monitoring activities
		Graduation policies
	Surrounding Resources	Access to universities
		Access to research facilities
		Collaboration with innovative communities
		Collaboration with government

Table 3-2. Conceptual framework: measurement of outcomes

Concepts	Variables	Indicators
Efficiency in creations of jobs, wages, and sales revenue	Number of Jobs	Growth in Number of Jobs
		Employment Growth Rates
		Annual Employment Growth Rate
		Changes of Number of Jobs over Time
	Estimated Wages	Growth in Wages
		Wage Growth Rates
		Annual Employment Growth Rate
		Total wages
		Changes of Wages over Time
	Sales revenue	Growth in Sales
		Sales Growth Rates
		Annual Sales Growth Rate
		Total Sales
		Changes of Sales over Time

CHAPTER 4
CASE STUDIES

Introduction

As indicated by existing studies, different motivations behind different sponsorship may not necessarily mean different service provisions (D.N. Allen & R. McCluskey, 1990). Nevertheless, different sponsorship means differences in the profile of available sources and capabilities. For instance, the public sector might be more efficient in helping firms to connect to existing networks or the public sector might be capable of formulating large-scale funding to start a large-scale incubator. No research has yet investigated the possible differences in modes of different sponsorships in addition to the relations with outcomes affected by such differences (Hackett & Dilts, 2004b). This chapter presents two case studies of two radically different models using three theoretical models about incubator and innovative economies previously discussed. The first model is a private for-profit incubator. This section illustrates how this model works with given conditions that are pre-constrained by its sponsorship, being a private manager. Second, it analyzes the working model of a public not-for-profit incubator. This incubator is founded and governed by a local government agency. The same issues are explored in terms of input measurement. First, in terms of a cost-reduction strategy, the case studies discuss issues related to strategies of minimizing production cost (thus maximizing cost-reduction effects). Reduction of production cost is expected to be obtained by moving in the incubators. Second, differences between intervention mechanisms are analyzed. Finally, based on evolutionary economic theory, the case studies discuss strategies of making use of surrounding resources that hinge on innovative activities. In terms of outcome measurement, the effectiveness of each sponsorship is evaluated by examining direct outcomes, i.e., business performance of their client companies: creation of number of jobs and sales revenue. In sum,

this case study is owed to the perspective of evolutionary theory of economies that sees economic or noneconomic institutions continuing to evolve (Nelson, 2006). This study also vows the presumption of the perspective in that it also expects to observe evolving patterns of private and public incubators while they seek maximization of given resources and face challenges.

The goal of this case study is to provide the public sector with lessons so that they can facilitate the program with a wise approach. To achieve this goal, case studies attempt to present a comparative perspective by illuminating differences between the models of incubators managed by two radically different types of sponsorship, rather than focusing on individual service provisions. The underlying assumption of this case study approach is that there might be optimal models that suit those different models constrained by the availability of resources and capability of utilizing those given to each sponsor. The ultimate goal of this research is, again, to present policy insights with which local economic development agents can make alternative directions that realize the differences in capacities and limitations observed from two radical models in this study. The case studies however, would be limited because it presents relatively weak quantitative support to show how such differences generate results in different outcomes, in terms of business performances of client companies. It is due to such a small number of sample populations, being not large enough to generate statistical inferences. The case studies will try its best to capture the quantitative magnitude generated by each model by providing descriptive statistics. Hopefully, this weakness could be offset with an intensive quantitative analysis provided in the next chapter, while the study area is different.

Public Incubator

Regional Information

- Population: 284,539

- Median household income: $36,441
- Average household income last yr ($) (2000): $49,336
- Unemployment rate (2000): 8.2%
- Pct. pers. 25+ yrs. old with a bachelors or graduate/prof. degree (2000): 36.7%

Incubator Characteristics

- Government owned and managed incubator
- Fostering economic growth
- Targeting employment growth

Overview

Incubator CG is owned and managed by County Research and Development Authority. The incubator is an effort to stimulate the economic growth of the region through providing a nurturing environment for technology business startups. It takes advantage of the abundant facilities and human resources available within the technology park in which the incubator is located, as well as of the serving area. The park offers office, lab, and manufacturing spaces, including hands-on business support. Currently, there are over 45 organizations located in the park, employing 1,700 people. As of 2008, the incubator has four resident clients, and some companies have moved or graduated. The incubator also helps virtual clients. Some companies were also helped even before the incubator was officially formed.

Establishment

The County R&D Authority held and managed the Research Park before foundation of the Incubator CG. When it was a typical research park, without an incubator on site, the park wanted an incubator in the park but did not have funding, and thus needed partners to help operate it. A partner did finally show up. Florida Agricultural and Mechanical University Small Business Development Center (SBDC) was trying to move out of its previous location and seeking a new site. The Park suggested leasing SBDC 4,000 square feet of space to use as a technology incubator. The Park was able to make that offer because it solved the mortgage issue for the

building that was slates to be used for the incubator, so there was no severe cost imposed to enable this partnership. The Park hopes for future expansion of the site and for more partners to join the program.

Motivation

The motivation of this incubator is rooted in the economic structure of the region. The small community's desire to diversify the employment base is rooted on the economies of the region, that is, mainly dependent on the universities and state government. The CRDA and the Research Park utilize university research to create jobs, and diversify the economy by operating the incubator as an agent that diversifies the region's economic/employment base.

Goals and Objectives

As a public incubator, this incubator aims to booster the local economy of the Capitol region. It is clearly dedicated to serving the local community, supported by survey results proving that more than 80% of the tenants of the research park come from the community. To meet this end, Incubator CG targets assisting technology-oriented startups and small companies during the critical phase of startup development as a means of increasing their level of income and employment opportunity. As a strategy to achieve these goals, the incubator provides clients with resources, hands-on assistance and a set of business-related services.

Advantage of Moving to the Research Park

The Research Park and the incubator were both located in the region even before the incubator's move to the Park. Moving to the Park, however, provided a set of new advantages for the incubator. The Park supports the incubator by providing space, including furniture and miscellaneous supplies. A county authority, County Research and Development Authority develops and manages the park. The Park and the SBDC collaborate to help the firms recruit employees.

Business Model

The business model of Incubator CG is along the lines of a typical real estate model. It provides the clients with office space, rent for the facilities, office supplies, and miscellaneous provisions, including furniture, etc. As a technology incubator, Incubator CG also consults client companies to give them appropriate business guidance, positioning the managers as business assistants. A Board of Governances is appointed by the county government to operate the incubator at the Park. The Board includes business and community leaders. Management is handled by the onsite staff of SBDC. The primary task of SDBC is to consult with the client companies. The member list of Board of Governance and the on site staff is comprised of agents from multiple organizations that enhance collaboration in an regional innovator community. Local government agents hold the responsibility of management. The position of chairman of the Board of Governance has been held by a person from local bank, the vice president from local community college, other members from the university and representatives of a community of local companies.

Two major characteristics of the real estate business model are inherited by Incubator CG. First, Incubator CG receives rent and fees as the return on the service package, rather than taking an equity stake. Second, the incubator serves clients as an external assistant. Services are provided as part of a package of multiple business sources. As mentioned, it covers services from physical infrastructure, such as office spaces, to business guidance, including networking opportunities. Typically, public incubators using the real estate model tend to focus on providing affordable rent as a way to help cut the initial cost for young companies. On this real estate-oriented model, the incubator tends to stay outside of business and provides formalized executive services that apply to all clients. The monitoring process is periodical and mandatory, based on given criteria established by Board of Governance. Progress is evaluated based on the

milestones created by the same process. There are set tasks that client companies should do each year, which are also formally required.

Incubator CG, however, goes beyond this model. In addition to flexible leases for spaces, there are one-on-one business consulting, mentoring, education development resources, networking, grant assistance, and marketing services all available for client companies, which combines the traditional models with strengths observed in private incubators. It seems to be a combination of the typical model and new incubation trends. Due to its relatively short history, it is irrelevant to conclude this new model's consequence; however, it seems to be a very interesting experiment The following is the list of generic services that are available for clients (with some flexibility).

List of services

- Business Development & Consulting
- Business Workshops & Seminars
- Legal & Financial Services
- Networking opportunities with established industries and universities
- Clerical Support/Receptionist
- Video conferencing capabilities
- Access to LCD projector and laptop
- Website links to Innovation Park and SBDC at FAMU homepages
- Short term/Flexible leases
- Marketing and Public Relations
- Furnished offices & Conference space
- High speed internet and email access
- Mail room
- Free parking
- Access to competitive grant money

Besides the above services, the incubator provides training and workshops to businesses upon their admission. Topics of the training and workshop include 'start a business,' 'business plans,' 'marketing,' 'financial projections,' and additional training based on the initial assessment. These programs are to mean to help startups through training in necessary skills and

knowledge for successful business development. Unless they are exempted, all clients are required to complete the core training workshop requirement. Other than these basic programs, SBDC requires clients to meet with a business counselor from SBDC to discuss business progress every month.

Selection of Clients

Client selection is determined primarily based on business feasibility. Incubator CG requires a feasibility proposal as part of application process. Basically, the proposal should describe the business idea. The incubator determines the business feasibility by evaluating the definition and information on the market, barriers to start-up and mitigating strategies, and potential actions and steps to begin and operate the businesses. The company should team up with persons who are knowledgeable about the business, as well as strongly motivated. To fulfill the mission to foster the economic growth of the region, the clients must show potential to make a significant and sustained contribution to local economies and eventually to create regional community wealth. It should indicate the quality and quantity of employment possibilities. The proposal also should include revenue creation possibilities, capital investment options and predictions for return of the investment, including strategies to reach the possible market share of the business. While the incubator provides accesses to venture capital, the incubator also sees an ability to attract external sources of investment and the availability of critical financial resources to support business operations through their first year. Finally, the applicant needs to address the reasons it needs to be in the incubator, and how the Incubator CG generates synergy by serving the business.

Monitoring Characteristics

The monitoring process varies by the different philosophies of incubators on business progress. Some incubators conduct formal processes to collect evidence that work as indicators

of business progress. Formal processes have two aims. First, they allow the formation of tracking data that form the basis for evaluation studies (NBIA website). Second, a formal process allows standardized analysis on the progress of client firms. Informal monitoring, on the other hand, is preferred by incubators that believe business progress is less determined by standardized measurement. Such incubators prefer to keep on their eyes on the business progress by maintaining informal relations with their clients. The type of progress monitoring may relate to the type of sponsorship. Public incubators may have a strong motivation to choose more rigorous and formal monitoring processes, as they are often required to submit progress reports to the authority supervising their use of public subsidy.

Incubator CG seems to use a style resembling both models. It has formal and periodical monitoring processes through which the incubator rigorously reviews the business progress of client firms. In terms of formality, the incubator requires tenants to submit a brief quarterly report on their progress and the SDBC reviews them. However, the incubator seems to be flexible on its definition of business progress. Rather, the incubator monitors progress based on self-defined needs and goals by individual clients and the SBDC (Manager, interview).

According to the incubator packet and supplemental explanation by the executive director of the park, first year clients are supposed to work with SBDC to develop a realistic business plan by the end of sixth month after the admission. The progress milestone for those clients is based on the progress of this work. Failure to develop a successful business plan at this review could result in a decision to release the business.

At the end of the first year, the Advisory Group reviews business progress to determine whether the incubator should continue support the company. Based on the review, the Advisory Group may decide to allow a company to graduate, or to terminate further participation. In case

a company seems to need more time in the facility, they can also increase rents to market rates. Possible decisions at this point also include simple extension, without changing anything. The Advisory Group may take any other action if necessary, as observed in the annual review.

Another unique factor of this incubator is that they look for actions that may affect business development indirectly, rather than measuring the business outputs, such as revenue sales and amount of external investment. They check on participation in training opportunities and workshops, which thus requires the clients to participate. The incubator also looks for the attendance of clients on mandatory and optional business conferences, social events, etc, as such activities are provided to help the clients achieve the goal of the company. The rationale for monitoring these activities, rather than focusing on outcomes, such as revenue and employment, is that the companies, in their early stages, should focus on building a solid foundation for the business. An interesting finding to note is that this is a public incubator, under political pressure to show a tangible contribution to local employment, and they don't push client companies to hire employees until they are mature enough.

As mentioned previously, public incubators usually care about the employment generated by client companies; this incubator is relatively flexible on that issue when it monitors the business progress of client firms. However, the employment numbers are still a critical factor for graduation. Graduating companies also report revenues and obtained capital. This information is collected but not with an aim to disqualify the company for graduation. This information may be used as a basis for program improvement. It is questionable whether this requirement acts as a stimulant to the business progress of client companies.

Source of Knowledge and Talent

In addition to the infrastructure provision, TBIs often provide sources of technology and licenses. Some incubators require clients to enter into binding contracts to use the technology

and licenses developed by associated universities, while most incubators provide connections to the resources of these properties. Incubator CG does not own any technologies. Instead, they maintain cooperative relations with technology transfer offices at area universities. Florida State University, Florida Agricultural and Mechanical University and Tallahassee Community College are members of the governing board for the park, and along with representatives of the municipal government. Local Economic Development Council and patent attorneys, they are sources for information about innovation.

Private Incubator

Regional Information

- Location: Mid size metropolitan area of central FL
- Population: 589,959
- Median household income: $40,649
- Average household income last yr ($) (2000) $56,753
- Unemployment rate (2000): 3.6%
- Pct. pers. 25+ yrs. old with a bachelors or graduate/prof. degree (2000) 24.6%

Incubator Characteristics

- For-profit private incubator
- Founded by an entrepreneur
- Dedicated to serving businesses with an Internet Business Model
- Practice business consulting services as active equity partner
- Serving only two companies per year to launch and fund

Overview

Incubator CP is a private, for-profit technology business incubator, established in 2001. Located in midwest Florida, it is directed and managed by one serial entrepreneur with help from three other entrepreneurs. The incubator is dedicated to serving businesses related to internet, new media and IT software industries. As of August 2007, this incubator has graduated 22 companies and it currently serves four tenant companies. One unique factor distinguishing the

business model of Incubator CP from the usual model most of incubators is that the Incubator CP recoups its costs in the long term by taking benefits from the client companies.

Establishment

With some financial engagement from angel investors, it was founded by a serial entrepreneur who established and sold two startup companies prior to his current career. Interestingly, Incubator CP was funded mostly by its founder, without any financial support from the public sector. The founder pays most of the cost, so that Incubator CP can be an equity holder in its client companies. The founder envisioned an investment of $500,000 to make this business model possible. When it was starting he was successful in funding about half of the money by himself. Harvey Vengroff, a regional entrepreneur, agreed to help the founder by providing contacts of investors and space in downtown Sarasota.

Motivation

Incubator CP was motivated to fill a business vacuum in surrounding counties, which lack high-tech startup companies that will drive the development of regional economies of the area by providing economic dynamism. It meant a lack existed of gatherings of smart people, not a lack of smart people. Incubator CP was established to bring talented people together and to contribute to the development of local and economies by making essential resources available.

Goals and Objectives

This incubator strives to achieve business success through working on three business guidelines to create profit out of the incubation businesses. First, it aims to produce profitable companies. Second, it plays as an investor, not just an assisting organization. Third, and ultimately, the incubator particularly targets fast-growing tech companies in Florida. From these three business guidelines, one sees Incubator CP's mission clearly: it is driven by commercial interest, rather than by public interest. Consequently, one can also note that expanding

employment opportunity is not considered to be of any significance, whereas profitability and practicability are explicitly emphasized.

Location Advantage

Out of many other possible areas for development, the founder chose Region P. The major reason for this choice was his observation of the presence of opportunity untapped by any other supplier. In his view, Region P is an area renowned for its retirees. The founder observed this dense group of retired individuals as a place where talented professionals and abundant capital came along hand in hand. It was his prior business experience that made him value abundant availability of capital as an important resource for businesses success. He fell short of capital when his first business was starting in Gainesville, a college town that is rich in young college-age talent, but poor in capital availability. In comparison to Gainesville, Sarasota appeared to be a better place for high-tech startups in terms of capital availability. Although there is no research university in the area, he believed growing business communities were sources of talent. Also, the absence of any existing competitor was another reason Incubator CP was welcomed by the local business leaders.

Business Model

A major characteristic of the business model of Incubator CP that is unique from the general model of business incubators is that it makes available an optional payment plan. Tenant companies can choose either the above monthly plan, or return equity stakes in exchange for customized business services later on. It means paying fees when they succeed. Based on the real estate-oriented model, the most popular model is that incubators receive some amount of rent in return for the physical infrastructure and monthly fees for executive services. This trend may have been inherited from the original direction of old incubators serving general small business, which aimed to cut the fixed costs required for starting small businesses in their early

phase. Conceptually, the real estate provision of the incubator implies an alteration of market supply by supporting the initial investment, usually by helping with the cost for office space and supplies (Eisinger, 1988; R. G. Phillips, 2002). The incubator provides the affordable real estate as if it is a chunk of subsidy, i.e. the indirect public supply that offsets cost of individual startups.

Although the strategy of taking an equity stake is also observed at other incubators, it is by nature difficult for private incubators to practice, in that the incubator will need enough capital on hand to run companies until they actually return profit. For this reason, this strategy might possibly work for incubators that receive strong financial backing from foundations, universities, or the public sector.

A reason that the model of Incubator CP appears to go against common business sense is that private agents largely tend to avoid risks (Eisinger, 1988). The reasons that they are not happy to invest in technology startups are threefold. First, startups are usually new, which means they are unknown to local bankers. Capitalists and bankers tend to not to trust strangers. Second, technology businesses demonstrate high failure rates when they are young. Therefore, chances of returning benefits to investors seem to be very low. Third, even when technology businesses hit a jackpot, it takes a large amount of investment, and takes long time to commercialize technologies. Incubator CP's model is a challenge to this common sense. It runs based on the principal of long term banking on a risky business, betting that a case with very low chances of winning will be successful. The reason it works for this incubator may be that the incubator becomes the partner of the client companies, so client companies are guided by the expertise provided by the core group of Incubator CP, a group that has experience and startup knowhow. In this relationship, the risk of failure is shared between incubator and startups, which may end

up in keeping entry very selective and thus lowering the failure rate in the end. The next section discusses, in detail, the rationales for the selection process.

One of Incubator CP's reason for taking an equity stake or a service fee, instead of receiving a rent fee, is that the founder realized that this rent fee is likely to burden startups rather than help them. He even stated that affordable rent is less likely to save costs for technology businesses. Instead he believes that focusing on critical aspects of technology startups is more critical for early stage NTBFs. He cited "technology development, funding, and recruiting people" as examples of critical support he found overlooked by most publicly funded incubators. He even believes "outrageous rents" instead "kill them trying to find ways to pay the rent (the founder, interview)." He believes typical incubator service provisions, such as clerical services and office services, do not add any value. The Incubator CP tries to not to create a 'one-size fits all' approach. Services are provided as they are needed. This principle applies to office space. Basically, the Incubator prefers a 'garage' model, in which startups can easily intermingle, over the 'corporate' model that doles out large office space, regardless of necessity.

Selection of Clients

Making a quality profile is a critical process that enhances the general performance of an incubator. In this sense, selection criteria not only reflect the rigorousness of the process, but are also filtering devices by which incubators realize the objectives of the organization. For instance, if an incubator is dedicated to improving local employment opportunity, the tenant profiles are likely to be comprised of labor intensive businesses that hire more people.

One unique character of Incubator CP, in regards to selection or process, is that it is relatively flexible about the location of the client companies. Usually, incubators require the client to move in so the incubator can work with them closely. Also, client companies prefer to move in with the expectation of saving costs. Incubator CP also prefers companies to be working

under its roof, but it is open to the choice of the client companies at the same time. One reason for this philosophy is that it does not have a large office facility (the founder, interview). In case client companies need a space, Incubator CP finds one for them from the local real-estate stock (The founder, interview). Incubator CP finds a cheap or free space from someone they know who has extra space. Usually, they receive it as a donation or for low cost through their local connections. Nevertheless, the founder expressed his wish to receive more support from the public sector or universities so Incubator CP may put their client in the same location. While Incubator CP usually finds such spaces easily, the founder described difficulties in getting the public sector to commit. One reason he suggested for these difficulties is the pessimistic perspective held by the public sector about incubator businesses. The other reason he indicated was an overly complicated process and too many restrictions.

The other possible situation is one in which the client companies prefer to work remotely. In this case, Incubator CP maintains a close collaborative relationship by keeping each other informed through online communication. The Incubator is developing online conference devices to serve such clients remotely.

Another characteristic of Incubator CP is that it has very narrow selection criteria, as briefly mentioned in the previous section. Generally, TBIs have a relatively wide definition of the target industry, such as ‘high-tech,’ or just ‘technology-oriented industry.’ ‘Bio-tech industry’ and ‘light-manufacturing industry’ are examples of the narrow definitions. Consequently, TBIs tend to focus on chances of success, instead of looking for chances for collaboration based on specific knowledge or skills required to succeed in a specified field. As a result, this process combined with incubator managers’ limited capability and understanding, may allow incubators to misguide client startups, thus lowering its chances for ultimate success.

Instead, Incubator CP looks for applicants who show possibilities for collaboration with the incubator. Obviously, one good judgment criteria would be whether or not the business is aligned with the knowledge and business expertise of Incubator CP. In this sense, "toughness" in admission standards may not be the right concept – “perhaps it is more about synergy (The founder, interview).” The admission rate is low, not because the selection process is picky with an aim to disqualifying applicants, but because the incubator selectively seeks applicants that they can help among many quality applicants. In short, Incubator CP chooses a company that it can help. The limitedness of its resource is a part of the reason for rejecting applicants, but the primary reason is a mismatch between applicant and incubator.

As discussed, Incubator CP’s extra cautiousness in recruiting seems to be due to its role as a business partner or investor. This position makes them believe that the success of the incubator hinges on the success of the client company. As a result, it must target businesses based on very narrow definition. In any case, the capacity of the incubator is about two new companies a year. Therefore, the admission rate is very low, about 1%, according to the manager. It should be noted that the number of admission criteria on its list is not greater than that of other incubators, on average. Some incubators have more than 10 selection criteria. The selection criteria for Incubator CP are as following:

- commitment to the business
- a viable business model which will enable the company to grow; a good product or service that will create a demand

Monitoring Characteristics

Serving client companies as a business partner or investor makes the incubator a part of the businesses, rather than an external agent that conducts periodic monitoring. Therefore, monitoring is rather informal but frequent or on a daily basis, rather than formal and occasional.

As a for-profit incubator, Incubator CP explicitly focuses on revenue growth and the amount of external investment attracted by client companies as indicators of the progress of its client firms. Hence, Incubator CP is less concerned with increasing the number of employee than incubators operated by public sector might be. The underlying philosophy behind overlooking the number of employees in its monitoring criteria states that the number of employee does not lead growth, but revenue growth causes it.

Graduation policy is not very different from the rationale of monitoring guidelines. The client companies leave the facility when the company starts making revenue income and operating by itself. Therefore, indicators of performance may vary company by company in that sense. The incubator helps clients with customized services to meet their individualized needs for progress. A relatively small service capacity, at two clients a year, may be the reason that this incubator allows customized service. In a nutshell, Incubator CP focuses on whether a business is ready to run independently. Incubator CP even suggests 'outsourcing' if a business seems not to be mature enough to hire full-time employees, but still needs them.

Another reason for their discouraging policy on employment is that the Incubator CP itself supports labor demand by providing technical support. Incubator CP provides the technical services and assistance that client companies require. For instance, the incubator supports credit card payment system when it is needed. The incubator clearly wants its clients to focus on product and sales.

Source of Knowledge and Talent

Resources for knowledge and talent are essential elements that make the TBI model work. Incubator CP seems to be in need of support from universities, for use of laboratories, libraries, and human resources, even though the manager noted the rich supply of talented business people. Region P does not have a major research university, only local universities and community

colleges that do not have research facilities. Neither do they have entrepreneurial/business programs which might provide a collaborative platform. Student resources are utilized, but in a very marginal fashion. Student interns work for the client companies, but this participation is limited due to difficulties with scheduling. The relationships between incubator and universities are still developing, according to the founder (the founder, interview). In regards to sources for technology and licenses, the incubator seeks out opportunities from major universities within the state. The University of Florida and University of Central Florida are the supplemental sources for technologies. But the incubator does not hold any formal relationship with any research center or any university.

Impact Study

This section presents business profile snapshots of client companies that worked with Incubator CP and Incubator CG. As briefly mentioned in the introduction, this section is meant to provide an idea of how the company has performed within the two incubators. Unfortunately, any statistical inference is unlikely to be drawn here, as the sample size is too small to conduct statistical analyses. Therefore, this section should be regarded as providing descriptive analyses, which give an idea of the business performance service of the two different types of incubators. Again, the data used in this section is taken from the NETS database. The number of samples depends on the availability of NETS database.

According to the manager and the website of Incubator CP, this private for-profit incubator is currently serving six client companies, and has helped about 18 companies. Three graduate companies have already acquired been by another company. Out of 24 companies, NETS data only provides data for five companies: three graduates, one current client and one formal client company, all acquired in 2006. The data on the acquired company was available up to year 2007, the last year the company reported the data. A partial reason for this small number is that

the subjects are too young to be registered in the database. Three of those companies stayed in the same city in which they were incubated, and are currently active in business. There is no evidence for the location of the acquired company. According to the manager, the company was acquired by a company located in Boston. The other graduate company was one that was helped by this incubator remotely from another region. This company was found from the list of client companies of another incubator in the same state.

For Incubator CG, founded in 2006 and recently expanded, four companies were available in the NETS database out of a total of seven client companies currently served. Since Incubator CG is relatively young, this section includes all of the business performance available in the NETS data, regardless of the residency or post-graduate period. The following section summarizes nine sample companies and the type of industries they represent.

Industry Type

According to SIC code and supplemental descriptions of NETS data, the eight businesses serve technology related businesses. One note here is that the clients of Incubator CP, a private for-profit incubator, seem to have narrow variation in terms of industrial type. For Incubator CP, two graduate companies (CP1G03, CP1G03) fall into same SIC category, 'Computer software development,' in different industry groups. The other two businesses work in different industries; company CP1T01 for Magnetic and optical recording media, and company CP1G04 for Electrical appliances, television and radio. However, they are both media-specialized, which is publicized as one of specialties of the Incubator CP. It is premature to draw conclusions only based on the data of four companies, but it may indicate the reason that the manager found active collaboration among client companies.

The next section provides growth in employment and sales in a descriptive manner. For external variables not being controlled, the growth of wage is not compared in this section. The

study period is between 2001, the earliest year of both incubators, to 2007, the latest year of available data.

Growth in Employment

Table 4-2 presents summary statistics of the number of jobs created by the client companies of the both incubators. In terms of growth, Incubator CG seemed to create one more job than the Incubator CP. The average number of jobs created by Incubator CG was 2, while only 1 job was created by Incubator CP. It may mean that an average of 1 additional job was created by Incubator CP between 2001 and 2007, and 2 jobs by Incubator CG between 2006 and 2007. The median number of jobs of the Incubator CP is also greater with 2 than that of the Incubator CG, of 0. But the number does not account for the employment size of the base year, which is the first year of the businesses.

The growth rate indicates the percentage of the created jobs in comparison to the number of jobs of the first year of individual business. It is calculated by dividing the difference in the number of jobs between the first year and the last year by the number of jobs reported in the first year. Incubator CP achieved 40% employment growth, while it reached 86% for Incubator CG. 200% was the greatest employment growth achieved by a client company of Incubator CP. A client company of the Incubator CG has achieved 133% employment growth as well. Summary statistics may mislead, however, in that Incubator CP has only one company increased 6 more jobs with five other companies that did not create any employment growth. As discussed in the previous chapters, growth and growth rate during the study period are a good reflection of the magnitude of economic contribution, but it may be misleading as to the actual level of performance, in that it disregards the length of businesses.

Annual growth rate is included to account for the length of business. Annual growth rate is calculated by dividing growth rate by the length of business. The client companies of the

Incubator CP seemed to have achieved about average 10% growth in employment, while Incubator CG achieved about 43% employment growth, every year.

The last column, 'Average employment,' provides insight into the employment fluctuation during the study period. Since growth and growth rate are calculated based on the number of jobs recorded in two critical time points, the first year and the last year of the businesses, the Table 4-2 may not capture jobs that are disappeared in the middle of study period. To calculate 'Average employment' the mean value of the number of jobs each year for a business are first produced. The final value 5.98 resulted as average of the values for Incubator CP. One inference is that client companies of the Incubator CP maintained on average 5.98 employees through the study period. Using the same logic, client companies of Incubator CG hired average 2.75 employees during the same frame.

Figure 4-1 demonstrates changes in the total number of jobs over time for both incubators. Over all years, Incubator CP, the for-profit private incubator, hired more people than Incubator CG. This pattern still appears even in the number of jobs per company, illustrated in the Figure 4-1. Figure 4-3 shows the number of client companies that contributed to the total number of jobs each year for each incubator.

According to the Figure 4-2, when the aggregated number of jobs is divided by the number of companies, the maximum number of jobs is seven for Incubator CP in year 2007, while a client company hired four people as a maximum number of jobs in the same year in Incubator CG. Note that the Incubator CG started in year 2006, so the number of clients before 2006 should be considered only as experimental values.

Growth in Sales

Table 4-3 presents summaries of sales growth. One difference of this table from the Table 4-2 is that sales of each year can be added together, while employment can not be added up

every year. Therefore, in Table 4-3, total sales are reviewed in the Total column. The values of the column are the summation of sales reported by client companies during their lifetime. Another difference is that the average sales may not have significance for reviewing sales since sales fluctuation is captured in the summation of sales. Hence, the column is excluded in Table 4-3.

In the Total column, the row 'sum' indicates the entire size of sales revenue reported during the study period. Since the value demonstrates quantitative magnitude of economic contribution, it is the most popular indicator used in the impact study. The sales revenue of the Incubator CP, at $19,725,800, is much greater than that of Incubator CP, at $1,993,200. Also, the average sales revenue for Incubator CP, at $3,945,160, is about five times greater than the average sales of the Incubator CG, of $498,300. Same patterns are observed from the median numbers of jobs of both groups. However, the growth rate tells a somewhat different story.

Client companies of Incubator CP did not only fail to grow, but also reported negative growth. In comparison to the first year, the sales of client companies of Incubator CP appeared to have declined; each business seemed to lose an average of -$63,000. However, one should note that the negative growth resulted because there was one company that made huge loss. The amount reported as minimum, of -$313,800, should be attributed to the negative average. Also, two other companies reported moderate negative growths in the group. Although the total sales were relatively small, the client companies of the Incubator CG produced average $191,133 sales during the same period. The median sales growth of the Incubator CG, of $153,400, is also greater than -$38,100 median sales growth of the Incubator CP. None of the client companies in Incubator CG reported negative sales growth.

While Incubator CG produced less sales revenue, the group has achieved a greater growth rate, with 88%, than the client companies of Incubator CP, which achieved only 4% growth. The maximum growth rate of the Incubator CG reached 133%, while the maximum sales growth of Incubator CP is only 47%. With a minimal decline in sales growth, the client companies of Incubator CP still demonstrated an average 6 percent annual growth. Again, the median growth rate of sales for the Incubator CP is -0.051, while it is 1.000 for the Incubator CG. Incubator CG reported also greater annual growth rate of the client companies with 44 percent than the Incubator CP that reported only 0.061.

Figure 4-4 demonstrates total sales over time for both incubators. Again, over the comparable time period, between 2006 and 2007, the total sales of the Incubator CP dominated Incubator CG. In the year 2007, five client companies of the private Incubator CP produced $5,258,800 together, while in Incubator CG, only $1,150,800 was produced by three companies.

Figure 4-5 demonstrates total sales per company. It is also calculated by dividing the total sales by the number of companies. The same pattern exists in Figure 4-5; a for-profit private incubator dominated in terms of sales per company over all time periods. The maximum sales revenue was $1,051,760 in year 2007 for Incubator CP, and $383,600 for Incubator CG in the same year. An interesting observation in Figure 4-5 is that Incubator CP reported negative growth from 2004 to 2005. In the year 2004, the client companies produced $3,603,800 as sales revenue, but this number dropped to $3,562,500 in the following year. The range of the decline reached -$41,300. Bouncing back in the following year seems to owe to new member's join. The sales revenue that the new member brought in was $1,638,100, which nearly matches the range of increase of $1,576,300. It explains the fact that the periodical increase of sales per company was only about $100 between 2005 and 2006.

Summaries and Discussion

Although the analyses of this section are done with a small sample, the pattern shown here is that the private incubator tends to be better in profiling in general, and the public incubator is either competitive or better in enhancing business performances. The followings are possible inferences; when reading, one may keep in mind the biases of a small sample and a relatively short study period.

In terms of the number of jobs, the private incubator hired more people, but a higher growth rate was continuously observed in the public incubator. It affirms that private incubator may have accepted companies that hired more people, but the companies may not increase the number of employment as much as the companies in the public incubator. Between 2006 and 2007, the average number of jobs in the private incubator was greater than those of the public incubator. However, the growth rate was competitive between both incubators. One reason that the private incubator hires less than the public incubator may be that the companies of the private incubator are less encouraged or less motivated or even discouraged by the incubator. Another reason for lower growth may be that it is related with industrial characteristics. A possible inference seems to be that it is due to private incubator's less rigorous motivation in employment expansion, according to the interview with the founder of Incubator CP.

According to the founder of Incubator CP, he stresses only production and sales. He continued that he suggests clients wait to hire new employees until they can independently afford them. Does the private incubator cause fast growth? It may not. The same pattern is observed. The private incubator demonstrated more sales revenue, but it also showed slow growth. Total sales revenue as summarized in the Table 4-3 is not eligible since the total sales, alone itself, is biased by the longer study period entered in the calculation of the total sales for the Incubator CP. But even between 2006 and 2007 in the Figure 4-5, the sale revenue of the private incubator

is about 4 times greater than that of the public incubator. Sales per company of the private incubator are also three times greater than that of the Incubator CG. The larger size of the client companies may be the reason that sales growth is sluggish for the private incubator. The public incubator demonstrated fast growth rates, but the size of the client companies seem to be relatively small. Age is not an explanatory factor in this case, since the slope of the first two years of Incubator CP, observed in 2001 and 2002, is not greater than those of Incubator CG in 2006 and 2007.

In conclusion, the clients of the private incubator might be driven to be more cautious when they accept client companies for their resource constraints. As results, they hire more people, and they produce more sales. But as discussed, it does not mean that the private incubator is better than public incubator in enhancing business performance, in that the public incubator showed better growth in both employment and sales. An implication might be that without the public incubator, small companies might have little chance to receive incubator services. The other implication is that the public sector may be better producer, at least in the incubation business. Should the public sector withdraw support from incubation businesses? This section found little evidence in favor of such argument.

Conclusion and Discussion

Cost-reduction Strategies

A major difference between the two types of incubators is observed in aspects related to cost-reduction strategies. Although there seems to be an upgrade, the public incubator, Incubator CG, followed the existing model that emphasizes the significance of cutting fixed costs. Therefore, affordable office space, office supplies, furniture and miscellaneous supplies are introduced as major service provisions in the packet, website and in the interview. Incubator CP, on the other hand, clearly developed an alternative method for cutting costs. Instead of focusing

on fixed cost saving, it suggests providing clients with sources of funding, recruiting, and technology in order to shorten the lag time to independence. This approach is also justified by the fact that technology businesses are not very sensitive to fixed costs. Instead, as a strategy to save costs Incubator CP chose not to expect direct returns for providing services, but instead to take an equity stake after client companies become successful so that they can save on redundant costs in the early stages. This strategy also seems adaptable to the public incubator, in that abundant capital backup is necessary to sustain the operation of the incubator itself while it waits profits to return.

Intervention Mechanisms

The same principle seems to be possibly extended in reviewing processes of selection and monitoring. Following the traditional model, public Incubator CG focuses on the feasibility of the business, with broader definitions of target businesses, while the private for-profit incubator takes a more cautious approach, thus accepting business plans with which the expertise of the incubator may possibly create synergy. The weakness of the model of Incubator CG may be that the approach does not consider whether the expertise of managing staff matches the business needs of the proposed plans. Obviously, the major tasks of incubator include more than just providing spaces and supplies. This approach, however, seems to offer chances for small businesses that have the potential to succeed, while matching tactics provides a relatively slim chance that the business idea and incubating expertise match. Also the strategy of the public incubator may be relevant to one of the organization's objectives, that is, diversification of the economic base, in terms that it opens chances to businesses that propose any feasible plans which allow the regional economic profiles to become more diversified.

On the other hand, the private Incubator CP's approach, focusing on whether the company matches the expertise of incubator, seems to bring about a closer collaborative relationship

between incubator and client companies. Based on the result of the impact study, this matching approach seems to have caused its selection profile to be comprised of companies that are readily successful; the client companies produced more employment and greater sales revenue, although they are sluggish in growth.

In terms of monitoring processes, Incubator CG employed a formalized approach. It requires periodical progress reports that should be entered by means of official forms. Incubator CP uses a more informal monitoring process. An interesting trait of public Incubator CG is that it does not necessarily check the growth of employment. It may be due to sharing the same philosophy with the private for-profit Incubator CP, that employment will follow when companies are successful enough.

Surrounding Resources

In utilizing its surrounding resources, Incubator CG takes advantage of its status of being supported by the public sector. The Research Park, the host of Incubator CG, is a major resource of knowledge and technology by itself. Also, the incubator and Research Park receive external resources from members of the governing board, representing the regional innovative community. Consequently, the Research Park provides a platform within which local government, business community, and academic community effectively intermingle. Although it is not stated in any document or interview, this supportive infrastructure and collaborative community are privileges that public incubator could easily enjoy.

The first and most serious challenge that Incubator CP faces is the passive local government. Complicated and numerous regulations may be a result of its limited perspective. According to the founder of Incubator CP, local and regional government seem unmotivated to devote resources to incubator businesses. Lacking a major research university is another problem. Although the founder saw talented regional businesspeople as a critical advantage, having no

major research university may be a major bias of the program that cannot be offset by the innovative business groups alone. As result, Incubator CP seems to be struggling to connect clients with sources of research and development. He himself travels to find sources of knowledge and licenses in other counties. It is, however, relatively long distance collaboration for an incubator. The founder also expressed regret that the government is reluctant to provide a place for his office. One possible economic approach for the public sector in developing incubators in an area is simply to make local real estate available for the private incubator to use as office space. In this way, the public sector takes advantage of the expertise of a private incubator, and the incubator can more easily provide office space for its clients.

Conclusion

In conclusion, the major difference between public and private incubators seems to lie in several factors related to its sponsorship. First, the capacity to utilize resources seems to drive different styles of management and operation. Incubator CG was able to take advantage of moving into the Research Park, because the Park was governed by a public sector that can manage large-scale real estate and capital subsidy. Another trait is that the public sector holds an advantageous position that can authoritatively formulate platforms within which the local innovative community can effectively collaborate. Second, the different direction of the private incubator is also driven by its relatively limited capacity to utilize resources. For limited capital stock, the incubator becomes cautious about recruiting clients; this business-mindedness motivates the incubator to rigorously examine the potential of applicants based on possibilities for collaboration, rather than feasibility alone. Consequently, only a limited number of companies are served, which leads to a closer collaborative relationship between incubator and client. Due to limited resources, the private incubator needs to seek out office space and sources of knowledge from external agents. Luckily, thus far the private incubator in question does not

have difficulties in searching for office space, but it does not seem to be easy to get attention from government and universities.

Table 4-1. Industry type of client companies

Incubator	Company Code	Industry	Industry Group	SIC4
Incubator CP	CP1T01	Magnetic and optical recording media	Misc. Electrical Equipment & Supplies	3695
	CP1G01	Computer software development	Computer and Data Processing Services	7371
	CP1G03	Computer software development	Personnel Supply Services	7361
	CP1G04	Electrical appliances, television and radio	Electrical Goods	5064
	CP1G05	Design services	Miscellaneous Business Services	7389
Incubator CG	CG1T01	Air and gas compressors	General Industrial Machinery	3563
	CG1T02	Computer related services, nec	Computer and Data Processing Services	7379
	CG1T03	Scientific consulting	Services, Not elsewhere classified	8999
	CG1T04	Commercial physical research	Research and Testing Services	8731

Table 4-2. Number of jobs, 2001-2007

		Age	Growth	Growth Rate	Annual Growth Rate	Average Employment
Incubator CP	Average	4.4	1	0.400	0.100	5.98
	Stdv.	1.8	3	0.894	0.224	1.80
	Minimum	2.0	0	0.000	0.000	4.00
	Maximum	7.0	6	2.000	0.500	8.40
	Median		0	0.000	0.000	6.00
Incubator CG	Average	1.8	2	0.861	0.431	2.75
	Stdv.	0.5	2	0.555	0.277	1.55
	Minimum	1.0	1	0.250	0.125	1.00
	Maximum	2.0	4	1.333	0.667	4.50
	Median		2	1.000	0.500	2.75

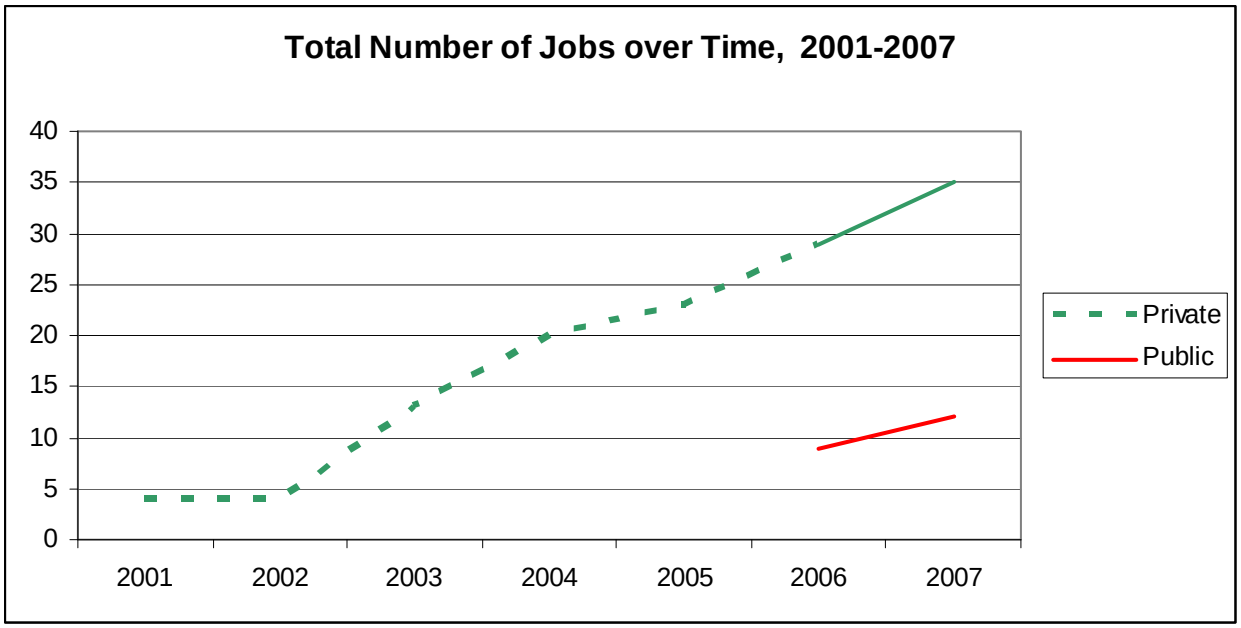

Figure 4-1. Total number of jobs over time, 2001-2007

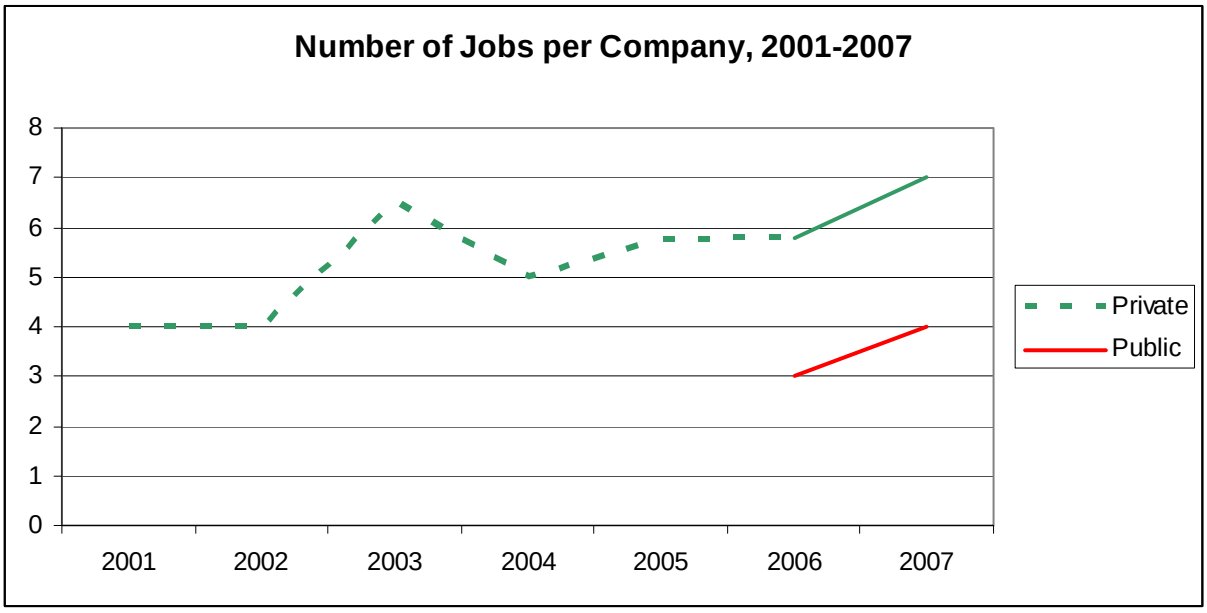

Figure 4-2. Number of jobs per company, 2001-2007

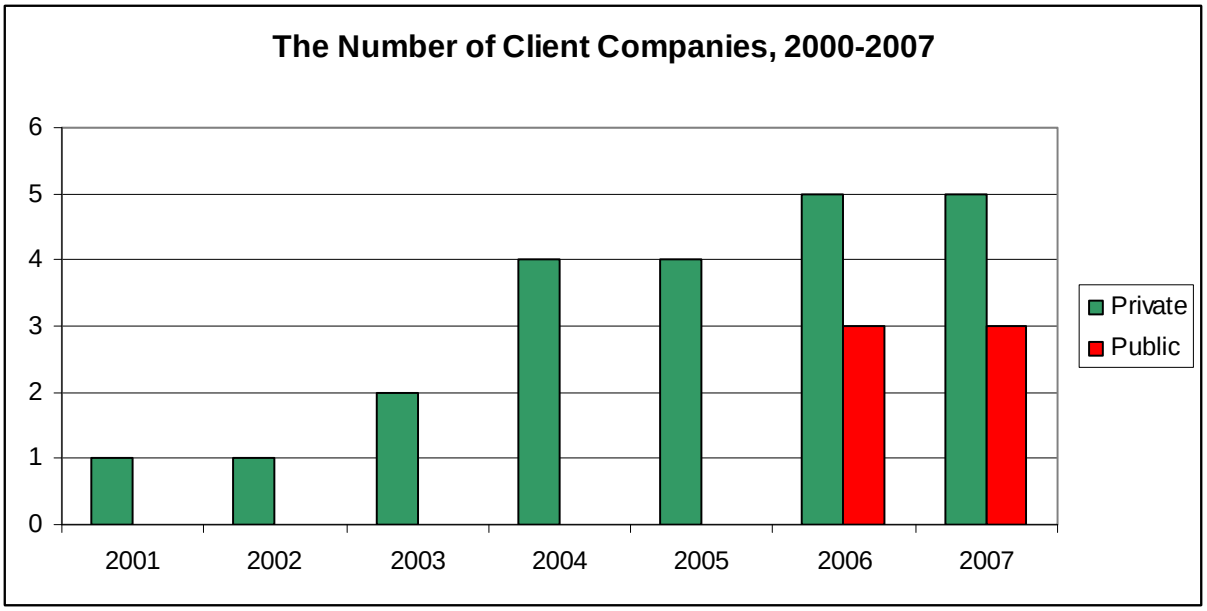

Figure 4-3. Number of client company, 2001-2007

Table 4-3. Sales revenue, 2001-2007

		Total	Age	Growth	Growth Rate	Annual Growth Rate
Incubator CP	Average	$3,945,160	4.4	-$63,000	0.040	0.061
	Stdv.	2,701,629	1.8	158,561	0.249	0.104
	Minimum	$1,113,500	2.0	-$313,800	-0.136	-0.014
	Maximum	$8,313,800	7.0	$124,600	0.479	0.216
	Median	$3,238,100		-$38,100	-0.051	-0.007
	Sum	$19,725,800				
Incubator CG	Average	$498,300	1.8	$191,133	0.880	0.440
	Stdv.	485,606.384	0.5	$114,751	0.524	0.262
	Minimum	$75,000	1.0	$100,000	0.305	0.153

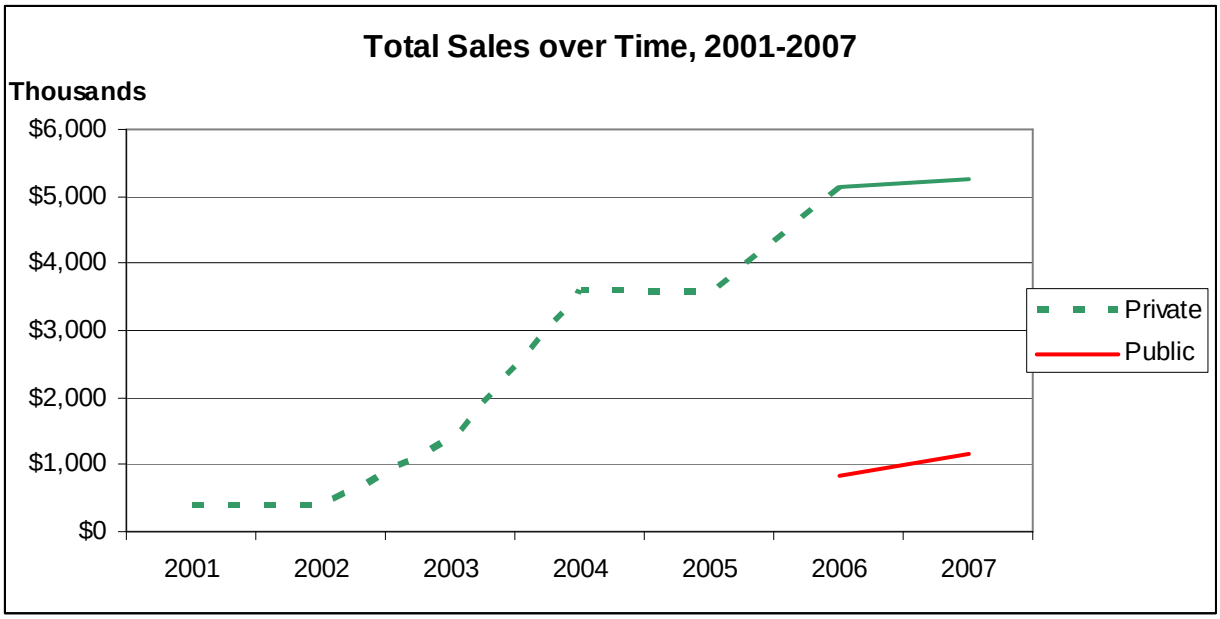

Figure 4-4. Total sales over time, 2001-2007

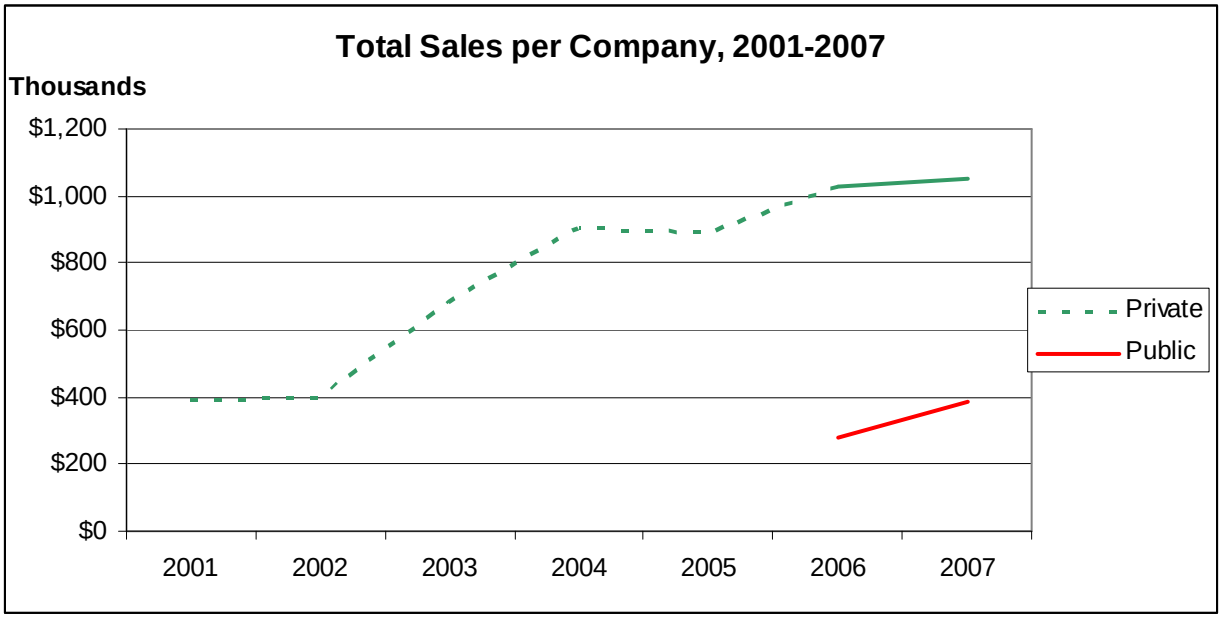

Figure 4-5. Total sales per company, 2001-2007

CHAPTER 5
TWO-GROUP COMPARISON

Introduction

While measuring firm growth is a daunting task because of its complexity, employment is one of the most popular variables for policy makers to use since they operate their programs under strong political pressure that demands better working circumstances of a served region. Sales is another variable that is popular as an indicator of growth (Davidsson, Leona, & Naldi, 2005). In this chapter, the first section explores characteristics of Montgomery County, Maryland to provide the contextual understanding of the study area through reviewing economic geography of the region and the surrounding area. The economic structure, resources for innovative economies, and tax incentives are also major focal points. Descriptive studies on sample client companies will follow. The performances of the private and public incubators are compared in multiple dimensions of employment and sales, using traditional approach of economic impact study and studies of program evaluation.

Issues About Measurement of Growth

The goal of this chapter is to investigate the primary question of whether TBIs with different sponsorships result in different outcomes as indicated by the business performance of client companies. Using the dominant growth concept (i.e., the change-in-amount perspectives (Davidsson et al., 2005)), sales and employment are chosen as two dependent variables of this investigation. According to Shane and S. Venkataraman (2000), firm growth can be achieved by introducing a new product or service, but they are outside the scope of this research. Davidsson and Leona (2005) include assets, physical output, market share and profits as candidates for growth indicators. Sales may not be applicable, however, since NTBFs in the biotech industry may have long development times. Thus, such companies might not able to report any sales or

revenues for a long time. In this case, a better indicator of growth might be the total changes in assets, such as knowledge of the product, patents, intellectual properties, license, and recruiting activities of quality researchers (Davidsson et al., 2005). In addition, the existing literature has demonstrated an increasing consensus for sales as a preferable choice, and it is also a popular indicator that young entrepreneurs themselves use (Barkham, Gudgin, Hart, & Hanvey, 1996). Furthermore, sales precede changes of other aspects, such as employment (Flamholtz, 1986), as mentioned by the manager of Incubator CP discussed in the previous chapter. One justification of this research's employment of sales as an indicator is that the public sector wants to observe a positive impact in employment from Incubator programs. Even a conclusion that some industries may not generate any sales growth may still contribute because it disenchants government agents and political masses who are blinded by the fantasy of technology. Instead, an industry like the biotech industry may be able to receive renewed support that makes long-term funding and institutional support available. Similar justification applies to employment as another indicator of growth.

Different types of business growth comprise a multi-dimensional phenomenon that can be investigated by different determinants and corresponding approaches (Davidsson et al., 2005). To investigate the treatment effect of TBIs on these specified dependent variables, independent variables include many other factors that are largely considered as determinants of business growth in the existing literature. Variations in geographic characteristics are one of the strongest factors that may determine scales of business performance. In this study, however, geographic variation is controlled beforehand by choosing subject samples from one region so that the characteristics constrained by the macro economics of geography are relatively homogeneous.

As briefly mentioned, when measuring business growth, one should consider the complicated dynamics of other related factors in that growth, including the outcomes of dynamics of internal and external factors. Most previous evaluation studies, however, appear to have disregarded the significance of external constraints imposed by different macro economic conditions that vary throughout different regions (Phillips, 2003). This may be due to the oversimplified concept of the treatment effect as a simple change in quantity in a given period of time that is affected by incubators.

As a way to minimize the impact of regional variation, this study investigates TBIs located in close proximity within one state. Although it is impossible to control regional influences perfectly, regional descriptions may provide a robust understanding of the spatial and economic background of the area underpinning business performance of client companies. This study will cover a wide range of issues related to location, from basic demographics to the tax structure related to businesses. It includes population characteristics, macro economic indicators, and tax structures of different municipality levels. Another reason to choose one region to study is to avoid selection bias that might otherwise occur when incubators are pooled together in a group.

Followed by a description of each study area, the selection criteria of the subject samples will be briefly discussed in the followings sections. Characteristics of the sample clients will cover, age, size, and type of industries. Then, this study will discuss factors supposedly affecting firm performance in order to formulate hypotheses of multiple regression analyses, and finally, to present the results of this study.

Description of Study Area: Rockville, Montgomery County. Maryland

The State of Maryland

This study investigates public and private incubators located in Maryland. Therefore, characteristics of Maryland influence the entire sample population. In other words, variation

regarding state policy and geography became minor issues in regards to the sample populations since the populations are exposed to very similar settings. Factors related to state policy and geography can be, in this sense, regarded as constant variables, rather than explanatory variables. Maryland is a background for the entire sample population, thereby either nurturing or hindering the business development of client firms. This section reviews the factors and characteristics of Maryland that might affect business performance. It includes a review of general economic factors such as labor statistics, state tax incentive provisions, and research and education system.

Maryland economy and major technology industries

Maryland's employment is comprised of about 22 percent of businesses in Trade, Transportation, and Utilities. Twenty percent is served by a Professional and Business Services cluster. The Education and Health Service industry contributes seventeen percent, which reflects the fact that the state is host to Johns Hopkins University, a world renewed medical science university. These industries are followed by leisure and hospitality, retail trade, and health care and social assistance. Table 5-1 reports the major industries of Maryland and their levels of employment in comparison to the total employment of the US. Using the base area of the US, the location quotients are either higher than 1 or near to 1, implying that the major industries of Maryland make up a larger share of Maryland employment than they do for the country as a whole. The fact that the industries of professional and business services, education and health services, health care and social assistance are included as competitive industries of Maryland implies that the area has relatively strong potential for the development of technology businesses in comparison to other regions of the state.

Median household income of Maryland, based on the 2000 Census, was $52,868, which placed the state near the top nationally. This higher level of income is one of the factors that is positively associated with the growth of technology businesses. Another factor that makes a

region attractive for the growth of technology businesses is the proportion of work force in management occupations to total work force. For Maryland, approximately 40% of the population that is 16 years old or older holds management occupations. This is about average in comparison with national statistics. The availability of leading businesses is another critical factor that facilitates the formulation of new businesses. Montgomery, Howard Counties and Baltimore together are home to twelve Fortune 1000 companies. [1]

Currently, Maryland has been transforming itself into a leading technology-oriented state, while it retains traditional strength in manufacturing, shipping, financial services, and government contracting. Information technology, telecommunications and aerospace and defense are the target industries of the new economy of Maryland. Table 5-1 summarizes the major technology industries of Maryland. [2]

Moderate growth in employment has been observed in all four industries. While the total amount of employees on the payroll of the aerospace industry slightly declined in the year 2002, growth in payroll reflects similar moderate growth. Total payroll employment of aerospace companies comprises 2.6% of Maryland's total payroll, but it contributes 4.8% of the total payroll of state. The average weekly pay of aerospace employees, $1,426, is about 80 percent greater than the average of all industries of Maryland ($782).

The information technology industry of Maryland appears to have experienced the global decline of the dotcom industry that occurred in the early 2000s. Employment in the IT industry declined by about 5.6% in year 2001 - 2002. A slow turnaround started in 2003 and added about 730 jobs to industry payrolls by 2005. Also, the average weekly wage in 2005, was $1,426, which was about 80 percent higher than that of all Maryland industries.

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[1] www.ChooseMaryland.org

[2] www.Choosemaryland.org

The healthcare industry contributes one in 10 jobs to Maryland's economy. The industry has continuously reported growth since 2001 without interruption. The city of Baltimore and Montgomery County supported this industry; in fact, 4 out of 10 jobs were created within these regions.

State tax incentive for NTBFs

As a means of incentive for investment in early stage biotech companies, Maryland provides income tax credits for investors in qualified biotechnology companies. Biotechnology Investment Tax Credit is equal to 50% of an eligible investment.

As in other states, Maryland also provides Enterprise Zone Tax Credits. Businesses located in a Maryland Enterprise Zone may be eligible to participate in this credit program. Income tax credits and real property tax credits are offered in return for job creation and investments. A one-time $1,000 credit per new employee is the general credit.

For businesses that conduct research and development, Maryland provides R&D tax credits, accounting for three percent of eligible R&D expenses through the Basic R&D Tax Credit program. The Growth R&D Tax Credit gives back 10 percent of total R&D expenses that exceed average expenditures in R&D over the last four years. [3]

The state created a fund, called The Maryland Venture Fund, which makes direct investments in technology and life science firms and indirect investments in venture capital funds. Software, communications and IT security receive about 60 percent of the fund, and the rest is invested in life science companies. The businesses will pay 8.25% of the State Corporate Income Tax for the year 2009.

[3]The City of Baltimore

There are 11 universities of in the state university system, called the University System of Maryland, and one private major research university, Johns Hopkins University in Maryland. They have created more than 250 research centers and science technology institutions. In the year 2004, the National Science Foundation report named Maryland as the fourth highest state for overall R&D spending. It was a significant change from the previous year when the state was ranked in 9th place; this shift resulted from a 41% increase in total R&D performance. The actual amount of money increased by nearly 4 billion dollars. Also, Maryland is now the second strongest state in terms of R&D intensity. In 2003, the proportion of R&D to state GDP was 6.3, whereas the national average was 2.4 (O'Malley, Brown, & Edgerley, 2007). In the 2006 NSF report, Maryland was ranked in 4th place in R&D expenditures at universities and colleges and 3rd place in federal government R&D spending at universities and colleges (Maryland Department of Business and Economic Development, 2009). Maryland was also ranked in 7th place in terms of the number of venture capital deals in 2007, of 99 deals, and for total capital investment (Maryland Department of Business and Economic Development, 2009). In sum, Maryland encourages research and development by providing institutional and capital support.

Selection of Study Area and Regional Specification

Selection of study area

The geographic focus of this study is Montgomery County. In this section, four counties and one city of mid-central Maryland are explored to highlight the characteristics of Montgomery County by providing regional context surrounding the subject area. The four counties and one city are Howard County, Frederick County, Montgomery County, Ann Arundel County, and Baltimore. One private for-profit incubator and one public non-profit incubator are examined; both incubators are located in Rockville City, Montgomery County. Table 5-3 summarizes the sponsorships, incubator code and locations of the sample incubators. To avoid

confusion, the public incubator is indicated by character G, as it is a government funded incubator as well.

Economic geography

Map 5.1 illustrates the geography of Montgomery County, Maryland. The map also presents the population of municipalities of the surrounding area. The purple circles, varying in size, represent the size of population. The area served by the two subject incubators is Rockville, the municipality boundary of which is colored red.

As shown in Figure 5-1, Rockville is a mid-size city in terms of population. Surrounding counties also have cities with similar populations. The population of Howard County seems to be similar but its low density means that the population is dispersed rather than concentrated. The most populated and concentrated areas appear to be the cities of Prince George's County located between Anne Arundel and Montgomery Counties. The Rockville area, bridging the city of Frederick and Prince George's County, seems to be good for incubator business. This regional context is presented using census 2000 data, as summarized in Table 5-2.

Table 5-4 summarizes regional characteristics in terms of demographics, economy, housing, and residential services. As shown on the map, Rockville is the largest city in Mongomery County. Annapolis is the smallest city in the region. The difference between Rockville and the largest city, Columbia, is about 50,000 people; the difference between Columbia, the largest city and the smallest city, Annapolis is about 150 percent, based on the population of Annapolis. In terms of population density, Howard County may have a dispersed population, indicating relatively lower density. In contrast, Annapolis reports the highest population density with the least population, which signals a high concentration within a specific area. Such a high population density may imply uneven development of the county. Or it could be interpreted positively, as an agglomeration of industry, a fact that makes the area attractive to

technology businesses, and precedes the formulation of an agglomeration of innovative businesses.

Availability of a highly educated work force is a factor that may facilitate an agglomeration of technology business. Rockville (53%) is, along with Columbia (59%), a city of which the majority of residents are highly educated, in terms of the proportion of people with college degrees or higher. Although Frederick reports the lowest percentage in this category, the city is between the top 25%- 30% if compared to 1,273 other places in the USA. Rockville shows an extraordinarily high rate (31%) of foreign born citizens, while the maximum foreign born population of the three other cities is only 13%. One should be cautious when interpreting this statistic. Richard Florida may see a large foreign born population as a positive signal of a creative economy because of its high diversity (Florida, 2003), but it also means a high potential for social struggles or social instability. Nevertheless, diversity is usually positively associated with innovative clustering (Florida, 2003).

In terms of income, Columbia in Howard County has the highest with a $71,524 median household income in the year 2000. Rockville takes second place. Annapolis and Frederick do not differ significantly in this category. This pattern repeats in any income related categories.

Columbia businesses appear to have been very active in 2000. The number of establishments is nearly double that of Frederick, which takes second place in this category. When it is adjusted by the population, the number of establishments per 1000 people within the four cities becomes similar, about 35.

Single family housing is dominant in Rockville and Columbia, which might indicate the economic prosperity of the cities. Both lead in the number of single family detached homes and homeownerships rates. The other two cities have relatively low proportions of single family

detached homes, either in comparison to other cities in this group, or to the rest of the nation. There seems to be no significant difference in the level of housing value among the four cities in other dimensions.

The four cities have similar levels of employment, between 65% and 75%. Also, the percentage of employment in sales and related occupations is similar, at about 22%. No significant difference is observed in relation to other indicators of employment. In conclusion, the four cities can be considered to be very similar in several dimensions. Annapolis may have a smaller population, but the size is offset by a relatively higher income level and a balanced economy. The next section specifically discusses the economies of the subject counties.

Employment structure

To provide a general understanding of the economies of the subject counties and city, Table 5-5 summarizes the top three industry categories in terms of employment and wages of the subject areas. The three industries, using NAICS three digit aggregation, are selected based on the percentage of employment. The data is based on the 2007 Quarterly Census of Employment and Wages data, using Maryland as the base area. In this section, the city of Baltimore is included in the discussion since some client companies practice their business in the city.

The three major employing industries of Maryland, Trade, Transportation, and Utilities, Professional and Business Services, and Education and Health Services appear many times in the list of each county. The majority of Montgomery employment is comprised of Professional and Business Services, which appear throughout the entire list. Trade, Transportation, and Utilities is the largest employing industry of Frederick and Anne Arundel Counties. Education and Health Services provides the majority of employment opportunities in Baltimore. Most location quotients of these industries also affirmatively indicate that the job share of the industry for the county is larger than it is in the base area, Maryland.

To provide a more detailed perspective, major employers of the counties are summarized in Table 5-6. The lists of employers are sorted by the type of industries to show the aggregated number of employment by industry sectors. [4] The information in this table is based on the data arranged in November 2008. The lists of major employers for each county are available on the website of the Department of Business and Economic Development.

Montgomery County's major employer seems to be the federal government and companies in the healthcare industry. Fourteen businesses in these industry categories employ around 58,553 people altogether. In Howard County, the number of employees hired by businesses in professional services is outstanding. But one business in education and one in information hire about 2,000 people each. There is no such outstanding observation in the profile of Frederick County. Employers in all industries hire about several thousands people. As observed in Table 5-5, Education and Healthcare appear to be major employment producers of Baltimore. Thirteen employers of these two industry categories employ 76,426, which is three times greater than the total number of employees, 19,169 people, hired by 19 major employers in Frederick County. In Anne Arundel, the federal government is the major employer. It employs 31,425 people.

Interestingly, subject counties possess a large cluster of major technology industries as explored previously. Overall, 28.8 percent of the entire Aerospace industry in 2003, 37 percent of Information technology in 2005, and 30.1 percent of all Bioscience businesses were clustered in Montgomery County. A cluster of Healthcare industry businesses is observed within Baltimore, which reaffirms previous findings. The city has the largest share, of 22.9 percent in 2005, of all industry clusters, in terms of number of establishments. Table 5-5 summarizes the employment and wages of these industries.

[4] The source does not indicate criteria of the collection.

As illustrated, a large cluster of Bioscience businesses affirms that Montgomery County has a very competitive Bioscience industry. The employment change of the industry between 2001 and 2003 was more than 10 times greater than Anne Arundel's change in the same period. The average wage of the area, however, remained at the same level of Howard County. The competitiveness of Anne Arundel's economy seems to be leveraged by the Aerospace industry. The employment change, of 449, between 2001 and 2003, was nearly nine times greater than what Baltimore achieved. Anne Arundel also reported the highest average weekly wage in the industry in the year 2003, $1,611.

However, Montgomery County suffered a major loss of jobs within the Information technology industry in the period from 2001 to 2005. It lost 4,296 jobs from the sector. Never the less, Montgomery County still reports the highest average weekly wage. Howard County took second place in terms of level of wage, but only 164 jobs were gained, whereas other counties gained about 500 jobs.

Montgomery County may offset the deficit caused by severe job loss in the Information technology cluster by gaining jobs in the Healthcare industry cluster. Although the county reported the second highest job increase, with 4,847, the average weekly wage was the highest among the group. In the period from 2001 to 2005, Howard County and Anne Arundel County only gained less than 2000 jobs in the Healthcare industry. The Biotech industry and advanced technology (mostly Information technology) are two of the four targeted industries of Frederick County, according to an announcement from the Department of Economic Development, but any of those areas can outperform comparable counties in any dimension.

Tax incentive programs

Table 5-8 provides a summary of tax incentives for businesses that are offered by municipalities. No significant difference is observed in the Local Personal Income Tax Rate.

Montgomery has the highest income tax, with 3.20%, and Anne Arundel has the lowest, of 2.5%. Baltimore is again ranked as the second highest. As shown in Figure 5-2, zero dollars of Frederick County is an extraordinarily low amount in comparison to the whole vicinity. Caroll County and Howard County are classified in the upper 25% in this category. However, Frederick County provides no tax exemption program whatsoever whereas all other municipalities allowed 100 percent of Manufacturing/R&D Machinery and Equipment and Manufacturing/R&D Inventory to be exempted. Baltimore has the largest Enterprise Zones. There are some Enterprise Zones in Montgomery County, too, but they do not seem to affect incubator clients as demonstrated in Figure 5-3.

Figure 5-3 illustrates the number of client companies by graduated colors. The map uses zip code area files to indicate the location of companies instead of geocoding the actual location. Dark red means that more companies aggregated in the corresponding zip code area. As indicated by the symbology, the closer one gets to Rockville, the more client companies are present. As mentioned before, Enterprise Zones located in southern Montgomery do not affect companies located within Rockville. In contrast, Enterprise Zones in Baltimore cover nearly half of the entire city.

Regional knowledge resource

TBIs located in the Baltimore-Washington area may enjoy the knowledge and talent produced by 65 accredited institutions of higher education. However, within the territory of Anne Arundel and Frederick Counties, there are only two 4-year institutions in each county, whereas Baltimore hosts 15 of them. Howard County and Montgomery County have good sources of knowledge and talents. Howard County has about 15 HEI. The number of institutions in Montgomery County may not be as high as that of Howard County, but Montgomery County has several major research universities in it, such as Johns Hopkins

University, Loyola College, the University of Phoenix, and the University of Maryland University College. More often than not, the availability of knowledge resources emerges as the strongest determinant that enhances the performance of TBIs.

Business incubators do not aim to create knowledge or talent by themselves, but the availability of such institutions within the vicinity affect the creation of both codified knowledge and tacit knowledge because clients of incubators can share and transfer their own knowledge. Montgomery County seems to have abundant resources that may provide platforms for regional innovative agents to interact each other. The county has 6 incubators, one technology center and one affiliated university, Technology Park. Baltimore has two business incubators at three locations. In addition, one research-oriented industrial park at Johns Hopkins University supports the regional innovative system of the area, along with two research and business parks affiliated with the same university. Howard and Anne Arundel Counties may currently be in the process of developing such a system. There is only one business incubator in Frederick County but it is located in two locations. The innovative activities of Frederick County, however, are supported by six technology centers and parks.[5] Table 5-9 presents the summary of this section.

Subject Sample

Brief review of sample incubators

Rockville provides an idealistic setting for comparative studies, as two treated groups, private for-profit and public incubators, are available within the same municipal boundary. The

[5] The data provided in this section is based on the following source. Incubators are inclusive all business incubators, regardless of technology or mixed-use. Technology and Science centers are selected based on the name of facility for that include any terms indicate technology or science orientation. Specialty of the facilities is not in consideration. Source: Brief Economic Facts, Maryland Department of Business and Economic Development (http://www.choosemaryland.org/regionsandcounties/randcindex.html)

client sample selected from these treated groups is composed of 10 client companies from private for-profit incubators and 36 companies from public incubators.

Based on an NBIA report (2003), a commonality of the private Incubator GP and the private incubator CP, reviewed in the case study section, is that they don't have established requirements for graduation. They both emphasize the sophisticatedly defined maturity of the individual situation of client companies. The major difference between GP and CP is that GP was established by an organization that utilized large scale investment, which presumably provided large scale research facilities necessary for bioscience research. The NBIA list includes an 'approved animal facility, an animal treatment room, a low temperature repository, a clean room, and warehouse space' (2003). Another difference is that GP is surrounded by abundant resources that may encourage innovative activities, whereas CP may struggle to bridge external resources with its clients. The availability of resources is beneficial in itself, and institutional efforts from the local community and government seem to be aggressive enough for those agents and organizations to be collaborative. Incubator GP, the public incubator of Rockville seems to enjoy such institutional and governmental support. Another similarity between the two public incubators is that CG and two of the subsidiary incubators within group GP are very young. They are still in the process of development. However, the reason that GP was chosen in this section is that one incubator is mature enough to provide many client samples. Also, Rockville seems to be a more nurturing setting for an innovative economy in that there are plenty of organizations of research and development, and the local government seems to be very supportive.

Client companies

There are several issues that need to be mentioned in regards to the dataset. Multiple sources were used to create the final sample. The incubator website was the primary source that

provided basic information of incubators and the list of client companies. One issue is that some incubators provide only a sample client list. Some incubators do not provide a list of graduates on their website. There was no way to make sure each website list was complete. Issues regarding the trickiness of acquiring complete lists of clients often include the fact that incubator managers use different standards to define client companies. Some managers use a very broad definition, including affiliates as well, but some oppose the idea. With a list of client companies provided on their website, creating a final subset depends on the availability of the necessary data in the NETS database. Client companies that moved to other states are also excluded from the final subset. Table 5-10 summarizes the client sample.

The proportion of client companies to the original population seems to be large enough to represent the population. The average age of the client firms is 7 years old. The oldest company is 18 years old, and the youngest one is 1 year old as of 2007. Figure 5-4 illustrates the sample distribution by age.

Client companies and type of industries

Using an NAICS code to provide a general perspective, Table 5-9 lists the major industries of client companies and decryptions. The major industry, for both groups of clients, seems to be concentrated in Research and Development in the Physical, Engineering, and Life Sciences. The portfolio of private incubator clients seems to be more focused, especially considering the minor type of industries; they are three companies in the Manufacturing industry (325412, 325414, and 334519), one company in Management consulting services (541618) and one company in the Technical consulting services (541690). The three companies in Manufacturing seem to be involved in biological or pharmaceutical production processes, while the industry focus of clients of the public incubator ranges from Building inspection to Manufacturing related to Photographic production.

Table 5-12 presents detailed descriptions of the client companies using SIC 8 digit classification. Industries of three client companies of the private incubator are classified as Biological Research, and the other three are classified as Biological Research, Commercial. Client companies in the first group appear to be older but produced fewer sales in their first year. One consideration that needs to be taken into account is the start year of each business. For these companies, the first year occurred in the early 1990s, so a simple comparison of the early 1990s dollar with today's dollar may be misleading in terms of actual significance of the amount of money earned.

As observed in Table 5-9, the largest concentration is in one specific industry: Biological research. The public incubator seems to focus on Commercial Physical Research. In the same industries, the number of first year employees and amount of sales generally look greater in the table of the private incubator, while further investigation is required to draw a convincing implication. An interesting point of this portfolio is the two lines of records at the bottom of the public incubator table. Four client companies classified as Medical research-noncommercial, and Medical research look differently. The number of first year employment is nearly three times that of any other comparable company. Also, first year sales are outstanding. Since the summary of the two companies may cause confusion, Table 5-11 provides disaggregated information. The new information shows that there are huge gaps between the two companies within each industrial class. However, no generalizable implication can be drawn at this point. Ages of companies are quite similar. One may also question how size affects the scales of sales. An in-depth study or any kind of further investigation review might be required to provide more information.

As of 2007, the NETS data has discontinued the list of eight companies among 36 client companies of the public incubator. Their last years are reportedly before 2007, the last year that the NETS database made this information available. The description of NETS data informs that such records indicate the deaths of companies.

Based on the information available on the website about length of residency, the client companies of the private incubator took approximately 5.9 years to develop. A shorter period of time has been committed by the companies incubated in the public sector, with an average length 2.3 years.

One interesting finding is that the number of tenants drastically started doubling around year 2000 for both incubators. The average number of resident companies is counted for each year. This section explored figures that provide description of the sample dataset, not the analytical findings. The next section of the paper offers an impact study that compares the performance of the client companies, in terms of job creation, estimated wages, and sales.

Impact Study

As stated in the methodology section, the evaluative studies of this research employ a nonparametric method because of its small sample size. A generous confidence level of 0.2 is used. As such, a generous range of significance is excused (R. G. Phillips, 2002). The analysis in this section investigates both absolute and relative figures to acknowledge the magnitude of economic impact actually contributed by the incubator, and the efficiencies of the incubator program measured from the unit of analysis, the client companies. A list of client companies is obtained from the subject incubators as well as related information such as year of admission and graduation. NETS database provides information about employment and sales. Wages are estimated using the Quarterly Census of Employment and Wages Publication Changes by multiplying the number of jobs created each year by each company.

A major purpose of this section is to present compare business performance of the private and public incubators, in regards to three business aspects: employment, wages, and sales. Three sub-hypotheses of this research will be tested throughout the chapter.

- **h4:** TBIs in the public sector generate greater jobs than TBIs in the private sector.
- **h5:** TBIs in the private sector report greater wages than TBIs in the public sector.
- **h6:** TBIs in the private sector report greater sales revenues than TBIs in the public sector.

Growth in Employment, Before and After Graduation

This section reviews hiring activities reported in the business performance of the client companies for two periods. The first period is when they were being helped under the influence of the two incubators. The second period is after graduation until the latest year the data is available. The major purpose is to compare the business performance in terms of employment and to find out if there is any difference between the two groups over the two periods. The subject of the analysis is the number of jobs of the companies during the two study periods, available in the NETS database. The major hypothesis of this chapter is hypothesis 4 of this research. Each subsection will present tests for hypothesis 4.

h4: TBIs in the public sector generate greater jobs than TBIs in the private sector.

Employment growth, before and after graduation

The first measurement is employment growth while the companies are under the direct influence of the incubators. The employment growth of the post-graduation period is compared. The primary objective of this analysis is to highlight business progress achieved through the program by comparing the same business performance in the period that the companies became independent of the program. Differences between the two groups are also investigated within the same periods. In this presentation, employment growth is the difference between the number of jobs at the year of graduation and also at the year of admission.

Figure 5-5 demonstrates the frequency distribution of employment growth achieved by individual client companies of both groups. Two extreme outliers, one at -45, and the other at 75, are excluded in the histogram. Also, the observations are widely distributed, with a fairly large standard deviation of 13.85, and the Figure is also somewhat positively skewed. With the given conditions that the normality assumption is severely violated, a nonparametric method appears to be appropriate.

In Table 5-14, two outliers are observed, one from the maximum of Incubator GP, the other from the minimum of Incubator GG. Both are excluded in the frequency distribution. Because the distributions are skewed and have a wide range with a couple of outliers, the median seems to be more relevant as a summary measurement. The average number of jobs, 11.22, of Incubator GP is highly influenced by the wide range with several outliers, and thus may not be an appropriate summary indicator. Among the 15 client companies of the private incubator, six client companies are excluded because they have only one year of employment records for which measuring growth is not appropriate. For the companies that stayed only one year in the incubator, the same reasoning is applied for exclusion. The median of the employment growth observed from the private incubator is 1, while it is 0 for the public group. To test the significance of the difference, a Mann-Whitney test is employed. Based on Table 5-15, the employment growth of the private incubator seems to be higher, with a higher mean rank 27.39, but the difference does not appear significant, with a p-value of .218, greater than the relatively generous confidence level of 0.2. The test hypothesis is as follows.

- **h4a:** There is no difference in employment growth between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 - F2 = 0$

  $H1 : F1 - F2 \neq 0$

Table 5-16 summarizes the descriptive statistics of employment growth reported by the client companies of both groups after they graduated. Again only nine companies are included from Incubator GP. This time, six companies are excluded because they are currently tenant companies of Incubator GP. As illustrated in Figure 5-6, the distribution is slightly skewed to the left, and Incubator GP has some extreme outliers.

After the client companies have graduated, a slight increase in number of jobs seems to be created by the public incubator, based on the greater mean rank of 23.08. Again, the average number of jobs appears to be inflated by the outliers of both incubators. Employment growth after graduation is the difference between the number of jobs at the latest year and the number of jobs in the year of graduation. It is to measure how much employment growth the client companies have achieved after they became independent from both incubators up to the point of this investigation. After graduation, the same pattern observed from the previous period seems to have continued. However, the medians, at 0, are not only the same, but also the test results, with a p-value of .923, are not significant, based on the results of the Mann-Whitney test summarized in Table 5-17. The only conclusion is that the difference between the two groups seems to be negligible.

Employment growth indicates the quantity of jobs created by the two incubators during the two study periods. Growth in the number of jobs, however, should not be interpreted as an indicator of the level of performance of both incubators, in that the number of jobs is mostly sensitive to the length of residency as well as the age of the program. Also, this analysis is effective in showing increase and decrease, but limited in appreciating the implications of such changes since the measuring framework disregards initial size of employment. For instance, it

does not distinguish differences between two additional employees from a company that started with four people and a company with an initial staff of one.

Employment growth rates, before and after graduation

To account for such limitedness, this section presents an analysis of growth rates of employment. To calculate the employment growth rate, two values are used. The first is the number of jobs created or lost at the end of the periods. The second is the number of jobs reported at the base year, which is the year of admission for the residency and the year of graduation for the analysis of post-graduation. Therefore, the difference between the number of jobs at the year of graduation and the number of jobs at the year of admission is divided by the number of jobs at the year of admission. The growth rate of the post-graduation period, using the same formula, is calculated by dividing the difference between the number of jobs in 2007 and the number of jobs at the year of graduation by the number of jobs at the year of graduation. For instance, if a company started the business with three people, and four jobs are reported at the year of graduation, the difference, one, is the number of jobs the company has created; thus one is divided by four to produce the growth rate. The employment growth rate of this company during the residency is 0.25, that is, 25 percent. The major difference of this presentation from the previous one is that this presents the percentage of the created/lost number of jobs, whereas only the number of jobs was presented in the previous analysis. Following is the test hypothesis.

- **h4b:** There is no difference in employment growth rate between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 - F2 = 0$

  $H1 : F1 - F2 \neq 0$

Table 5-18 presents the descriptive statistics on the employment growth rate of the client companies of the two groups. Figure 5-7 demonstrates the frequency distribution of the employment growth rate that is positively skewed with some outliers.

While they were in the incubator, the median employment growth rate of the clients of the private incubator was 25 percent, slightly greater than that of clients of the public incubator, with a median of 0. Again, the 45 percent average employment growth rate of Incubator GG is inflated by the outliers. Based on Table 5-19, the test also finds that the difference is not statistically significant, based on the p-value of .249 — slightly above the acceptable level of 0.20.

One outlier exists in the public Incubator GG, as illustrated in Figure 5-8. Distributions of both incubators have a long tail on the right hand of the curve, with extreme outliers in Incubator GG. Based on the descriptive statistics in Table 5-20, after graduation, the median growth rate of the private incubator dropped to 0 percent, while the median growth rate of the public incubator remained the same. One company that started with only one job ended up creating 17 additional jobs, thus reporting 1700 percent employment growth. It also inflated the average growth rate of Incubator GG to 84 percent.

In both periods, however, the Mann-Whitney test does not support significant differences, presented in Table. 5-21. The P-value, 0.82, is extremely higher than the acceptable level of 0.20. Therefore, the difference does not appear to be statistically significant.

Employment growth rates are presented to account for the difference of the initial employment size between the two groups. In both periods, both groups do not appear to be significantly different. One cannot, however, link this finding to a conclusion, as the level of performance of both incubators may or may not be different, in the sense that periodical growth

rates are also sensitive to the number of years through which companies continuously hired and fired. The next table presents annual growth rates that account for the length of the residency and post-graduation period.

Annual employment growth rate, before and after graduation

As mentioned, the first section was effective in presenting quantitative aspects of the employment impact of both incubators, but was limited in capturing the given size of employment. The second section provided, accordingly, the proportional employment growth, that is, the employment growth rate. The proportional employment growth is insightful in that it accounts for the default employment size, thus distinguishing different implications of the same number of employment growth. However, the analysis does not account for the number of years the companies were in business. This section provides annual growth rates, by dividing the proportional employment growth by the number of years. The numbers of years is the length of residency and years of business after graduation, respectively. This indicator effectively captures marginal changes affected by the program. For this reason, the annual employment growth rate is the most popular indicator in the area of the evaluation studies of economic development. It is also widely called simply employment growth rate. The test hypothesis is as follows.

- **h4c:** There is no difference in annual employment growth rate between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 - F2 = 0$

  $H1 : F1 - F2 \neq 0$

In Figure 5-9, the distribution of the annual employment growth rate of both groups has long tails on the right side. Also, several outliers are observed from both incubators. Table 5-22 summarizes the descriptive statistics of the two groups. The distribution is slightly skewed to the

left and has some outliers. The maximum annual employment growth rate is 200 percent of one client in Incubator GG. Incubator GP shows a slightly greater median, 0.05 greater than Incubator GG, of 0. ---According to SIC code and supplemental descriptions of NETS data.

The minimal difference between the two groups is confirmed by the Mann-Whitney test, summarized in Table 5-23. Although a slightly higher mean rank is observed from Incubator GP, at 26.61, the p-value .305 is still greater than the acceptable level of 0.20.

Based on the frequency distribution of annual employment growth in the post-graduation period, the two groups seem to show very similar patterns observed from the analysis of residency, as illustrated in Figure 5-10. Although the curve shows relatively even distribution, with a moderate positive skew, several outliers call for use of the median, rather than the mean. Most of the distribution is concentrated around 0. In Table 5-24, the medians of both groups are also 0, which indicates that the annual employment growth of both groups is relatively marginal. The maximum annual employment growth rate of the private incubator is 340 percent.

In Table 5-22, the difference between means is very small, and in Table 5-25, test results support no difference between the two groups with the p-value of 0.794, which is greater than 0.20. Although the difference is not statistically significant, the private incubator seems to have achieved larger employment growth while the clients were in the incubators. After they graduated, the annual growth rate of the graduates of the private incubator, again, dropped to 10 percent a year, whereas the same value of 17 percent is observed from the graduates of the public incubator in both periods.

Is there any difference in job creation between the two incubators? None of the measurements turned out to be statistically significant. The following section visualizes the

employment impact created by the subject incubators, through measuring growth in employment and sales over time.

Changes of total number of jobs over time, before and after graduation

Primarily, the employment impact means the degree to which a program contributes to the creation of new jobs in a region. Suppose an incubator started a program a couple of years before research begins, and a program manger wants to know how many jobs it has created thus far. The investigator counts the number of jobs in the client company report at the moment of investigation.

Changes of total number of jobs, before graduation. The summation of the number of jobs is the total number of jobs that the program has created in the meantime. Using same two study periods, before and after graduation, Figure 5-11 illustrates changes in the number of jobs generated by tenant companies, by showing jobs reported each year. Both groups seem to have increased over time. The line of tenants of the public incubator shows fast growth in the late 90s until its peak in 2004 and it showed a slowdown at 2003, 4 years thereafter. The number of employment reported by tenants of the private incubator seemed to have stayed between 50 and 100, roughly. After year 1999, public incubator appeared to have provided more employment opportunities for the region than the private incubator.

Figure 5-12 presents job gains and loss each year reported by the tenant companies of both incubators. An interesting finding is that the tenants of the private incubator tend to rather maintain given number of jobs, than actively hiring many people. With some fluctuation, on the other hand, client companies of the public incubator seemed to be rigorous with hiring activities, while they lost some time, through their life time. Over all period, the number of jobs of the private incubator seemed to be larger, but they might have been a bit cautious with expanding employment opportunity.

Number of jobs per client, before graduation. Again, the fact that the total number of jobs of each ear is sensitive to the number of clients should be remembered. Therefore, the average number of jobs should be counted together, in order to better illustrate incubator performance. Figure 5-13 demonstrates the number of jobs per client for each year. The primary purpose of this presentation is to show the amount of jobs per company for each year. To produce Figure 5-13, the total number of jobs in each year is divided by the number of tenant companies of the corresponding year during their residency. Using this method, Figure 5-13 shows the average employment numbers for each year. In the previous section, the public incubator seemed to have provided more number of jobs than the private incubator. But in Figure 5-13, when the number of companies joining the hiring activity in the same year is also accounted for, the story becomes different. As a result, the Figure 5-13 shows that average number of jobs created by the private incubator seemed to dominate nearly all periods. Figure 5-14 provides the number of companies resided in both incubators each year.

Changes of total number of jobs, after graduation. The Figure 5-15 presents the same indicator, total number of jobs, by companies after they graduated both incubators. Graduate companies of the public incubator, collectively, provided more jobs after year 2002 than the graduate companies of the private incubator. Again, the number of jobs created by the graduates of the private incubator did not show intense fluctuation in this presentation.

Any interpretation of the periodical change in the total number of jobs here should not disregard implications of the magnitude of these changes. To illustrate the change in the number of jobs over time, Figure 5-16 shows the amount by which jobs increased and decreased each year, which is illustration of slopes of the curves in Figure 5-14 and Figure 5-15.

For the job gain and losing of graduate companies, Figure 5-16 presents changes of them over time. The same pattern observed from the Figure 5-12 reappears in the Figure 5-16 that public incubator seemed to have been rigorous in hiring and firing, while the client companies of the private incubator was rather passive in such activities.

The number of jobs per company, after graduation. Same pattern of the Figure 5-13 appears in the Figure 5-17 that presents the number of jobs per graduate companies, although the period of analysis is shorter than the previous one. For all periods, graduate companies of the private incubator have hired more people than the graduate companies of the public incubator. Severe job loss observed from 1995 to 1996 periods is because a major employer has got of business at year 1995. The company, presumably going out of business in 1995, died with 95 jobs. As a reference, Figure 5-17 illustrates the number of graduates of each year.

Growth in Wage, Before and After Graduation

This section investigates estimated wages possibly paid by the client companies of two periods. Again, first period is when they were being helped under the roof of the two incubators. Second period is after graduation until the latest year the data is available. The major purpose is to compare the business performance in terms of wage creation and to find out if there is any difference between two groups, over the two periods. The subject of the analysis is the estimated wage calculated by multiplying number of employment of the companies, available in NETS database, by the average weekly wages, of the Quarterly Census of Employment and Wages Publication Changes, during the two study periods. The major hypothesis of this chapter is hypothesis 5 of this research.

- **h5:** TBIs in the private sector report greater wage creation than TBIs in the public sector.

Methodological discussion

Counting employment numbers is a meaningful investigation, in that it effectively quantifies the extent to which the incubators contribute to the local economy by offering jobs to the region. However, counting the total number of jobs created by a client company during its residency may capture only the jobs available in the moment of investigation, whereas the company may have created more jobs at some point of its residency. Such displaced jobs are not accounted in the traditional methods of LED since they don't appear in the moment of investigation (Hughes, 1991). From the perspective of the area, the region could have benefitted even from such a temporary availability of employment opportunity.

Responding to this challenge, this chapter reviews the estimated weekly wage effect of employment as a proxy indicator to capture the employment impact of the programs. Three underpinning reasons of this supplemental approach are as follows. First, the amount of wages do reflect the changes in the numbers of jobs, whereas counting employment figures may inflate the actual impact, in that the sum of jobs does not correspond to the number of employees. Consider adding up the numbers of jobs through three years, in order to not to miss any jobs displaced in the middle of the period. The company reported 8 jobs in the first year, 11 jobs in the second year and 10 jobs in the third year. To overcome a drawback that ends up concluding that only 2 jobs were created based on a simple subtraction of number of jobs, an investigator adopted a new approach of adding up every job that appeared during the study period and may instead have concluded that the sum of all jobs equals 29 jobs, which is where inflation occurs from double counting number of jobs that existed from the previous years.

The second reason to investigate weekly wages, in addition to summaries of the number of jobs, is that wages do not assume the prolongation of the impact. Back to the example: the actual number of employees benefited by the company may be less than 29, since the members that

hold the primary 8 jobs were unlikely to change. Until the number of jobs occupied by these primary members is assured, an investigator is unable to figure out the actual hiring impact created by this company. But is there any data that informs us about the replacement of members of each establishment? Concluding that a company created 29 jobs does not only inflate the actual impact, but also elongates their implication; 19 jobs of 29 jobs do not even exist any longer. Measuring wages reflects the actual employment numbers, even if the wages are paid to the same people. Also, the primary assumption of wage is that its effect is instant, although its impact may actually continue as it circulates wealth in the service area.

The third reason to investigate the weekly wage is that the wage also allows appreciation of different powers of wealth distribution in different industries, whereas merely counting the number of jobs neglects the different values among jobs. Measuring wages allows this difference to show up. As different industries pay different wages, the same number of jobs may return different wages. Figure 5-19 demonstrates a comparison between traditional methods that sums up of the number of employees, and an accounting of employment through the wage effect.

Using employment data of the Private group as an example, the green dotted line represents the sequential changes of total weekly wages of each period over time. The dotted line is created through multiplying the number of jobs of each year by the average weekly wages of each year for each industry. Values of the Y axis are the actual amount of dollars of the total average estimated weekly wage paid by the client companies of the private incubator. The green solid line shows the change of the simple summation of all employees over the same period. To make both patterns, not the actual values, show up in the same bracket, the solid line is artificially created by multiplying the actual number of total jobs by 1000. Thus the number in

the Y axis should not be taken as the actual number of jobs. Although inflated, the pattern should remain same.

As demonstrated, the wage effect makes the sequential patterns of lines different from the pattern illustrated by the solid line. As it passes the year 2001, the slope of the dotted line explosively escalates. It means that either businesses paying high wages joined in this period, or that the level of wages of overall industries increased in this period. The number of companies in each year is controlled in this case, as it is same for both lines. In either case, one inference is that the dotted line accounts for wage effects, whereas the solid line, the number of jobs, nearly ignores differences in wages over industries and over different seasons. One can argue that gauging sales may meet the same objective. But this position is open to the criticism that it does not distinguish the industries that produce wealth and industries that distribute wealth.

Using employment and wage data of one particular sample company, Figure 5-20 demonstrates the effects of seasonal wage change. The solid line and dotted line represent the same variables as in Figure 5-19. The values for the actual number of employment in Y axis are 1000 times inflated to show the pattern on the Figure, and thus should not be interpreted as actual numbers of employment.

As hypothesized, the seasonal wage fluctuation changes the pattern, sharpening some peaks at the year 2000 and the year 2004. In Figure 5-11, sequential changes in the average wage in this particular industry support this inference, showing fast increases in two years, the year 2000 and 2004 respectively. Also, while the number of jobs between 1994 and 2000 either maintained its level or decreased, the total weekly wage line inclined or remained the same in this period as result of constant wage increases, demonstrated in Figure 5-21. In the year 2002, wages dropped drastically, according to Figure 5-20, thereby resulting in a decrease in the total

weekly wage of the year, even when maintaining the same or similar number of jobs, as demonstrated in Figure 5-19. Accounting for the fact that the company has been in the same industry (titled "Research and Development in the Physical, Engineering, and Life Sciences" based on NAICS 6 digit aggregation) without changing at any time during the study period, these differences can be interpreted as the results of the wage market effect within an industry.

Wage growth, before and after graduation

Growth in wage. With all these accounted, this is a supplemental investigation to estimate the wages that might have been paid for the jobs created by the companies. Wage growth means how much the dollar amount has increased or decreased during the periods of the residency and post-graduation. By subtracting the total amount of weekly wages at the year of admission from the total amount of weekly wages at the year of graduation, the wage growth during the residency is calculated. In both periods, the wage increase in the private incubator was more intensive than that in the public incubator. The test hypothesis is as follows.

- **H5a:** There is no difference in wage growth between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 - F2 = 0$

  $H1 : F1 - F2 \neq 0$

As demonstrated in Figure 5-22, the distribution of wage growth is moderately skewed to the right, if an extreme outlier of the public incubator is excluded. Six companies out of 15 clients of the private incubator are also excluded for the reason stated in the previous section.

The greatest sales growth achieved by the clients of the private incubator is $21,000, and $15,856 for the public incubator. One interesting observation is that a client company of Incubator GG lost $53,265 while it was in the incubator. The median value of the private

incubator, $1,946, is a lot greater than the median value of the public incubator, 0, based on the descriptive statistics presented in Table 5-26.

The difference appears to be significant based on the results of the Mann-Whitney test that returns a p-value, 0.106, which is below the acceptable level of 0.20 of this study. With the combination of higher mean and median, the wage growth of the private incubator seems to be greater than that of the public incubator.

In terms of average, the sales of one client company of the private incubator appear to have increased by $5,026 during the residency, while the wage increase of the public incubator was only $863. Figure 5-23 demonstrates the distribution of frequency of the wage growth achieved after graduation. Distributions of the both groups have long tails on the right-hand side, with a very wide range.

As illustrated, there are several extreme outliers in Incubator GP. Wage increase after graduation for the private incubator was $60,839 on average, and $6,885 for the public incubator. There may be a couple of extreme outliers in the private incubator. The maximum wage growth was $477,840, which is even out of the scope of Figure 5.23. For the very wide range of frequency distribution of both the public and the private incubator, a nonparametric method seems to be inevitable for the test statistics. For the difference of the wage increase after graduation, however, it is not significantly different, with a p-value of 0.853, much greater than 0.20.

Wage growth indicates the amount of wage that has increased or decreased, but it does not distinguish levels of wages at the beginning year. Obviously, this implication would be interpreted differently if the value of the starting point were different. So, the next section

presents the proportional growth of the weekly wage, accounting for the different initial size of the weekly wage.

Wage growth rates. Wage growth rates are calculated by dividing the wage increase/decrease by the wage of the base year. For instance, one company paid $30,000 in weekly wages in the year of admission, and became able to pay $40,000 in the year of graduation. The wage increase is $10,000. By dividing $10,000 by $30,000, the wage growth rate is about 0.33. The test hypothesis to compare differences in wage growth rates is as follows.

- **H5b:** There is no difference in wage growth rates between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 - F2 = 0$

  $H1 : F1 - F2 \neq 0$

Figure 5-24 demonstrates the frequency distribution of wage growth rates achieved during the residency. One extreme outlier exists in the public incubator, a client that achieved 616 percent growth in wages. Most in the public incubator achieved a wage growth rate between 0 and 0.5. Also, the median of the public incubator is zero.

The private incubator seems to have achieved a 53 percent wage growth during the residency on average. The maximum growth rate is 180 percent for this group, as summarized in Table 5-30.

A very small difference is observed from average and median, showing a greater growth rate from Incubator GP. In terms of average, there is only a 20 percent difference between the two groups. The client companies of Incubator GP seem to have increased by about 20 percent more than the clients of Incubator GG. The median value of Incubator GP is only 0.09, and it is 0 for Incubator GG. Nevertheless, the Mann-Whitney test strongly supports that they are

significantly different, with a p-value of 0.065, significantly less than 0.20, the acceptable level of this study. Table 5-31 presents the results of the test.

Figure 5-25 demonstrates the frequency distribution of wage growth rates recorded after the clients graduated from the incubators. Both groups have a very wide range of distribution. The maximum wage growth of Incubator GP is 497 percent, and one company increased its total weekly wage by 1690 percent in Incubator GG, according to the summaries in Table 5-32.

This growth rate was slightly increased to 71 percent after the companies graduated, while the growth rate of the public incubator decreased to about 103 percent. In spite of some gaps observed, the Mann-Whitney test does support difference, with a p-value of 0.522, summarized in Table 5-33.

Wage growth is an effective indicator for showing how much wages increase or decrease during the periods of interest. However, in terms of efficiency, it is sensitive to the number of years of the residency and post-graduation period. The longer the period gets, the higher the wage growth would be likely to return.

Annual wage growth rate. The annual wage growth rate is alternatively presented to measure yearly change in wages. It is calculated by dividing the growth rate by the years of periods, the residency and post-graduation. One extreme outlier is found in Incubator GG, a company that achieved about 200 percent annual wage growth in wages. However the median of the group, zero, is below the median of the other group of Incubator GP, 0.20, since Incubator GG seems to have companies that reported negative annual wage growth. The descriptive statistics are summarized in Table 5-34. On average, total weekly wages of the clients of Incubator GP seem to have increased by 14 percent a year, whereas 12 percent growth has been

achieved by the clients of Incubator GG. The test hypothesis to compare differences in wage growth rates is as follows.

- **H5c:** There is no difference in annual wage growth rates between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 - F2 = 0$

  $H1 : F1 - F2 \neq 0$

In Table 5-34, a small gap between the two groups became even narrower, which implies a longer length of residency of Incubator GP. The median of the incubator is only 2 percent, whereas it is 0 percent for Incubator GG. Two percent is also the difference of the average annual growth of the two groups. Nevertheless, the difference seems to be significant enough, based on the test results summarized in Table 5-35. The p-value, 0.120, is significantly smaller than the acceptable level of 0.20 of this study. One implication that can be drawn here is that the clients of the private Incubator GP seem to have shown better wage growth than the clients of Incubator GG, at least while they were in the incubator.

Figure 5-27 demonstrates the frequency distribution of annual wage growth rates reported after graduation. It has a long tail on the right-hand side, with several extreme outliers in Incubator GG. The distribution has a slightly wider range than that in the previous period. Two outliers are observed from the clients of Incubator GG. The maximum value of Incubator GG is 3.398, which indicates that a company achieved 340 percent annual wage growth.

Both groups have companies that ended up decreasing the total weekly wages. On average, however, both groups achieved positive growth. Clients of Incubator GP seem to have increased total weekly wages by 17 percent a year, and 22 percent was increased by the clients of Incubator GG after they graduated from the incubators.

Such differences, however, do not appear significant, based on the test statistics, summarized in Table 5-37. The p-value, 0.618, is significantly higher than the acceptable level of 0.20 of this study. The two groups do not appear different.

In summary, both incubator companies increased weekly wages. One interesting finding is that the private incubator showed a higher wage growth rate, without statistical significance, when the companies were in the incubator. After graduating from the incubator, clients of the public incubator tended to grow better. This pattern is supported by the greater annual wage growth rate as well.

Total wages, before and after graduation

Although it is useful, measuring growth rate using several time points may mislead in appreciating the comprehensive contributions that the client companies have made to the serving area. As discussed before, wages reported in the middle of the gauging point remain unaccounted for. It is due to the rationality of the traditional method of evaluation studies for LED that measures the difference between before and after. The method is not bad in the sense that it marginalizes temporary achievement appeared in the middle of study period and disappeared at the moment of investigation. In this paradigm, therefore, such an observation is not regarded as a consequence of a program. In addition, subtracting last wages with the wages at the first year is only a valid method when linear growth is generally accepted. In the application of this paradigm to evaluation of a technology incubator, it may be misleading to marginalize the significance of wage fluctuation in between since those wages indeed contributed to the economies of the serving area. To take those unaccounted wages into consideration, total wages are reviewed in the next section.

Total wages, before graduation. Table 5-38 summarizes the total wages created by client companies of the public and private incubators. Total wages created during residency is

produced by adding up all the wages paid by client companies of a group. Again, the number of years and season are not taken into consideration in this analysis. The Figure 5-28 demonstrates frequency distribution of the total weekly wages, paid during the residency.

The total amount of dollars paid as wages by group Public seem to be as much as twice the wages estimated by the private incubator. As the number of client is greater for the public incubator, the total estimated wage of the group Public, with $1,411,512, is about two times greater than the group Private, of $749,621, Table 5-19 provides total estimated wages of their post-graduation period.

In terms of total weekly wage, public incubator appeared to have paid more than the private incubator. After converting total into average, the order is reversed. The client companies of the private incubator have paid average $49,974.73 as weekly wage while they were in the incubator, while the average weekly wage of the client companies of the public incubator was only $39,208.67. The difference seems to be also insignificant for p-value, 0.950, higher than 0.20.

One should be cautious in interpreting this finding in that total amount of wages is always sensitive to the number of companies and the lengthy of residency. The only implication can be drawn this statistics is that the there is difference in terms of magnitude of economic impact that clients of two incubator have contributed to while they were in the incubators.

Total wages, after graduation. The Figure 5-29 shows frequency distribution of total wages, reported after graduation. In compared to the total wage observed during the residency, the gap has become narrower when the client companies have graduated. The weekly wage client companies of the private incubator have reached $2,575,678, while the counter part paid slightly more than that, with $2,748,056. Both groups have companies paid zero as weekly wage.

It may be due to no employment in the study period. In Table 5-40, descriptive statistics are provided.

The weekly wage per company then increased to $286,186.44 after they graduated for the private incubator. It is about five times increase from the previous period. The median of the Incubator GP, of $32,361, is, although, slightly smaller than that of the Incubator GG, of $48,340. Perhaps, it is because wide range of distribution and extreme outliers. Table 5-41 presents test results that compared the two groups. With very large p-value 0.629, there is no evidence to support the difference of the two groups in terms of the total wages they paid after they graduated the incubators. In sum, in terms of total dollar amount paid as weekly wage, public incubator demonstrated greater contribution in either period. However, Incubator GP produced greater dollars paid as weekly wage for a company, based on the average, although differences are not significant by Mann-Whitney test.

Changes of weekly wages over time, before and after graduation

Weekly wages over time, before graduation. The next presentation is the aggregation of weekly wages reported each year, the most popular milestones of impact studies. The purpose of this presentation is to visualize changes of the aggregated estimated weekly wage paid by the incubators over time. The aggregated weekly wages indicate differences in the amount of weekly wages that each group has produced each year. However, it should not be interpreted as the public incubator performed better in helping firms to produce more since Figure 5-30 only reports lump sum weekly wage records of the two groups, which disregards the number of tenant companies.

Figure 5-30 demonstrates seasonal change of the weekly wages, reported while they were in the incubator. After 1999, the year with a dramatic increase, public incubator dominantly paid more wages than the private incubator. The domination continues until 2005, even after 2003

when wage started dropping. Presumably, within this period, such large wages paid by the companies of the public incubator could have contributed to an increase of tax revenue. Tenant companies of the private incubator appear to have maintained a similar level of wages creation through the study period, regardless of the number of the contributing companies. Figure 5-31 presents changes of the weekly wages of tenant companies over time. It presents increases and decreases of weekly wages each year based on the record of the previous year.

Weekly wage of the public incubator seems to be more fluctuating than that of the private incubator. The only period that the public incubator maintained positive growth wages in two consecutive years is between 2001 and 2003. After that period, the public incubator continuously reported negative wage growth.

Aggregated weekly wage provides a seasonal perspective of the performance of both incubators. As discussed, a policy maker could easily find out that the public incubator collectively paid more weekly wages than the private incubator from 1999 through 2005. However as it is lump sum dollar amount of weekly wages, it does not tell the number of client companies contributing to the aggregation. The Figure 5-32 provides weekly wage per company to account for the number of tenant companies.

Weekly wages per company, before graduation. According to Figure 5-32, the previous hypothesis, the aggregated weekly wage affected by the number of tenants was valid. The dominancy of the public incubator over virtually all period does not appear Figure 5-32. Rather, the tenant companies of private incubator seemed to pay more wages than the tenants of the public incubator. Average weekly wage of the year 2001 of the private incubator reached $28,000, while it was only about $12,776 for the public incubator. However, after 2000, the

wage of the public incubator maintained over $10,000, but the weekly wage of private incubator dropped below $10,000 at year 2007.

Weekly wages over time, after graduation. The study period of this section is from the year of graduation to the last year that the data of each company are available. For most of the record, the last year with the most recent availability of NETS data is 2007. But the last years of some companies were prior to 2007 because they might have stopped their businesses. The last years of such companies are the year the last employment data was available, because estimated wages are multiplied by the number of jobs.

In the Figure 5-33, both incubators showed fast growth after 2001. Public incubator's domination again appeared after 2001, but the weekly wages of the private incubator also increases at similar phase. Maybe such a radical increase is due to the explosive increase of the number of client companies incepted to the public incubator starting from the early 2000s. The number jumped from two in 1998 to 17 in 2000, whereas there were only two tenant companies at the same period in the private incubator. Figure 5-34 presents changes of weekly wages the graduate companies have made from the previous year. As illustrated, both incubators recorded positive growth after 2001, although there were some fluctuations.

Weekly wages per company, after graduation. The increase of weekly wage of the public incubator, observed in the Figure 5-34, seems to be the result of the increase of the number of contributing graduate companies. In the Figure 5-35, the weekly wage per graduate company of the public incubator stayed about $20,000 from 2001 to 2007. In the same period, the graduate companies of the private incubator explosively increased. The highest wage for the private incubator was $ 110,319 at year 2006. On the other hand, the maximum weekly wage of

the public incubator was recorded, with $27,663, at year of 2003 and the second highest wage was $22,674 at year 2006.

Recapping this section, although the greater total wage should not necessarily be interpreted as a positive growth in that it is also sensitive to change of number of employee, it is a good indicator that demonstrates degrees of contribution to the local economies. Also, in reality, given program capacity that determines size of economic contribution is hard to change as is in hypothetical situation. First higher wage imply positive contribution to improving level of income. Second, higher wage also means that companies have increased local tax revenue in that the wage eventually returns as income tax. Third, higher wage is likely to stimulate circulation of wealth within the area. One possible application is that industry with higher wage may have greater multiplier effect than industries with lower wages. It may leads to formulations of local capital stocks that are potential stimulation for further development. Two limitations to this method exist, however. First, this method relies on the estimated average weekly wage, so there may be differences in the actual values. Second, by using the estimated average weekly wage, this method does not account for differences between occupations within a company. Obviously, the wage of CEO will be different than that of a researcher. Fortunately, the subject of this research being young, small companies would hopefully render this bias negligible.

In sum, in terms of total dollar amount paid as weekly wage, public incubator demonstrated greater contribution in either period. Both incubator companies increased weekly wages positively. One interesting finding is that the private incubator showed higher wage growth rate, with statistical significance, when they are in the incubator. After graduated the

incubator, clients of the public incubator tend to grow better. This pattern is reassured by greater annual wage growth rate as well.

Growth in Sales

This section reviews the sales record and business performance of the client companies during the same two periods. Again, the first period was when they were being helped by the two incubators. The second period was after graduation until the latest year that data was available. The major purpose is to compare the business performance in terms of sales and to find out if there is any difference between the two groups. The subject of the analysis is the sales record of all the companies during the two study periods, available in the NETS database. This section tests the sixth hypothesis of this research.

- **h6:** TBIs in the private sector report greater sales revenues than TBIs in the public sector.

Sales growth before and after graduation

Growth in sales. Emulating previous chapters, the first section compares growth in sales between two periods. Sales increases while the companies are under the direct influence of the incubators are compared with that of the post-graduation period, in order to see if there was a difference between the programs. Again, sales growth means the difference between the amount of dollars at the year of graduation and also at the year of admission. As illustrated in Figure 5-36, the sales growth of all the clients in both groups had a wide range of distribution with a couple of outliers. The test hypothesis is as following.

- **h6a:** There is no difference in sales growth between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 – F2 = 0$

  $H1 : F1 – F2 \neq 0$

Table 5-42 summarizes descriptive statistics. The client companies of the private incubator appeared to have gained an average of $1,389,270 in sales growth during the residency. In the same period, client companies of the public incubator have lost an average of $36,550. Based on the average, during the residency, Incubator GP showed positive growth in sales, while Incubator GG ended up losing sales. Due to extreme outliers, the median may summarize the distribution more appropriately than the means. The median of Incubator GP, of $159,800, is greater than the median of Incubator GG, of zero. Also the maximum growth achieved by clients of Incubator GP seems to be about four times greater than the maximum growth of clients of Incubator GG, while a client of Incubator GG seems to have lost $7,815,000 when it was graduating the incubator. The difference of the two groups seems to be obvious and is supported by the Mann-Whitney test summarized in the Table 5-43 that generated a p-value of 0.180, below the 0.20 confidence level of this study.

Sales growth after graduation is the difference between the sales record of the latest year and the amount of dollars in the year of graduation. It is to measure how much growth the client companies have achieved after they become independent from both incubators up to the point of investigation. The positive growth of the group Public changed after they graduated the incubator. Also, average sales of the group Private also dropped to $257,521 while the group still maintained positive growth from $1,389,270 in the previous period. After graduation, again, client companies of the public incubator reported a loss in terms of average sales. The loss was about $339,741 per company.

However, with a given distribution illustrated in Figure 5-37 that has an extreme outlier in Incubator GG, the negative average may mislead the actual distribution of the growth rate. Figure 5-37 shows that many clients of Incubator GG also demonstrated a positive sales growth,

while a number of clients indeed ended up reporting negative growth in sales. The negative average seems to be a result of the huge loss recorded by one u client. Based on the median of Incubator GP, zero, is greater than the median of Incubator GG, of -$12,650, still the same conclusion is reached, as the clients of Incubator GP produced more sales growth than Incubator GG in general, in the post-graduation period. Table 5-44 presents descriptive statistics of the sales growth. Based on the Mann-Whitney test resulted in 0.798, a larger p-value than 0.20, the two groups are not statistically significant.

Sales growth implies the amount of dollars one client company would have made during the two periods. It might also refer to the amount of tax revenue each client might have paid. The difference is indicated only from the period of residency by the Mann-Whitney test. Although the same test revealed that both incubators are not significantly different in the sales growth achieved after graduation, their economic impact on the region may be different because the amount of dollars created differs. However, sales growth should not be interpreted as an indicator of the level of performance of both incubators because the amount of sales created are sensitive to the total sales, sales of the base year, and finally, the length of residency.

Sales growth rates. The next analysis presents comparisons of the growth rates of sales that account for variations in the initial size of sales; growth rates proportionally increase or decrease from the sales of the base year. For instance, when a company raised its sales $10,000 a year and the company's sales in the first year was $40,000, the growth rate was 25%. Whereas, for a company with initial sales of $50,000, an increased growth rate of $10,000 is only 20%. The implication of the amount of the money is different, while the created amount of sales is the same. The growth rate is essential to account for variations in the first year of sales, which

results in some changes in the patterns observed from the analysis of growth. The test hypothesis of this section follows.

- **h6b:** There is no difference in sales growth rates between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  H0 : F1 – F2 = 0

  H1 : F1 – F2 ≠ 0

Figure 5-38 demonstrates that the distribution of Incubator GP has one extreme outlier of 19.64. Even without the outlier, the distribution is skewed to the right which indicates a violation of the normality assumption. The Mann-Whitney test is again the appropriate method.

Based on the descriptive statistics of the sales growth rates, presented in Table 5-46, Incubator GP seems to report a higher growth rate, with an average of 344 percent, while it is only 49 percent for Incubator GG. The higher average of Incubator GP is, however, affected by the extreme outlier. A greater median for Incubator GP, of 1.476, nevertheless, still supports higher growth rates. Mann-Whitney test results, presented in Table 5-45, support the difference with a p-value of 0.123 which is smaller than the 0.20 level of confidence for this study.

During the residency, the companies of the private incubator achieved an explosive average sales increase of 340% (although is the increase is inflated to large extent). However, the remarkable phase of growth slowed down after they graduated the incubator; they ended up reporting negative growth. After they graduated, the sales growth rate of Incubator GP fell to about an average 4%, based on the summary of Table 5-48. The client companies of Incubator GG achieved about 49.1 % in sales increase during the residency. But after graduation, the sales growth rate doubled to about 107.5%, in average. Figure 5-39 demonstrates the frequency of the distribution of the sales growth rates achieved by clients after they graduated. Two extreme

outliers are observed from the clients of Incubator GG. The doubled sales growth rate is possibly a result of the calculation including these two extreme outliers.

The negative median of Incubator GG, -0.034, presented in Table 5-48, affirms an inflated average of Incubator GG. The median of 0 for Incubator GP indicates slightly higher sales growth rates for Incubator GP than for Incubator GG. However, the difference is not supported by the Mann-Whitney test with a p-value, 0.712 being greater than the acceptable level of 0.20.

Tests supported the differences as significant for the sales growth reported during the residency. One fair implication drawn from this analysis is that the client companies of the private incubator saw larger sales growth during the residency. One cannot conclude, however, the level of performance of both incubators may be different since periodical growth rates are also sensitive to the number of years that companies accumulate dollar amounts. The longer they stayed in the incubator, the larger growth rates they experienced. The next section presents annual growth rates that individual companies have achieved.

Annual sales growth rate. Annual sales growth rate is analyzed to account for the length of residency and post graduation period. It indicates the proportional growth achieved every year. The test hypothesis is as following.

- **h6c:** There is no difference in annual sales growth rates between the client companies of Incubator GP and the client companies of Incubator GG, before and after graduation.

  $H0 : F1 - F2 = 0$

  $H1 : F1 - F2 \neq 0$

Figure 5-40 demonstrates a wide range of distribution that is skewed to the right. According to descriptive statistics in Table 5-48, the maximum of Incubator GP is 245%, 194% is the maximum for Incubator GG.

In Table 5-50, it is shown that the client companies of the private incubator achieved about 57% in sales growth annually while they were in the incubator. The growth rate of the client companies from the public incubator during their residency seem to be lower than the counterpart, with only 17.4% a year. The difference in annual growth rate of sales during the residency between the two groups seems insignificant according to the Mann-Whitney test; a p-value of 0.242 being greater than the 0.20 confidence level of this study, as presented in the Table 5-51.

After graduation, however, the clients of Incubator GP reported negative growth. The sales seem to have decreased by 4% every year. The clients of Incubator GP, who grew by 17% a year during the residency, seem to have recovered the deficit by making 23% in annual growth after graduation. Figure 5-41 shows the frequency of the distribution of the annual sales growth. The public incubator, Incubator GG, has several extreme outliers. The 23% annual sales growth of Incubator GG seems to be perhaps inflated by the extreme outliers.

Based on the descriptive statistics presented in Table 5-52, a client of Incubator GG achieved 412% in sales growth annually, while the maximum annual sales growth of Incubator GP remained at only 4.5%. The average of Incubator GG being inflated and having a client lost 24% annually, the median of Incubator GG, of -.0.013 is smaller than the median of Incubator GP being zero.

Although the client companies of the private incubator suffered from negative growth after graduation, and the counterpart enjoyed a positive annual growth after graduation, the difference does not appear to be significant according to the result of the Mann-Whitney test generating a p-value of .798, above 0.20, as presented in Table 5-53.

Three dimensions of growth rate are explored thus far. Sales growth indicates the extent to which both client groups have contributed to the local economy by producing sales. Changes in the total amount of sales effectively illustrate the quantified implication of the economic contribution. During the residency, sales growth achieved by Incubator GP turned out to be greater than Incubator GG. But it may be due to a longer length of residency. Unfortunately, the sales growth of Incubator GG in the post-graduation period, turned out to be negative, but it was due to sensitivity to the aggregated dollar amount. If the sum of total sales of individual companies came out negative, affected by the big loss of a particular company, it could have made the growth negative for total sales growth. The growth changes from negative to positive in the following analyses, which presented the average growth rate and annual growth rate of each company because they showed proportional growth regardless of the initial sales size. The last table presented an annual growth rate of sales in order for the analysis to account for number of business years.

During the residency, sales growth rates of Incubator GP again turned out to be superior to Incubator GG. Although the Mann-Whitney test failed to support this, the same pattern is observed from an analysis of annual growth rates during the same period. In the post-graduation period, Incubator GP still maintained a superior position, although the rates are not statistically significant. One implication may be drawn as the hypothesis of this section. An assumed higher sales growth being observed from a private incubator is moderately supported. The difference is explicit especially while they were in the facility. It became less explicit after they graduated the incubators.

Total sales, before and after graduation

Total sales, before graduation. The primary concern of this section is to quantify economic contributions made by the sales of the groups of client companies. The aggregation of

sales refers to the summation of all sales reported every year during each period. The total sales are the aggregation of all sales for both groups. Again, the number of years and seasons are not taken into consideration in this analysis. Figure 5-42 demonstrates the frequency of the distribution of total sales reported before graduation. The distribution displays a long tail to the right with several extreme outliers.

Table 5-54 presents a summary of descriptive statistics of the total sales for both incubators during the study periods. The total amount of dollars created as sales by Incubator GP seem to be twice as much as the sales reported by the group Private. The maximum record of sales of the group Public, with $51,685,000, is also nearly two times greater than the maximum sales of the group Private, with $28,779,070. Among the clients of Incubator GG, however, five companies failed to make sales while they were in the facility. Two companies among the five were categorized as research related businesses, which usually take a long time to make a profit. The Mann-Whitney test, in Table 5-55, does not find the difference to be significant either, by returning a probability of 0.591, greater than the 0.20 confidence level of this study.

Total sales, after graduation. Figure 5-38 demonstrates the frequency of the distribution of total sales reported after graduation. Again, the distribution displays a long tail to the right with several extreme outliers in both Incubator GP and Incubator GG.

Table 5-40 provides the summary of descriptive statistics of total sales of the company's post-graduation period. The total sales generated by Incubator GG, of $237,721,364, are twice as much as Incubator GP has produced, $106,178,359, even in the period of post-graduation. This time, both groups reported companies with zero sales after graduation since both groups had companies go out of business without making any sales after graduation.

Obviously, bigger total sales are the result of a large number of client companies in both periods. This is supported by the large average total sales of Incubator GP, being $11,797,595.44, while Incubator GG's sales dropped to $6,603,371.22. The medians are however very similar. This difference is due to a wide range of distribution and extreme outliers for both incubators. The median of the Incubator GP, of $3,908,000 is slightly greater than that of the Incubator GG's $2,603,007. Thus, the Mann-Whitney, in Table 5-57, test does not find the difference to be significant either, by returning a probability of 0.561, greater than the 0.20 confidence level of this study.

Changes of total sales over time, before and after graduation

Total sales over time, before graduation. Figure 5-44 demonstrates the amount of sales dollars produced by tenant companies of both incubators. The total numbers of sales are summations of sales records by all tenant companies that were residents of each incubator at the corresponding period.

A fast sales increase is observed between 1999 and 2003 from the tenant companies of the public incubator. At a glance, the public incubator seems to have created a strong impact on the region by increasing outstanding sales in virtually all periods of time since 1998. Again, it should have contributed to an increase of tax revenue. Tenant companies of the private incubator appear to have maintained a similar level of sales creation through the study period. The group reported $11,919,100 as maximum sales in 1999, whereas it was $52,604,200 for the counterpart in 2003. Figure 5-45 presents changes of the total sales of tenants over time. It presents increases and decreases of sales each year based on the record of the previous year. Tenants of the public incubator showed a bumpy sales record between 2001 and 2004.

Sales per company, before graduation. In Figure 5-46, the total sales are divided by the number of tenant companies of each year. As demonstrated, the tenant companies of the private

incubator produced more sales in general until 2002, which is a contrasting finding from previous observations.

According to Figure5-46, the previous hypothesis, the total sales affected by the number of tenants seems to be right. Recall that the total sales of the public incubator after 2000 was greater than the counterpart; the average sales record of the public incubator after 2000 is relatively low in Figure5-45. It means that the steep increase observed from total sales was possibly caused by the increase of the number of client companies. Figure5-47 evidences this hypothesis, showing an explosive increase of the tenant company after 2000 in the public incubator. As a result, the average sales of the group Public become rather constant through the study period after a dramatic increase in 1993. In addition, average sales of the tenants of the group Private show a fast increase in 2000, which did not explicitly stand out in the previous section.

Changes of total sales over time, after graduation. Again, the study period of this section is from the year of graduation to the last year that the data of each company are available. Total sales are summations of all sales records reported within the period defined by the described method. Figure 5-48 demonstrates total sales created by the graduate companies of the private and public incubators. Recall, between 2001 and 2003, the total sales of tenant companies of the public incubator skyrocketed as illustrated. A similar pattern is observed in Figure 5-48, even from the graduate companies. Total sales of the group Public increased from 2001 through 2004, which also dominates the sale of graduate companies of the private incubator.

Such a radical increase is due to the explosive increase of the number of client companies incepted to the public incubator starting from the early 2000s. The number jumped from two in 1998 to 17 in 2000, whereas there were only two tenant companies at the same period in the

private incubator. The maximum number of tenants was only six in 2004, according to Figure 5-47. As mentioned previously, the aggregated dollar amount, however, should not be interpreted as an indicator of efficiency. Sales records of individual client companies are embedded, but do not stand out from the angels of these presentations. To observe average sales per company, Figure 5-49 presents changes of sales the graduate companies have made from the previous year.

For the group Public, it shows a continuous increase from 2002 through 2004. After the sharp drop in 2005, negative growth continued, while the group Private achieved moderate growth during the same period after two years of consecutive losses between 2002 and 2003.

Sales per company, after graduation. As discussed, the total sales does not account for the number of companies. Figure 5-50 demonstrates total sales per company. Again, the amount of dollars in the Y axis represents the amount of sales a graduate company made in the corresponding period. Two-year consecutive loss re-appears in Figure 5-50 from the line of the group Private in 2002 and 2003. Nevertheless, the yearly sales total of graduate companies of the private incubator seem to be larger (most of the time) than yearly sales created by the graduate companies of the public incubator. Figure 5-51 provides the number of graduate companies that has created sales each year.

Again, such an explosive increase in the number of graduate companies of the public incubator after 2002 seems to be the reason for the expansion of total sales, whereas average sales were actually not larger than that of the group Private. However, it is arguable that larger capacity of the public incubator might be a unique strength of the incubator founded by the public sector. It is closely associated with large investments that private agents can hardly utilize.

Table 5-1. Major hiring industries of Maryland*

Industry	Statewide Employment Share	Location Quotient
Trade, Transportation, and Utilities	22.65%	0.98
Professional and Business services	19.02%	1.21
Education and Health services	17.22%	1.13
Leisure and Hospitality	11.23%	0.96
Retail trade	14.45%	1.06
Health care and Social assistance	14.52%	1.09

* Bureau of Labor Statistics

Table 5-2. Major technology industries of Maryland 2001-2005*

Industries	Employment				Payroll ($)				Average Weekly Wage ($)
	2001	2002	2003	2005	2001	2002	2003	2005	
Aerospace	62,659	63,049	63,616	Na	4,475,479,587	4,558,917,880	4,717,201,657	NA	1,426
Information Technology	96,222	90,856	88,334	89,564	NA	6,667,648,817	NA	7,216,116,727	1,549
Healthcare	233,838	241,677	248,507	257,750	8,763,528,547	NA	NA	11,232,295,480	838
Bioscience	33,080	35,669	36,964	NA	2,188,718,204	2,280,394,146	2,455,501,963	NA	1,277

*www.ChooseMaryland.org

Table 5-3 Summary of sample incubators

Sponsorship	Incubator code	City	County
Private	GP	Rockville	Montgomery
Public	GG	Rockville	Montgomery

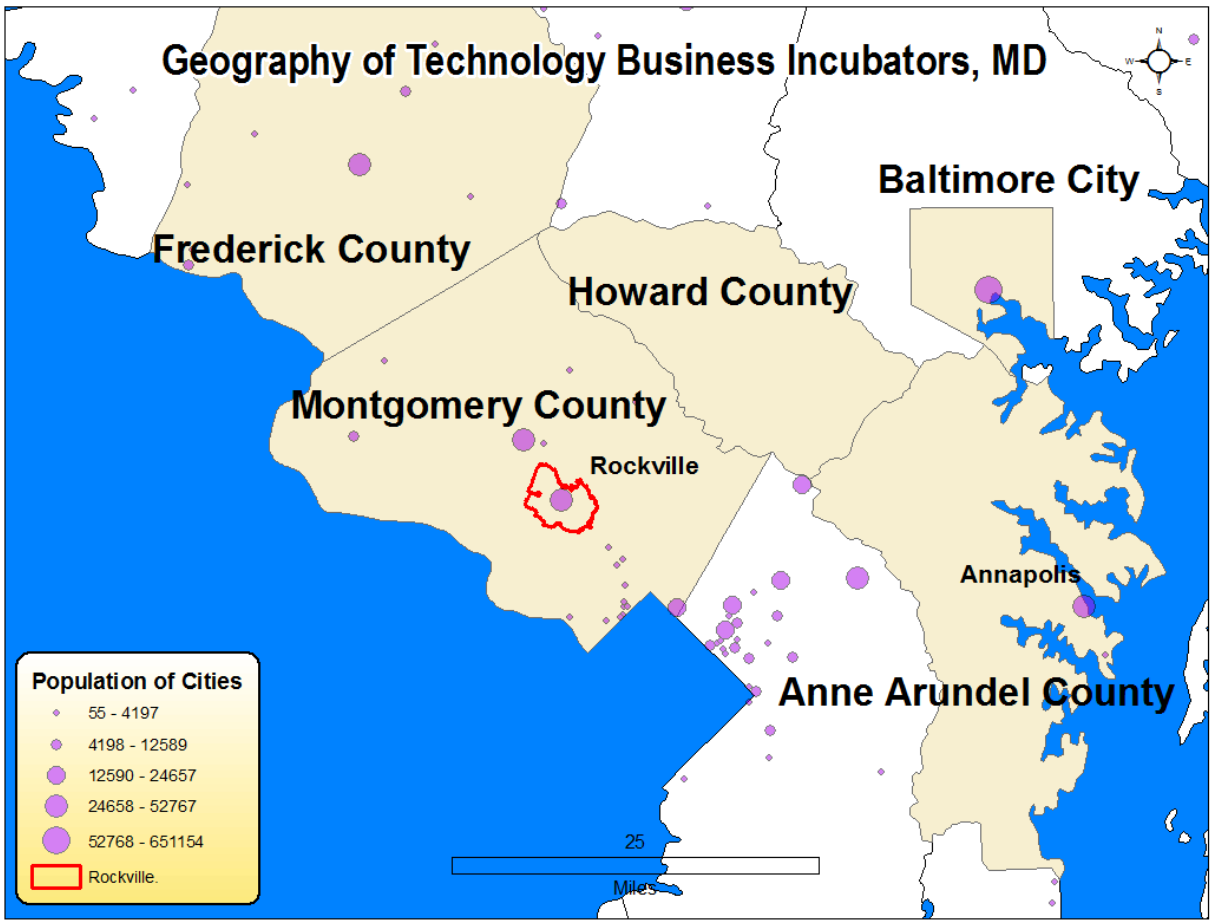

Figure 5-1. Geography of technology business incubators, Rockville, MD

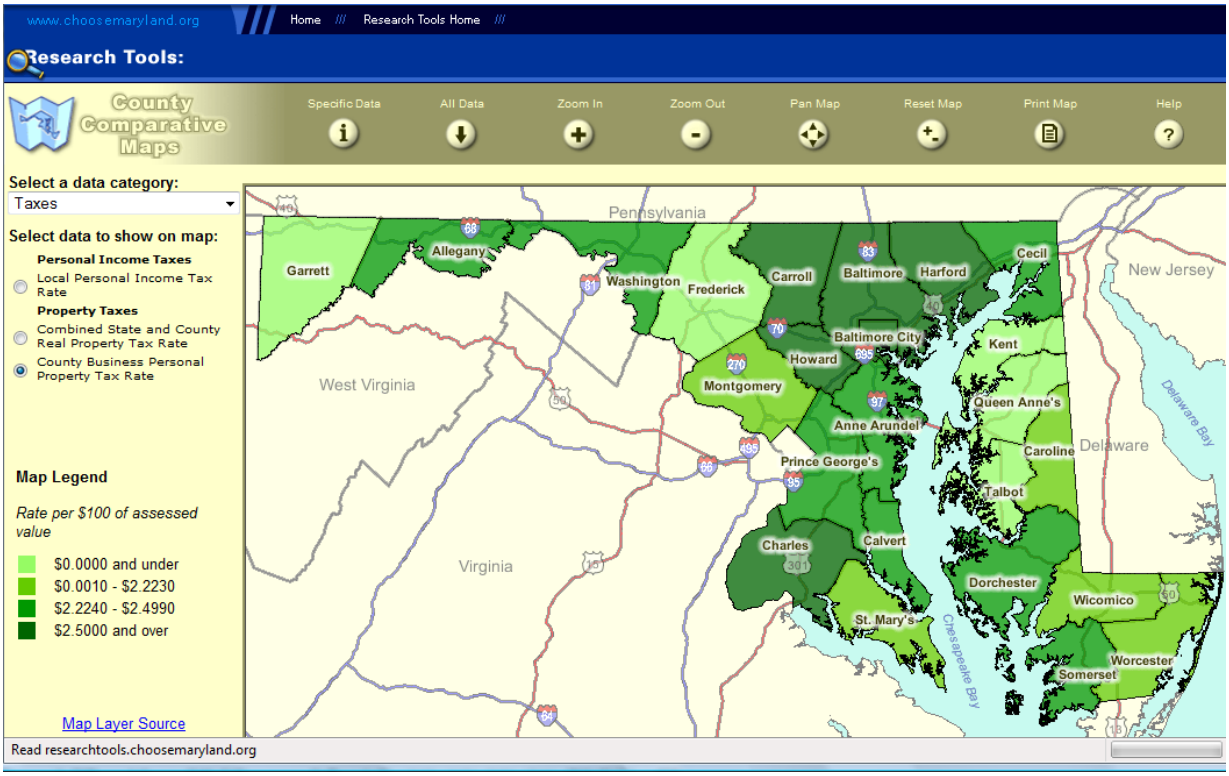

Figure 5-2. Geography of County Business Personal Property tax rate

Table 5-4. Regional description of incubator locations

	Frederick (Frederick)	Rockville (Montgomery)	Annapolis (Anne Arundel)	Columbia (Howard)
Total population (2000)	52,693	47,257	35,806	88,391
Population density (2000)	2,580.831	3,514.394	5,321.224	3,206.972
Pct. pers. 25+ yrs. old with a bachelors or graduate/prof. degree (2000)	29.9%	52.9%	38.7%	59%
Pct. foreign born population (2000)	7.3%	31%	9.7%	13.2%
Median household income last yr ($) (2000)	$47,700	$68,074	$49,243	$71,524
Average household income last yr ($) (2000)	$57,064	$82,211	$63,586	$83,876
Median household income last yr ($) (2000)	$47,700	$68,074	$49,243	$71,524
Average household income last yr ($) (2000)	$57,064	$82,211	$63,586	$83,876
Total number of establishments (2003)	1,764	N/A	1,367	3,033
Number of establishments per 1,000 population (2003)	33	N/A	38	34
Median year structure built (2000)	1979	1967	1968	1980
Pct. housing units in single-family detached homes (2000)	34.6%	58.9%	39.6%	41.8%
Homeownership rate (2000)	55.9%	67.9%	51.9%	66%
Average value of specified owner-occupied housing units ($) (2000)	$154,194	$230,582	$218,519	$202,120
Pct. pop. 16 years old and over who are employed	69.8%	64.9%	67.8%	74.7%
Pct. persons 16+ years old employed in mgmt. occ. (incl. farms) (2000)	39.2%	55.6%	42.9%	62.3%
Pct. persons 16+ years old employed in sales and related occ. (2000)	25.9%	22%	24.9%	21.9%
Pct. persons 16+ years old employed in production occupations (2000)	9.8%	4.8%	6.9%	3.5%

Table 5-4. Continued

	Frederick (Frederick)	Rockville (Montgomery)	Annapolis (Anne Arundel)	Columbia (Howard)
Pct. employment in establishments with 10-49 employees (2003)	29.5%	N/A	33.8%	25%
Number of commercial banks per 1,000 population (2003)	0.6	N/A	0.6	0.4

Table 5-5. Top three hiring industries*

	Industries	Percentage of Employment	Number of Employment	Location Quotient
Maryland	Trade, Transportation, and Utilities	22.56%	472,497	NA
	Professional and Business Services	19.02%	396,619	NA
	Education and Health Services	17.22%	359,183	NA
Montgomery	Professional and Business Services	27.12%	103,191	1.43
	NAICS 541 Professional and Technical Services	16.5%	62,799	1.55
	Trade, Transportation, and Utilities	16.45%	62,639	0.73
Howard	Trade, Transportation, and Utilities	27.18%	35,374	1.20
	Professional and Business Services	24.64%	32,057	1.30
	NAICS 54 Professional and technical services	16.37%	21,302	1.54
Frederick	Trade, Transportation, and Utilities	21.63%	17,402	0.95
	Professional and Business Services	17.29%	13,915	0.91
	NAICS 44-45 Retail trade	16.23%	13,059	1.12
Baltimore City	Education and Health Services	34.385	91,727	2.00
	NAICS 62 Health care and social assistance	25.12%	67,010	1.73
	Professional and Business Services	15.89%	42,400	0.84
Anne Arundel	Trade, Transportation, and Utilities	28%	54,941	1.24
	Professional and Business Services	17.65%	34,634	0.93
	NAICS 44-45 Retail trade	16.91%	33,176	1.17

*Quarterly Census of Employment and Wages, Bureau of Labor Statistics

Table 5-6. Summary of major employer by county*

	Type of Industry	Number of Employer	Total Employee
Montgomery	Federal government	8	38,881
	Healthcare	6	19,672
	Sum	14	58,553
Howard	Education	1	2,500
	Healthcare	5	3,618
	Information	1	2,028
	Manufacture	4	1,951
	Professional services	8	10,124
	Sum	19	20,221
Frederick	Federal government	1	4,436
	Finance and insurance	6	5,103
	Healthcare	3	3,344
	Manufacturing	6	2,143
	Professional services	3	4,143
	Sum	19	19,169
Baltimore City	Educational services	5	3,4604
	Healthcare	8	41,822
	Sum	13	76,426
Anne Arundel	Federal government	2	31,425
	Manufacturing	1	8,000
	Professional services	6	6,090
	Retail trade	7	6,517
	Sum	16	52,032

*Department of Business and Economic Development

Table 5-7. Employment and wages of major technology industry*

		Baltimore	Howard	Montgomery	Frederick	Anne Arundel
Bioscience	Empl. Change (2001-2003)	484	523	1285	168	90
	Average Weekly Wage (2003)	952	1,492	1,426	989	1,322
Aerospace	Empl. Change (2001-2003)	56	326	224	33	449
	Average Weekly Wage (2003)	1,218	1,515	1,425	1,038	1,611
Information technology	Empl. Change (2002-2005)	509	164	-4,296	262	564
	Average Weekly Wage (2005)	1,464	1,646	1,751	1,333	1,531
Healthcare	Empl. Change (2001-2005)	5,371	1,233	4,847	698	1,911
	Average Weekly Wage (2005)	890	771	919	784	834

* Career and Workforce Information, Maryland Department of Labor

Table 5-8 Tax incentive of municipalities*

	Anne Arundel	Baltimore City	Frederick	Howard	Montgomery
Local Personal Income Tax Rate	2.56%	3.05%	2.96%	3.20%	3.20%
County Business Personal Property Tax Rate **	$2.20	$5.67	$0.00	$2.535	$1.652
Manufacturing/R&D Machinery and Equipment Exemption	100%	100%	NA	100%	100%
Manufacturing/R&D Inventory Exemption	100%	100%	NA	100%	100%
Corporate Income Tax***	None	None	None	None	None
Acreage in State Enterprise Zones	0	21,615	0	0	627

* Maryland Department of Business and Economic Development
** per $100 of assessed value
*** Brief Economic Facts by County

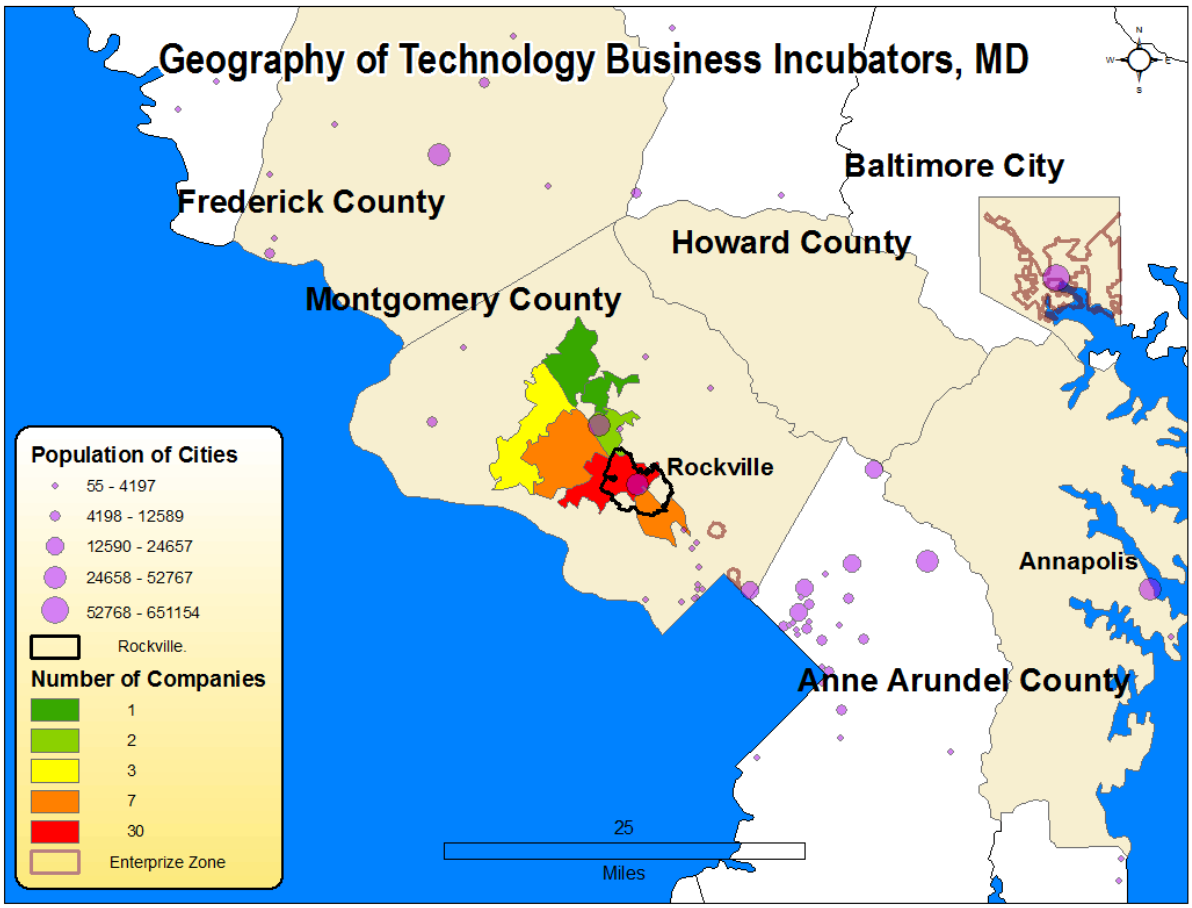

Figure 5-3. Numbers of client companies by zip code

Table 5-9. Area incubators and other innovation centers

	Anne Arundel	Baltimore City	Frederick	Howard	Montgomery
Incubators (locations)	1	2(3)	1(2)	1	6
Technology Park & Centers	0	3	6	0	2

Table 5-10. Sample Client Companies

Incubator code	Location (City/County)	Company		Final Sample Size	Proportion
GP	Rockville/ Montgomery County	tenant	12	6	50%
		graduate	15	9	60%
		total	27	15	55.6%
GG	Multiple locations/ Montgomery County	tenant	28	20	71.4%
		graduate	22	16	72.7%
		total	50	36	72%

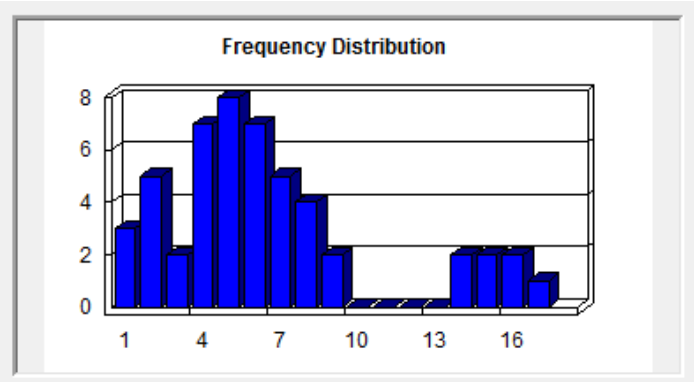

Figure 5-4. Sample distribution by age

Table 5-11. Client companies by type of industry, total

NAICS Code	Number of Incubator			Description
	Private	Public	Total	
541710	7	15	22	Research and Development in the Physical, Engineering, and Life Sciences
517910		3	3	Other Telecommunications, Cellular and Other Wireless Telecommunications, Satellite Telecommunications
423450		2	2	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
541511		2	2	Custom Computer Programming Services, Computer Programming Services
541350	1	2	3	Building Inspection Services
325412	1		1	Pharmaceutical Preparation Manufacturing
325414	1		1	Biological Product (except Diagnostic) Manufacturing
334519	1		1	Other Measuring and Controlling Device Manufacturing
339112		1	1	Surgical and Medical Instrument Manufacturing
325992		1	1	Photographic Film, Paper, Plate, and Chemical Manufacturing
541810		1	1	Advertising Agencies
334611	1	1	2	Software Reproducing
541512		1	1	Computer Systems Design Services
443120		1	1	Computer and Software Stores
541519		1	1	Other Computer Related Services
621111	1	1	2	Offices of Physicians
621112			0	Offices of Physicians, Mental Health Specialists"
621511		1	1	Medical Laboratories
621999		1	1	Health and Allied Services, NEC (except blood and organ banks, medical artists, medical photography, and childbirth preparation classes)
541990			0	All Other Professional, Scientific, and Technical Services
541618	1	1	2	Other Management Consulting Services
541690	1		1	Other Scientific and Technical Consulting Services
532490			0	Medical Equipment Rental and Leasing
NA		1	1	NA
SUM	15	36	51	

Table 5-12. Client companies by type of industry, major only

Private SIC8	Description	Cnt.	Avr. Age	Range First Yr.	Avr. First Yr. Employee	Avr.First Yr. Sales
87310100	Biological Research	3	13	1989-1993	13	$691,533.3
87310102	Biotechnical Research, Commercial	3	5	2000-2003	10.3	$1,170,700.0
Public SIC8						
87310000	Commercial Physical Research	3	7	1999-2001	5.7	$465,566.7
87310102	Biotechnical Research, Commercial	3	5	2000-2005	6.3	$387,100.0
87339902	Research Institute	3	4.66	1999-2003	7.7	$626,733.3
48999901	Data Communication Services	2	6.5	1999-2000	7.5	$770,600.0
73710301	Computer Software Development	2	9.5	1991-2004	5.5	$501,450.0
87330102	Biotechnical Research, Noncommercial	2	7.5	1998-2001	17.5	$2,316,200.0
87330103	Medical Research	2	3.5	1999-2003	34.0	$2,888,400.0

Table 5-13. Biotechnical research, noncommercial and medical research in public incubators

SIC 8		First Year Employee	First Year Sales
	Client 1	25	$3,750,000.0
87330102	Client 2	10	$882,400.0
	Average	17.5	$2,316,200.0
	Client 1	65	$5,525,000.0
87330103	Client 2	3	$251,800.0
	Average	34	$2,888,400.0

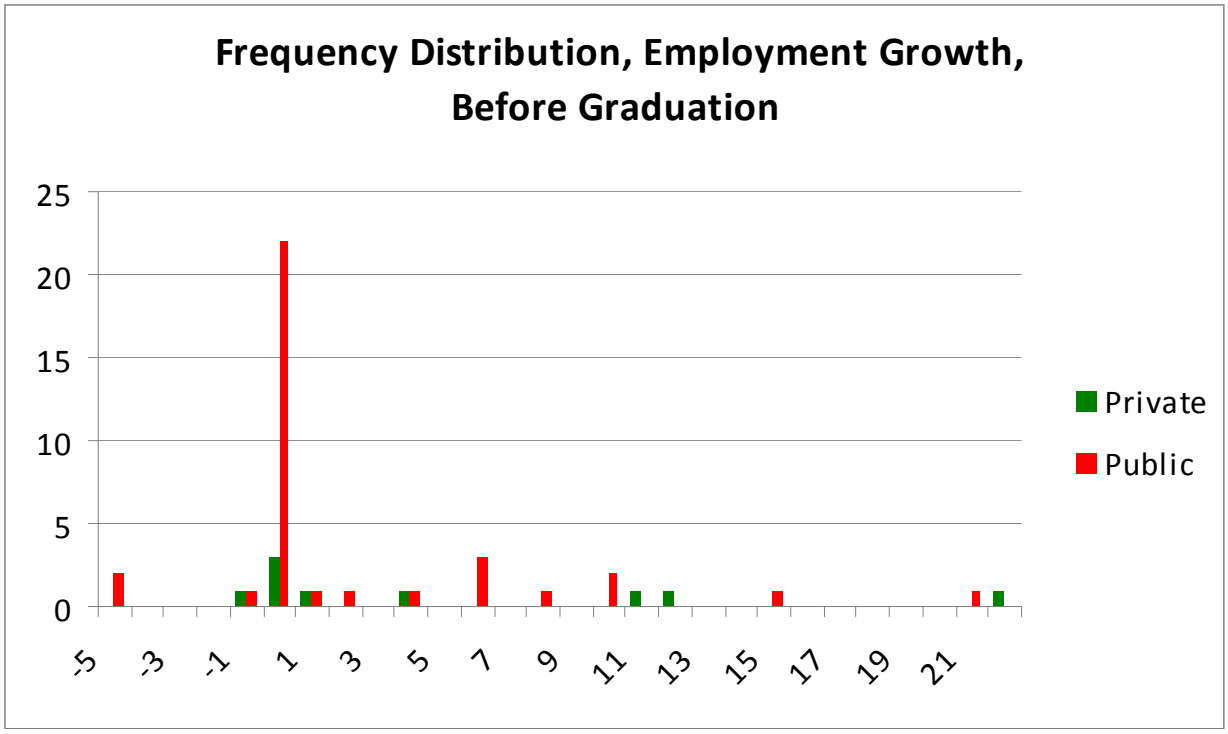

Figure 5-5. Frequency distribution, employment growth, before graduation

Table 5-14. Descriptive Statistics, employment growth, before Graduation

Employment Growth Achieved During the Residency	Incubator GP	Incubator GG
COUNT	9	36
MAX.	74	21
MIN.	-1	-45
STDEV.	24.05	9.37
MEDIAN	1	0
MEAN	11.22	1.06

Table 5-15. Mann-Whitney Test results, employment growth, before graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	27.39	122.5	788.5	.218
Public	21.90			

*Mean rank is the sum of the ranks divided by the number of cases for each group

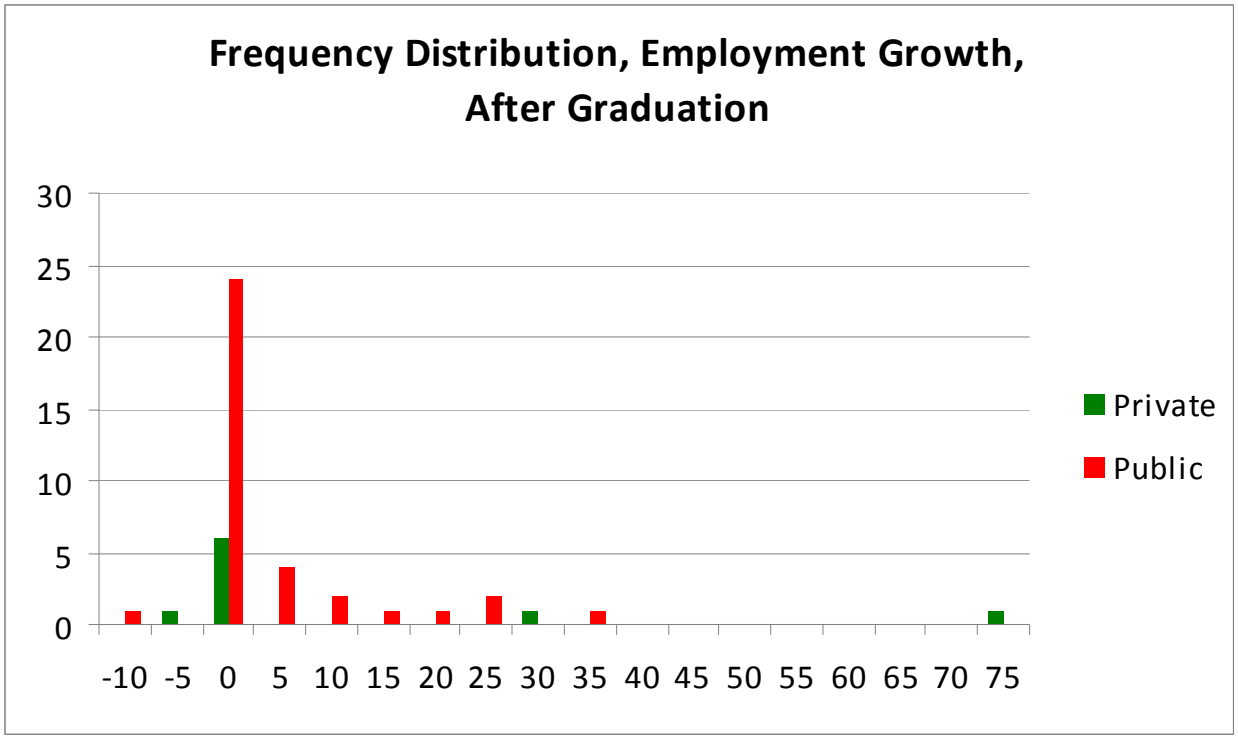

Figure 5-6 Frequency distributions, employment growth, after graduation

Table 5-16. Descriptive statistics, employment growth, after graduation

Employment Growth Achieved After Graduation	Incubator GP	Incubator GG
COUNT	9	36
MAX.	73	33
MIN.	-5	-10
STDEV.	8.48	8.56
MEDIAN	0	0
MEAN	10.89	3.22

Table 5-17. Mann-Whitney Test results, employment growth, after graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	22.67	159.0	204.0	.923
Public	23.08			

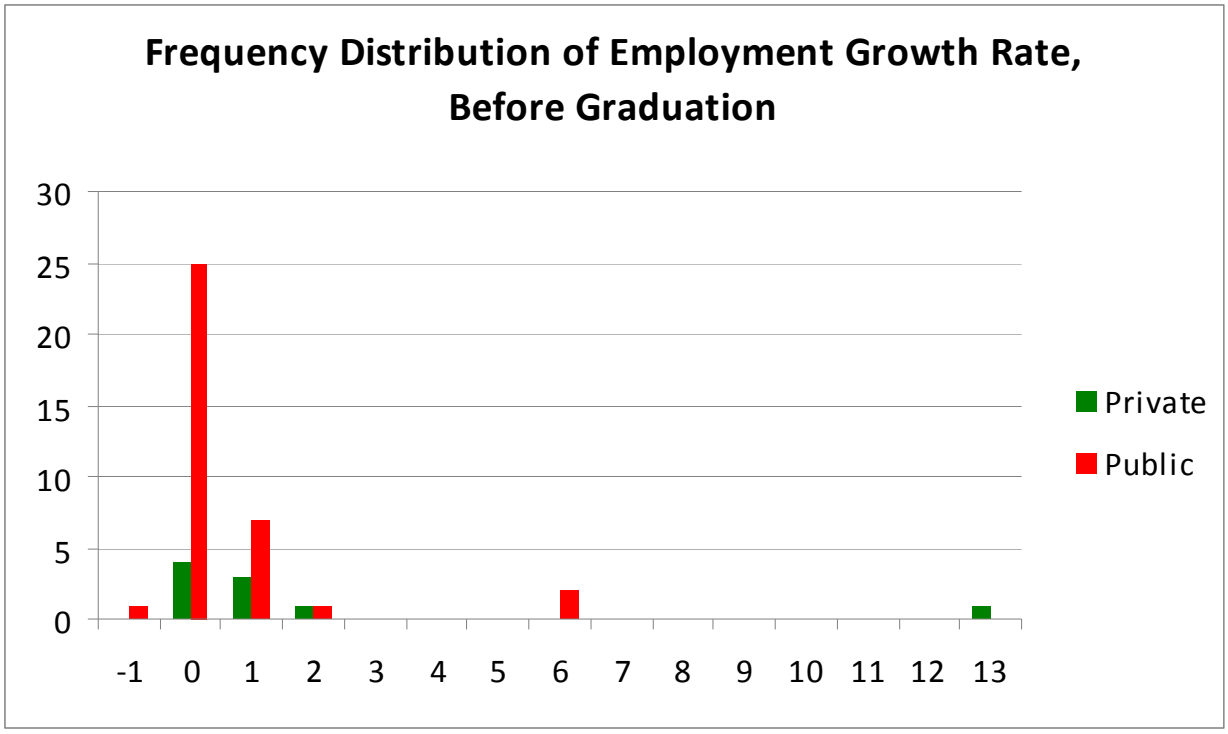

Figure 5-7. Frequency distributions, employment growth rate, before graduation

Table 5-18. Descriptive Statistics, employment growth rates, before graduation

Employment Growth Rates Achieved During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	12.33	6
MIN.	-0.06	-1
STDEV.	4.03	1.35
MEDIAN	0.25	0
MEAN	1.641	0.453

Table 5-19. Mann-Whitney Test results, employment growth rate, before graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	27.06	125.5	791.5	.249
Public	21.99			

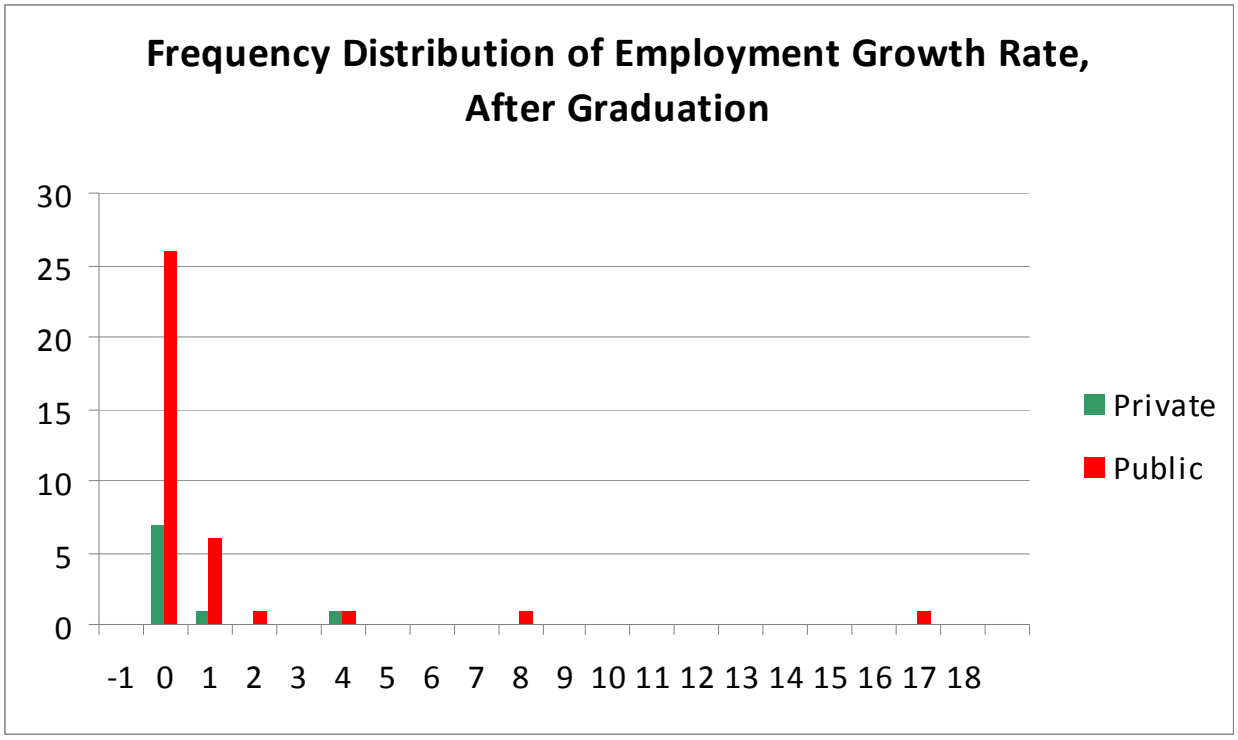

Figure 5-8. Frequency distributions, employment growth rate, after graduation

Table 5-20. Descriptive statistics, employment growth Rate, after graduation

Employment Growth Rate, After Graduation	Incubator GP	Incubator GG
Count	9	36
MAX.	3.31	17
MIN.	-0.26	-0.5
STDEV.	1.11	3.08
MEDIAN	0	0
MEAN	0.381	0.848

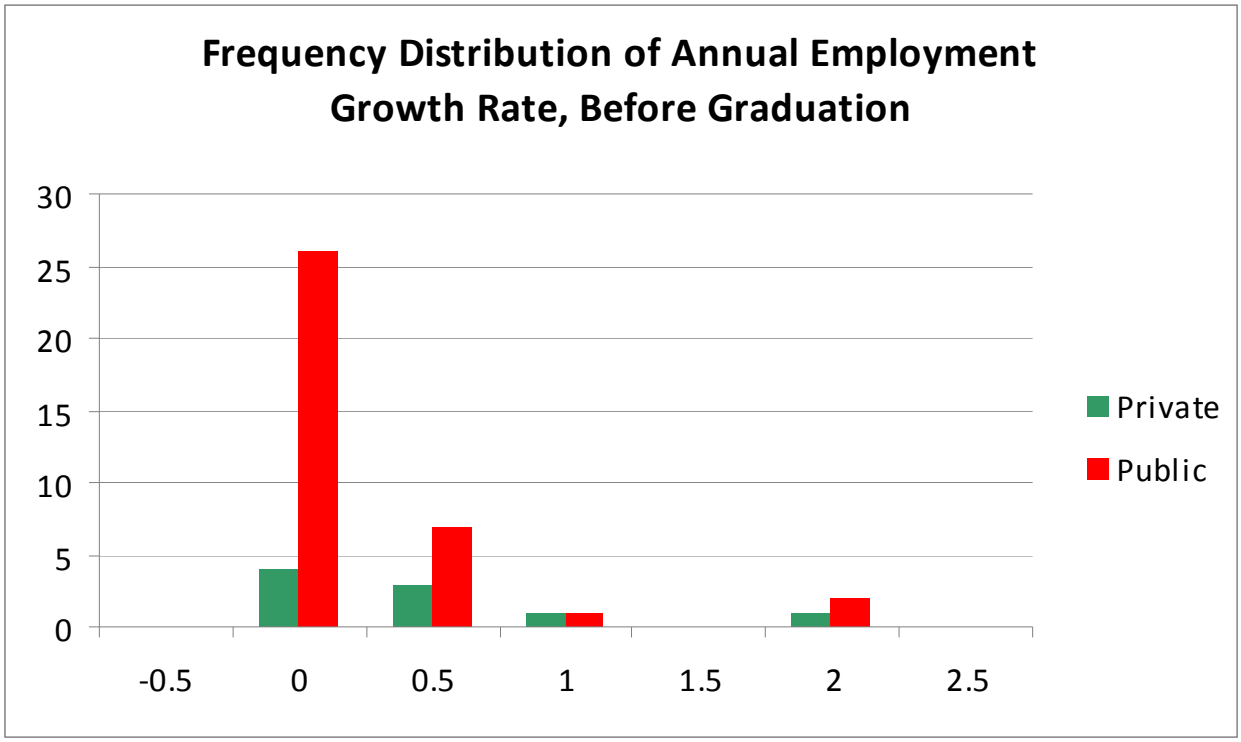

Figure 5-9. Frequency distributions, annual employment growth rate, before graduation

Table 5-21. Mann-Whitney Test results, employment growth rate, after graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	22.22	155.0	200.0	.820
Public	23.19			

Table 5-22. Descriptive statistics, annual employment growth rate, before graduation

Annual Employment Growth Rate During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	1.55	2
MIN.	-0.01	-0.33
STDEV.	0.52	0.47
Median	0.05	0
Mean	0.26	0.17

Table 5-23. Mann-Whitney Test results, annual employment growth rate, before graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	26.61	129.5	795.5	.305
Public	22.10			

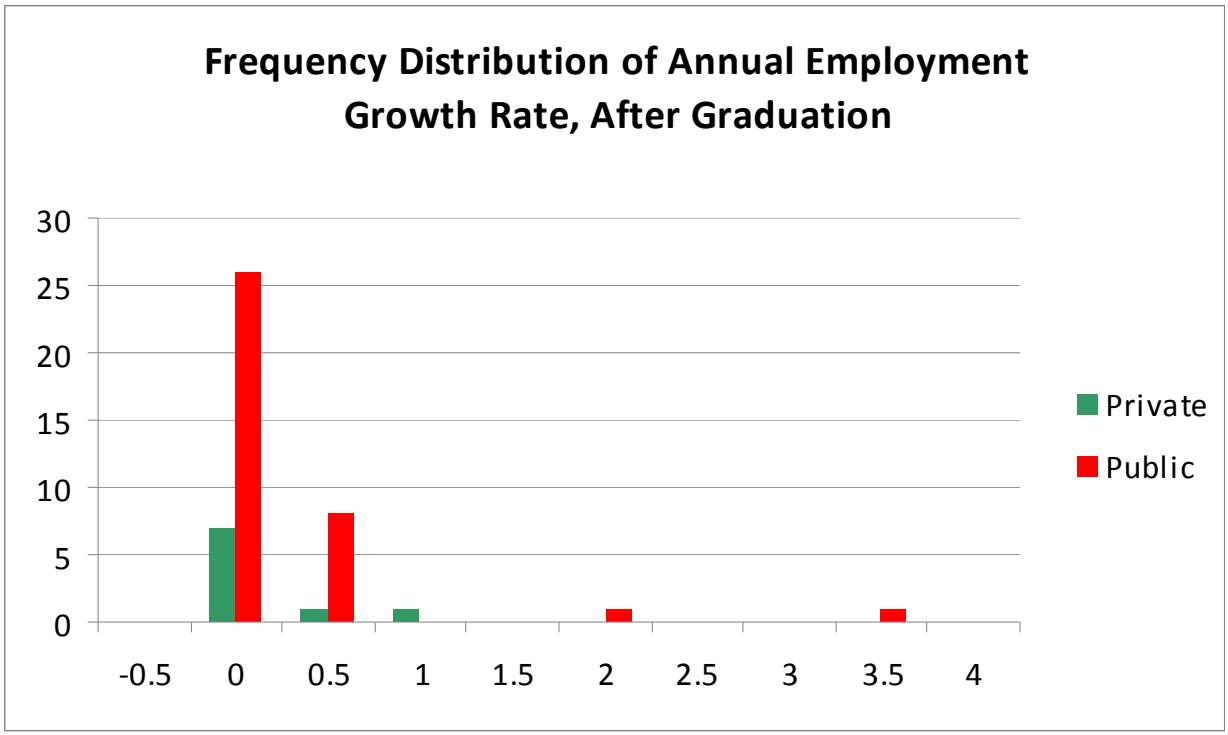

Figure 5-10. Frequency distributions, annual employment growth rate, after graduation

Table 5-24. Descriptive statistics, annual employment growth rate, after graduation

Annual Employment Growth Rate Achieved During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	0.83	3.4
MIN.	-0.02	-0.13
STDEV.	0.27	0.63
Median	0	0
Mean	0.1	0.17

Table 5-25. Mann-Whitney Test results, annual employment growth rate, after graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	22.11	154.000	199.000	.794
Public	23.22			

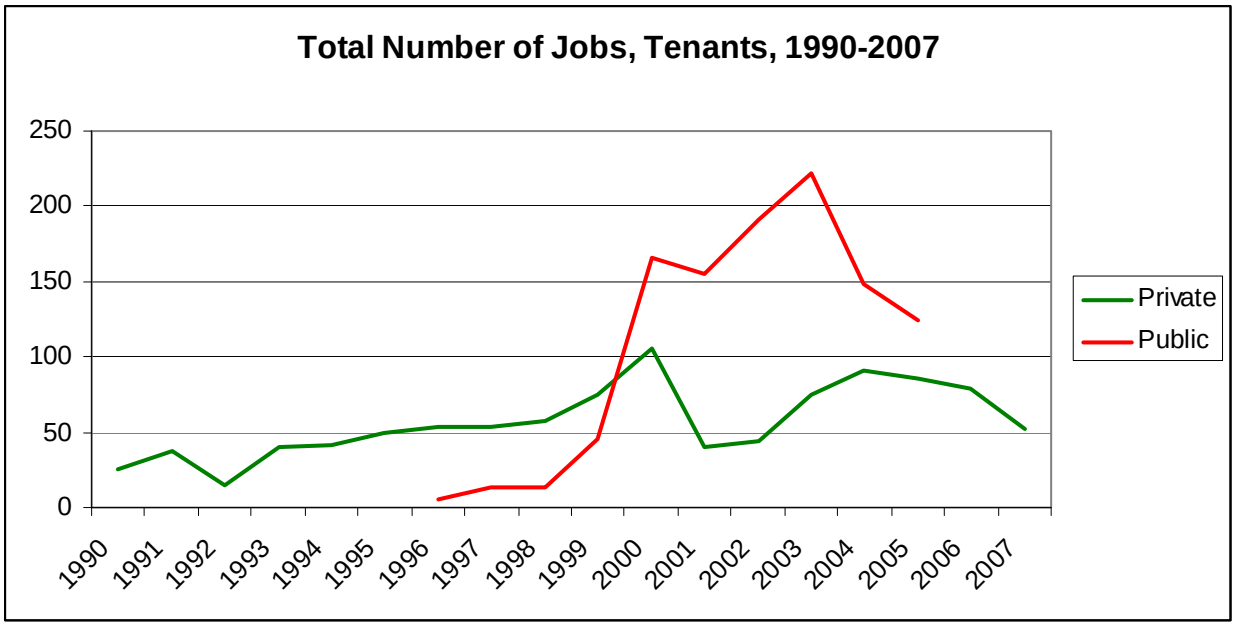

Figure 5-11. Total number of jobs, tenants, 1990-2007

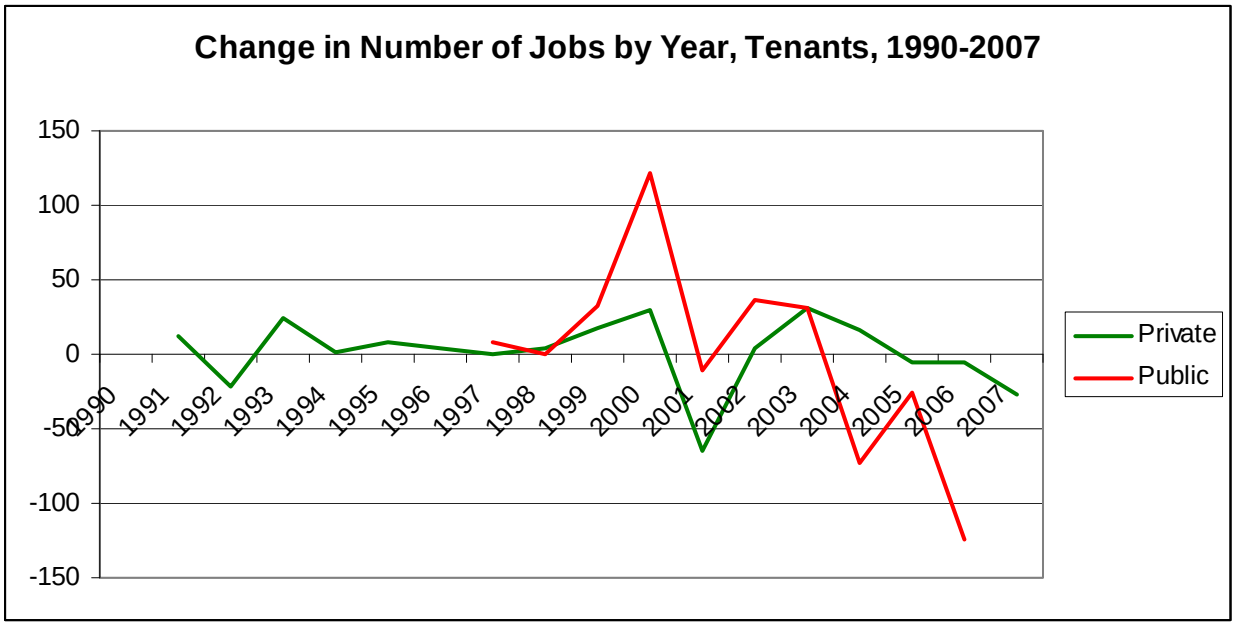

Figure 5-12. Change in number of jobs by year, tenants, 1990-2007

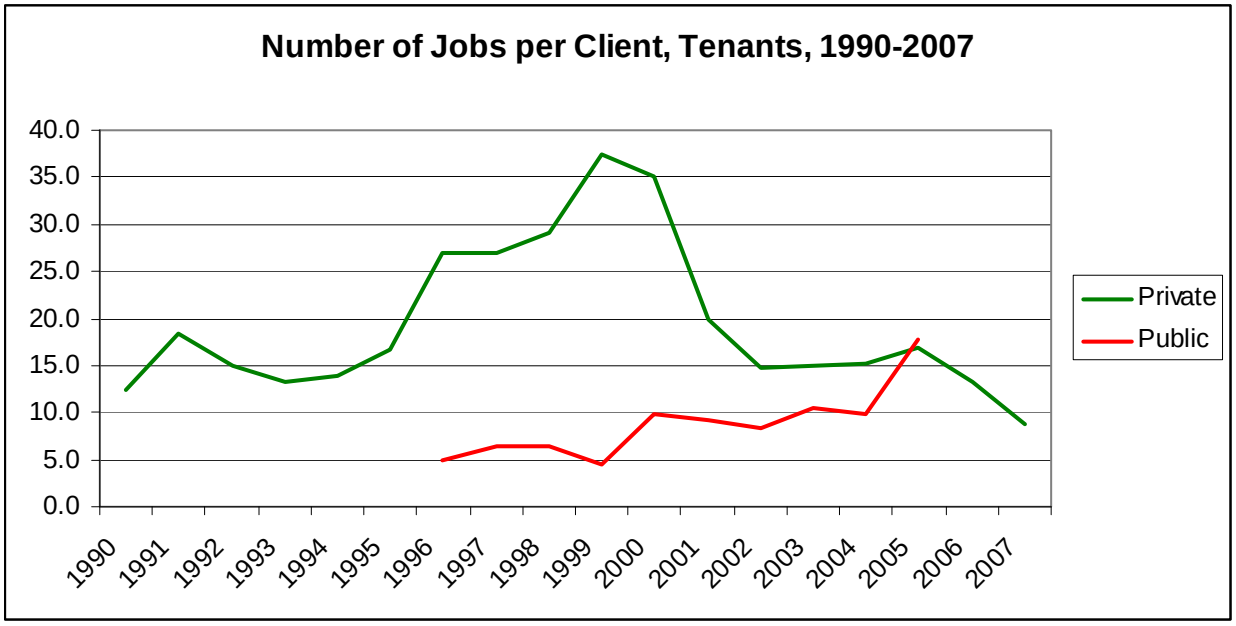

Figure 5-13. Number of jobs per client, tenants, 1990-2007

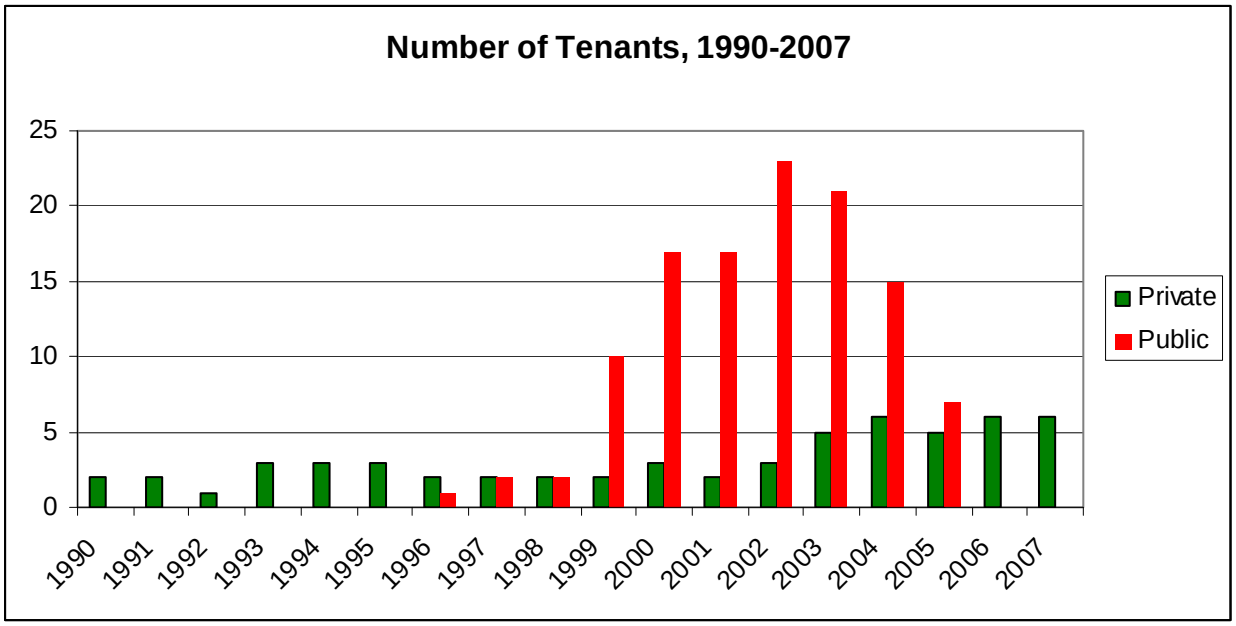

Figure 5-14. Number of tenants, 1990-2007

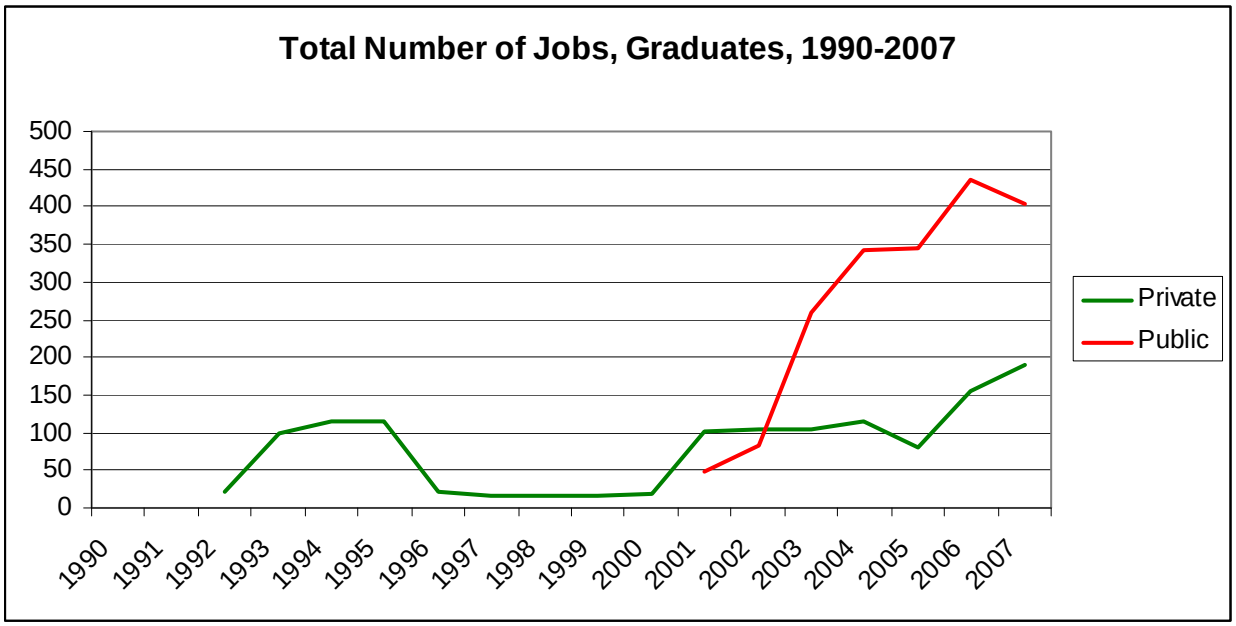

Figure 5-15. Total number of jobs, graduates, 1990-2007

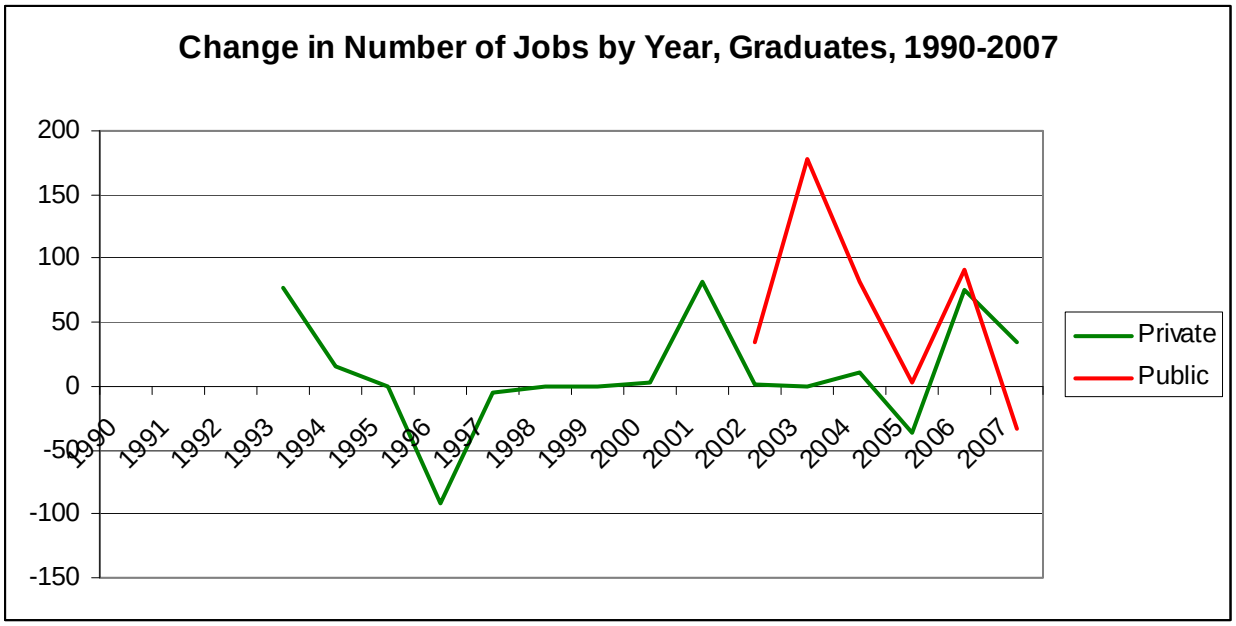

Figure 5-16. Change in number of jobs by year, graduates, 1990-2007

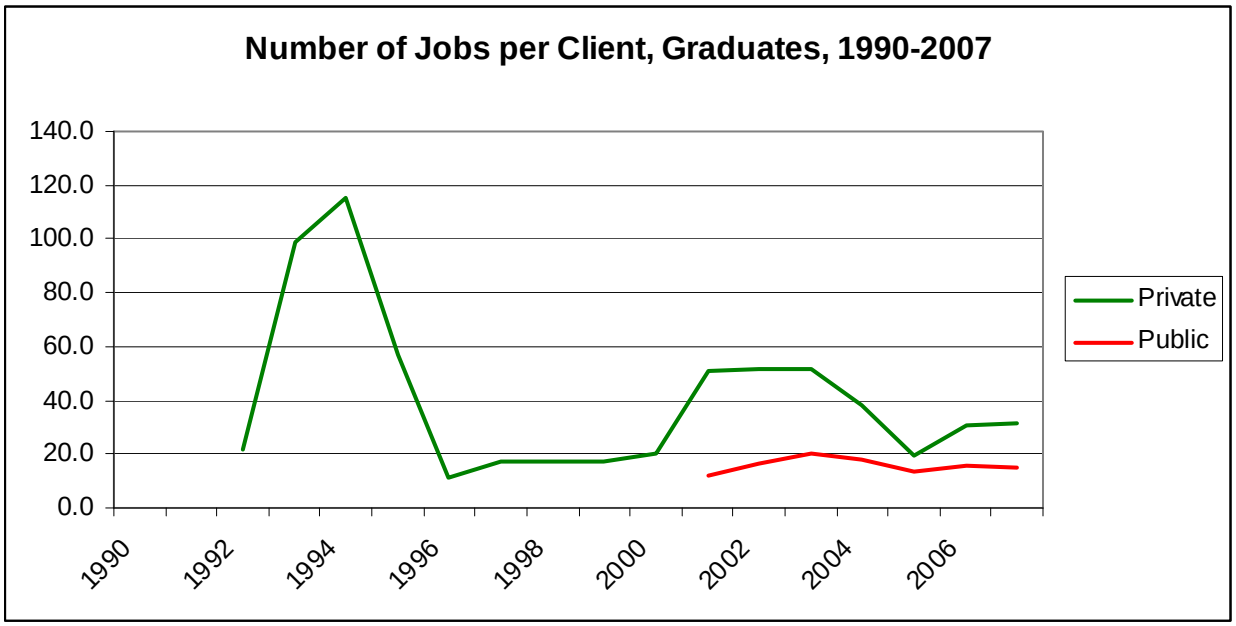

Figure 5-17. Number of jobs per client, graduates, 1990-2007

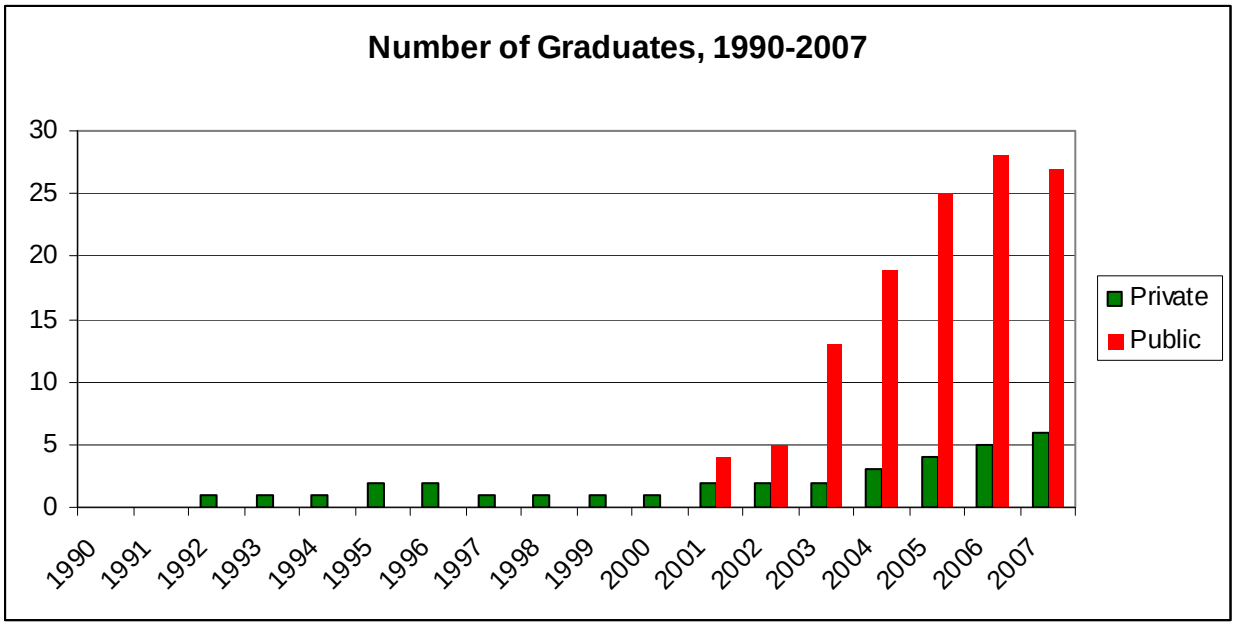

Figure 5-18. Number of graduates, 1990-2007

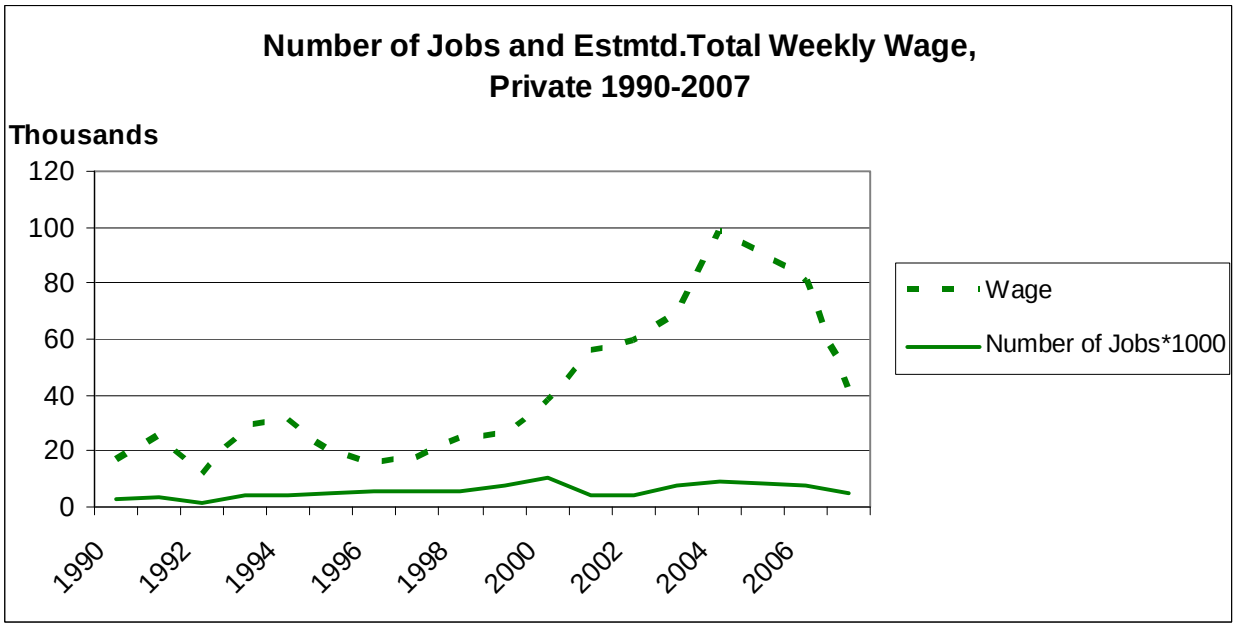

Figure 5-19. Number of jobs and wage effect, private 1990-2007

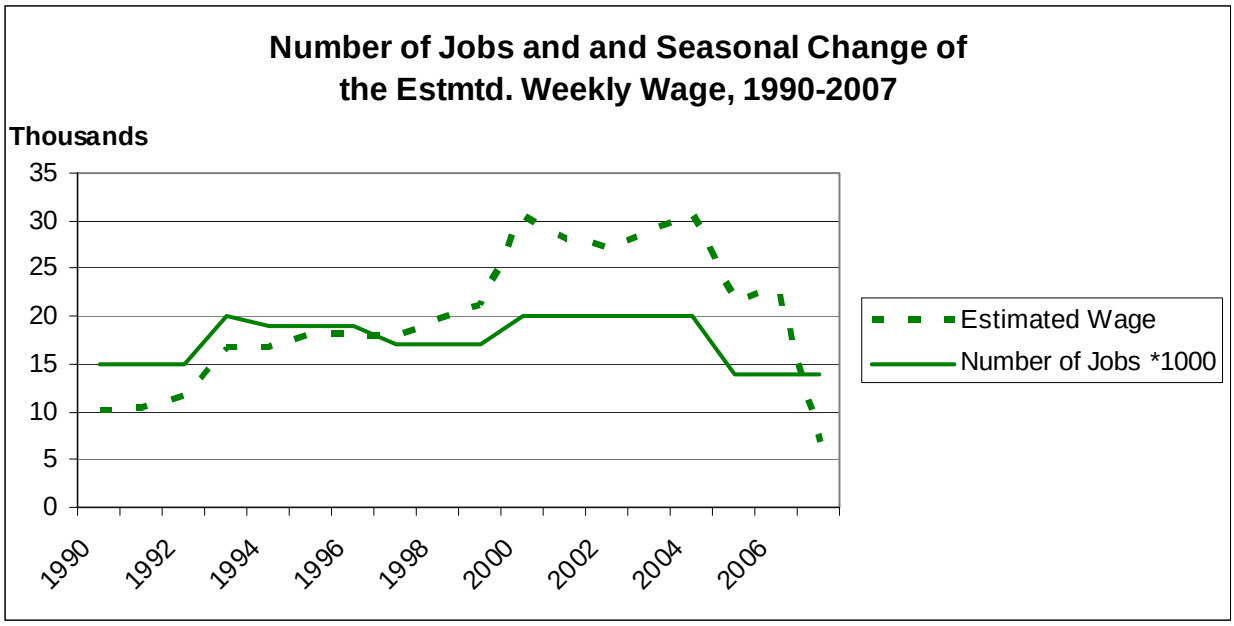

Figure 5-20. Number of jobs and seasonal change of the estimated weekly wage, 1990-2007

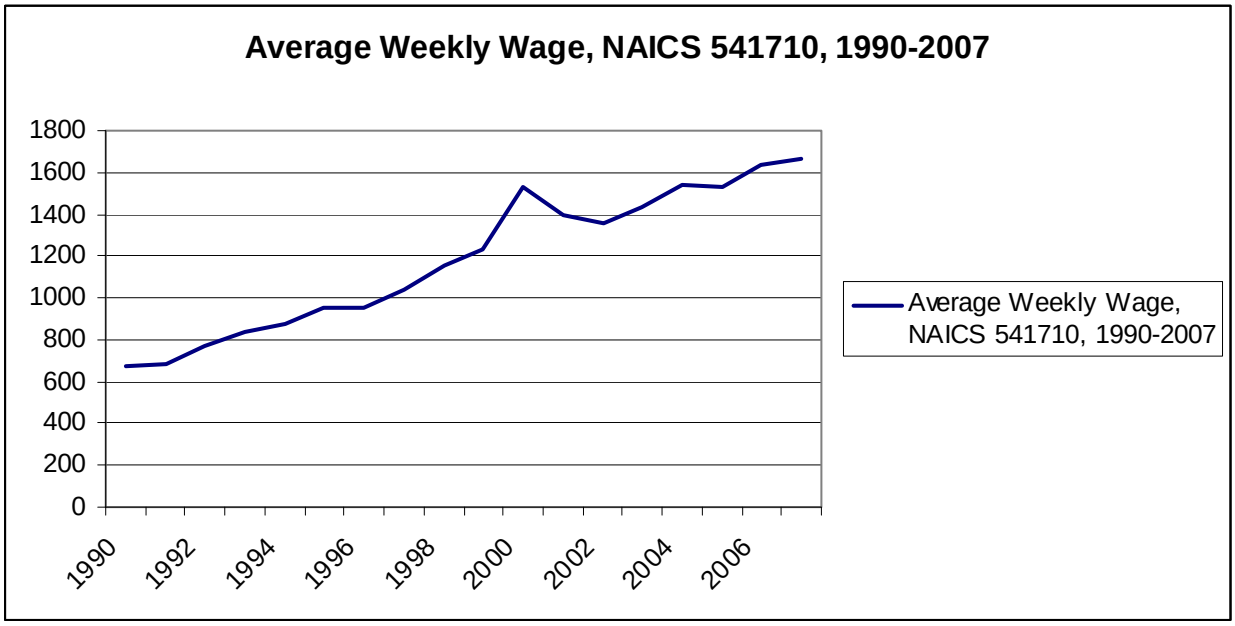

Figure 5-21. Average weekly wage of NAICS 541710, 1990-2007

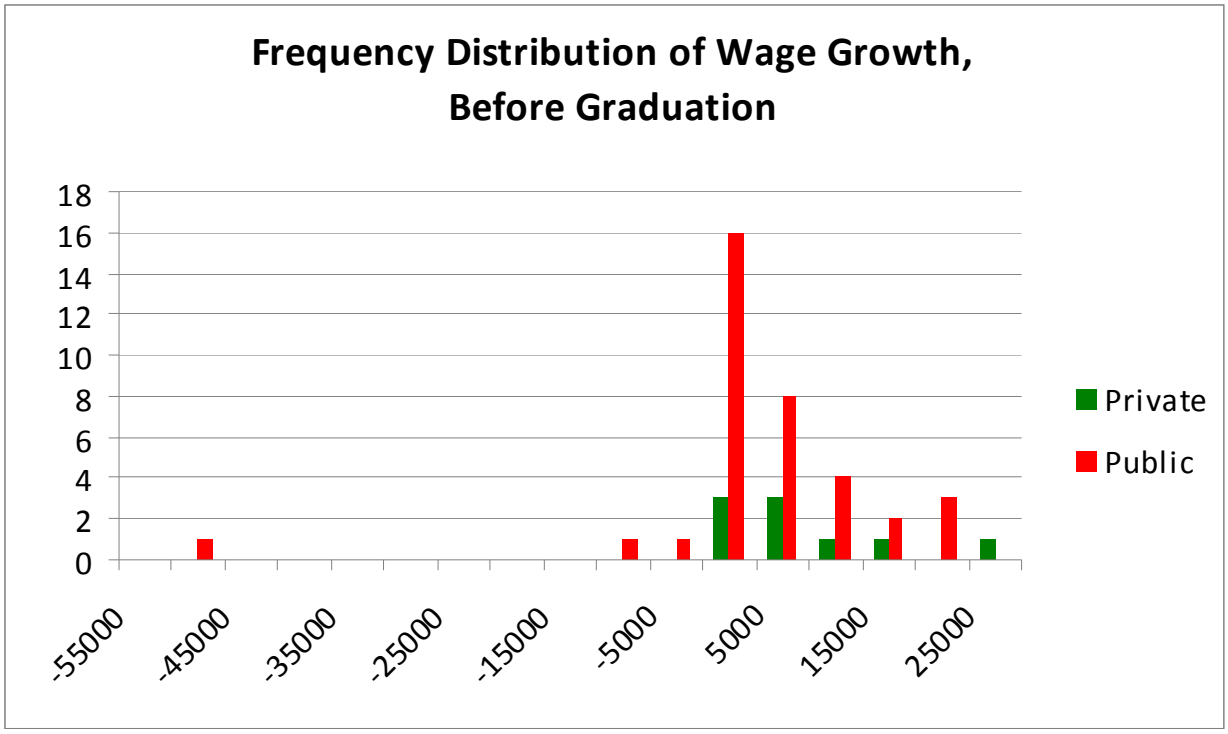

Figure 5-22. Frequency distributions, wage growth, before graduation

Table 5-26. Descriptive statistics, wage growth, before graduation

Wage Growth Achieved During the Residency	Incubator GP	Incubator GG
COUNT	9	36
MAX.	$21,000	$15,856
MIN.	$0	$-53,265
STDEV.	$7,120	$11,035
MEDIAN	$1,946	$0
MEAN	$5,026	$863

Table 5-27. Mann-Whitney Test results, wage growth, before graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	29.28	105.5	771.5	.106
Public	21.43			

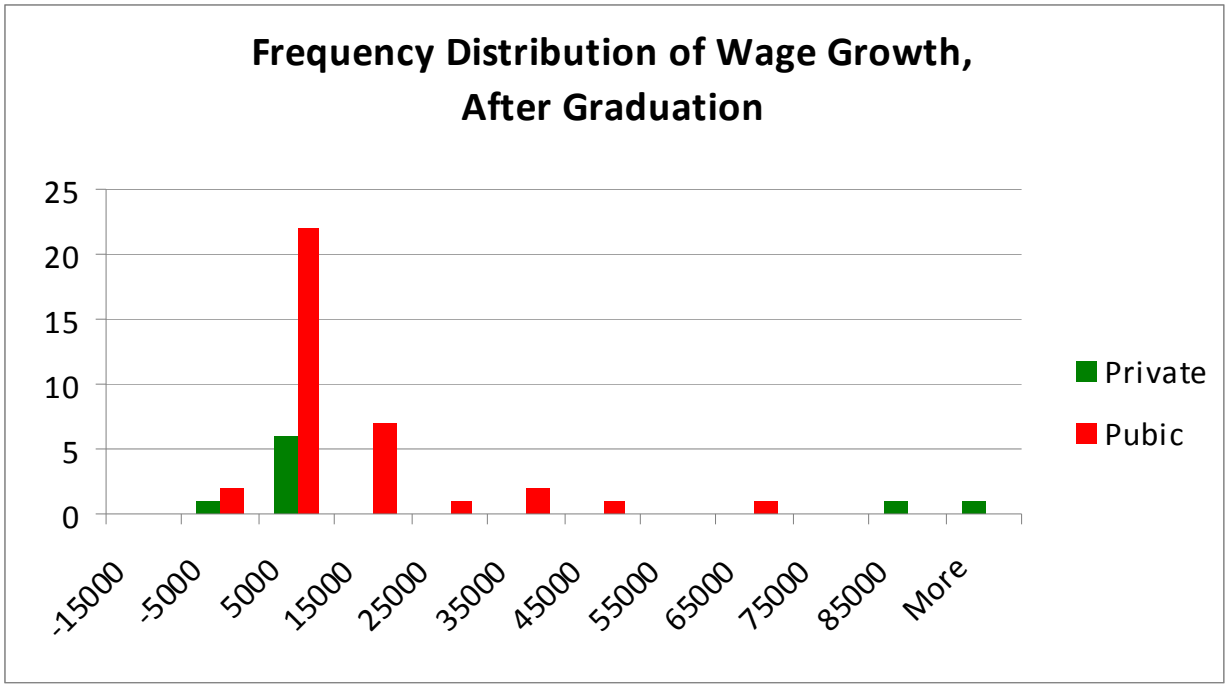

Figure 5-23 Frequency distributions, wage growth, after graduation

Table 5-28. Descriptive Statistics, Wage Growth, After Graduation

Wage Growth Achieved After Graduation	Incubator GP	Incubator GG
COUNT	9	36
MAX.	$477,840	$56,232
MIN.	$-10,007	$-10,568
STDEV.	$158,430	$13,807
MEDIAN	$350	$1,318.5
MEAN	$60,839	$6,885

Table 5-29. Mann-Whitney Test results, wage growth, after graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	22.28	155.5	200.5	.853
Public	23.18			

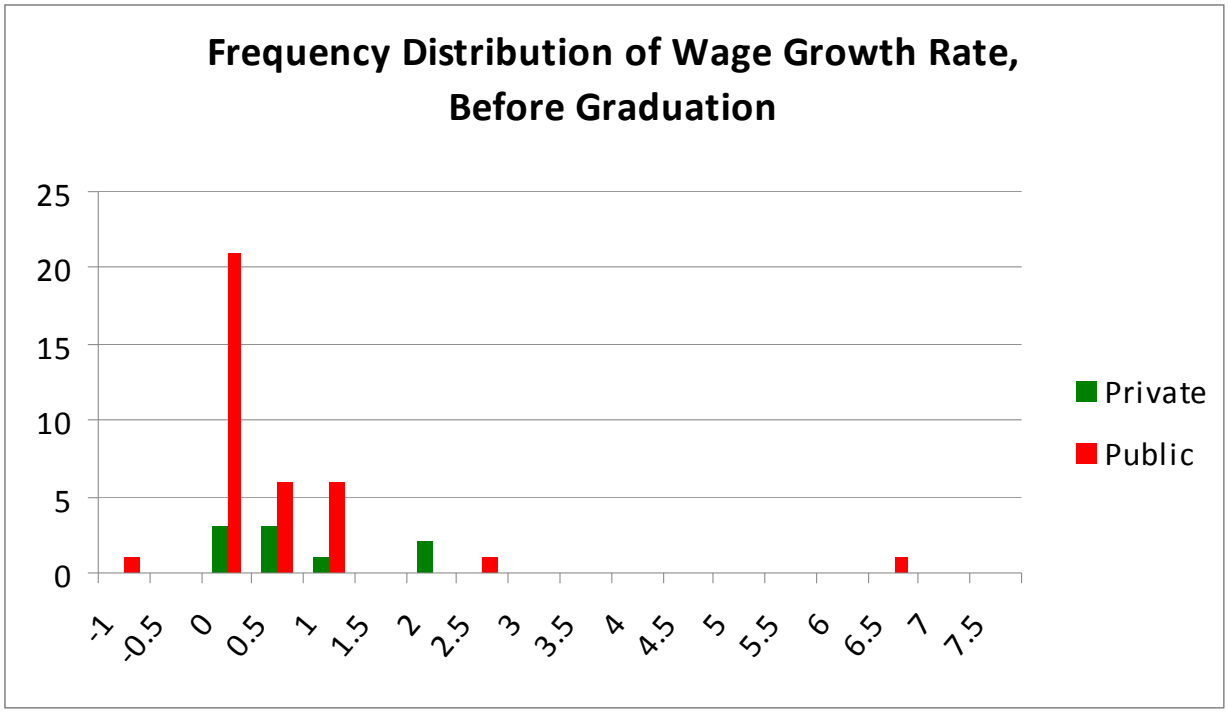

Figure 5-24. Frequency distributions, wage growth rates, before graduation

Table 5-30. Descriptive statistics, wage growth rates, before graduation

Wage Growth Rate Achieved During the Residency	Incubator GP	Incubator GG
COUNT	9	36
MAX.	1.801	6.165
MIN.	0	-1
STDEV.	0.732	1.122
MEDIAN	0.093	0
MEAN	0.535	0.338

Table 5-31. Mann-Whitney Test results, wage growth rates, before graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	30.06	98.5	764.5	.065
Public	21.24			

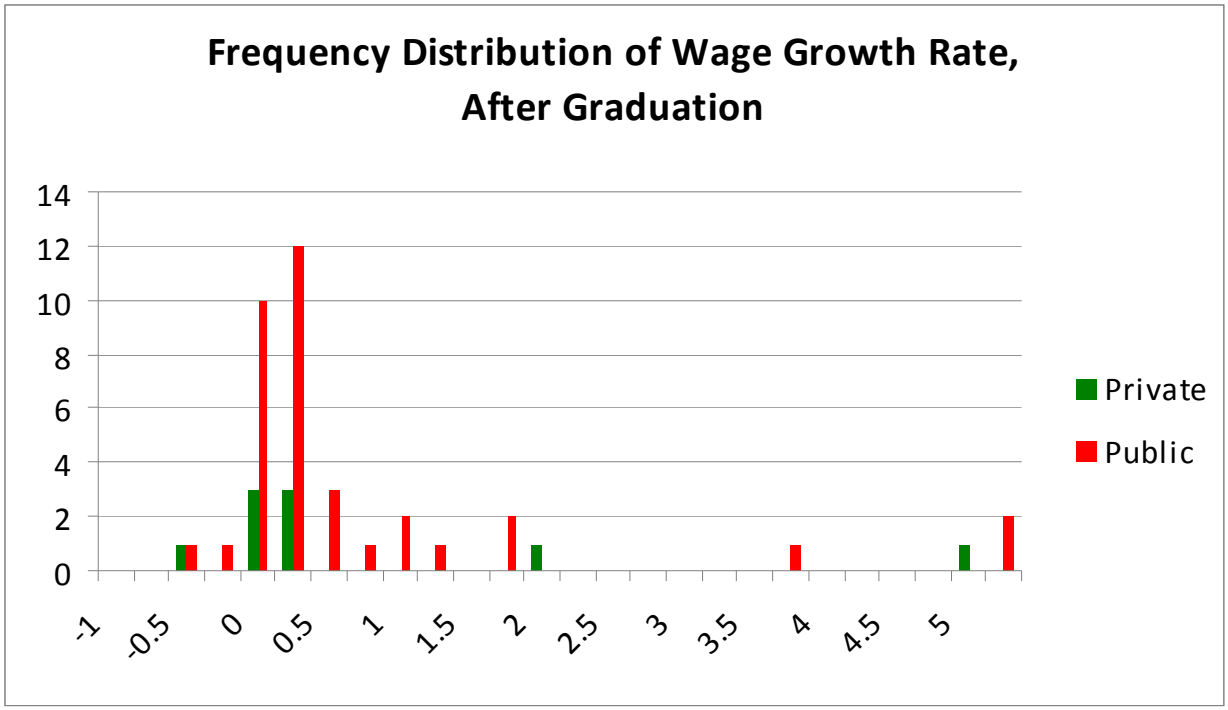

Figure 5-25. Frequency distribution, wage growth rates, after graduation

Table 5-32. Descriptive statistics, wage growth rates, after graduation

Wage Growth Rate After Graduation	Incubator GP	Incubator GG
COUNT	9	36
MAX.	4.975	16.988
MIN.	-0.601	-0.614
STDEV.	1.731	3.178
MEDIAN	0.012	0.087
MEAN	0.710	1.039

Table 5-33. Mann-Whitney Test results, wage growth rates, after graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	20.50	139.500	184.500	.522
Public	23.63			

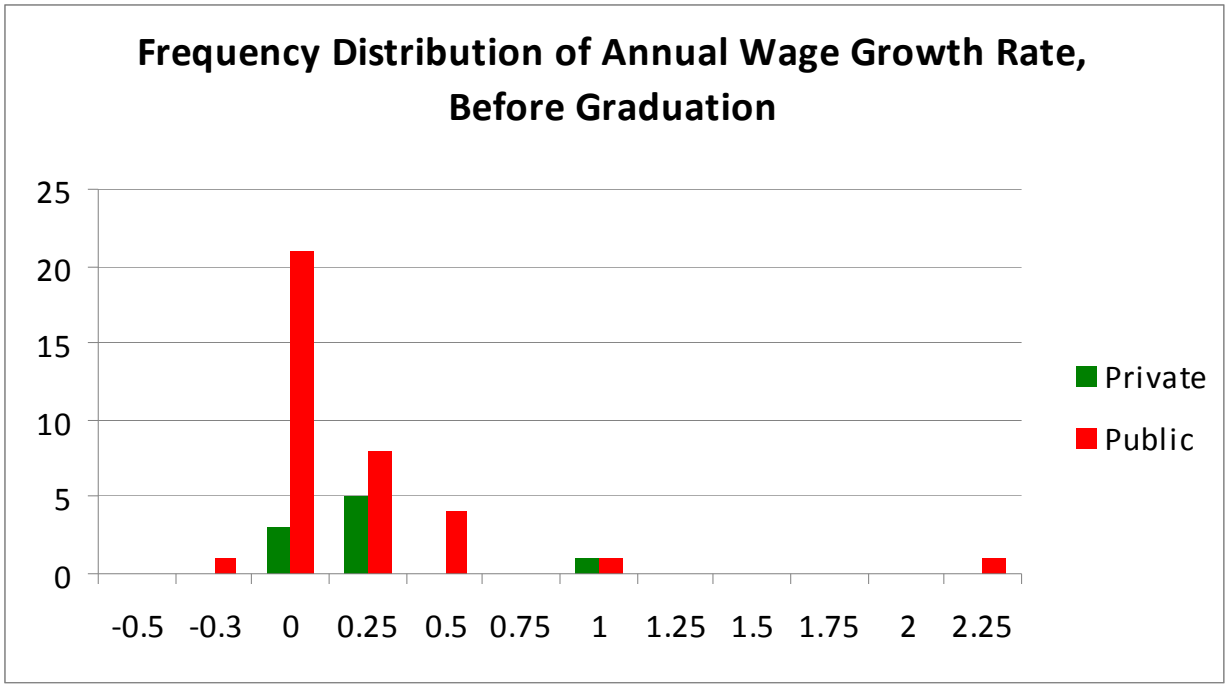

Figure 5-26. Frequency distributions, annual wage growth rates, before graduation

Table 5-34. Descriptive statistics, annual wage growth rates, before graduation

Annual Wage Growth Rate During the Residency	Incubator GP	Incubator GG
COUNT	9	36
MAX.	0.860	2.055
MIN.	0	-0.333
STDEV.	0.276	0.395
MEDIAN	0.020	0
MEAN	0.141	0.126

Table 5-35. Mann-Whitney Test results, annual wage growth rates, before graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	28.94	108.500	774.500	.120
Public	21.51			

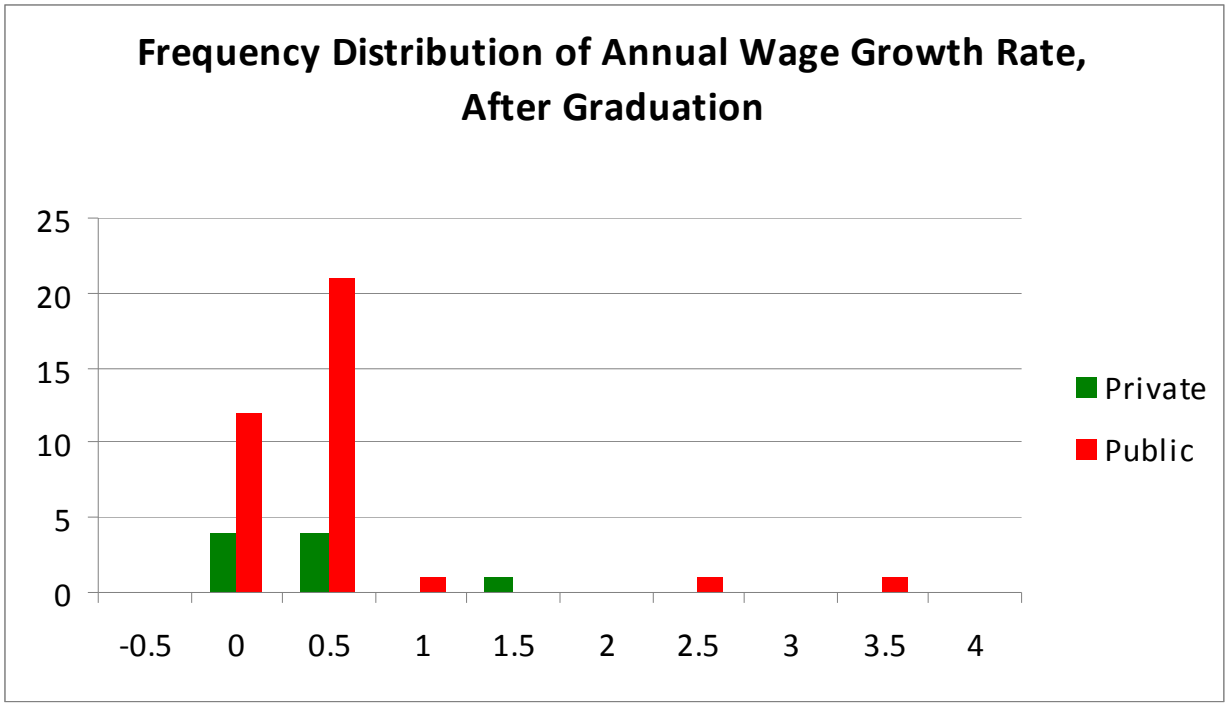

Figure 5-27. Frequency distributions, annual wage growth rates, after graduation

Table 5-36. Descriptive statistics, annual wage growth rates, after graduation

Annual Wage Growth Rate After Graduation	Incubator GP	Incubator GG
COUNT	9	36
MAX.	1.244	3.398
MIN.	-0.046	-0.123
STDEV.	0.412	0.041
MEDIAN	0.012	0.666
MEAN	0.171	0.221

Table 5-37. Mann-Whitney Test results, annual wage growth rates, after graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	21.06	144.500	189.500	.618
Public	23.49			

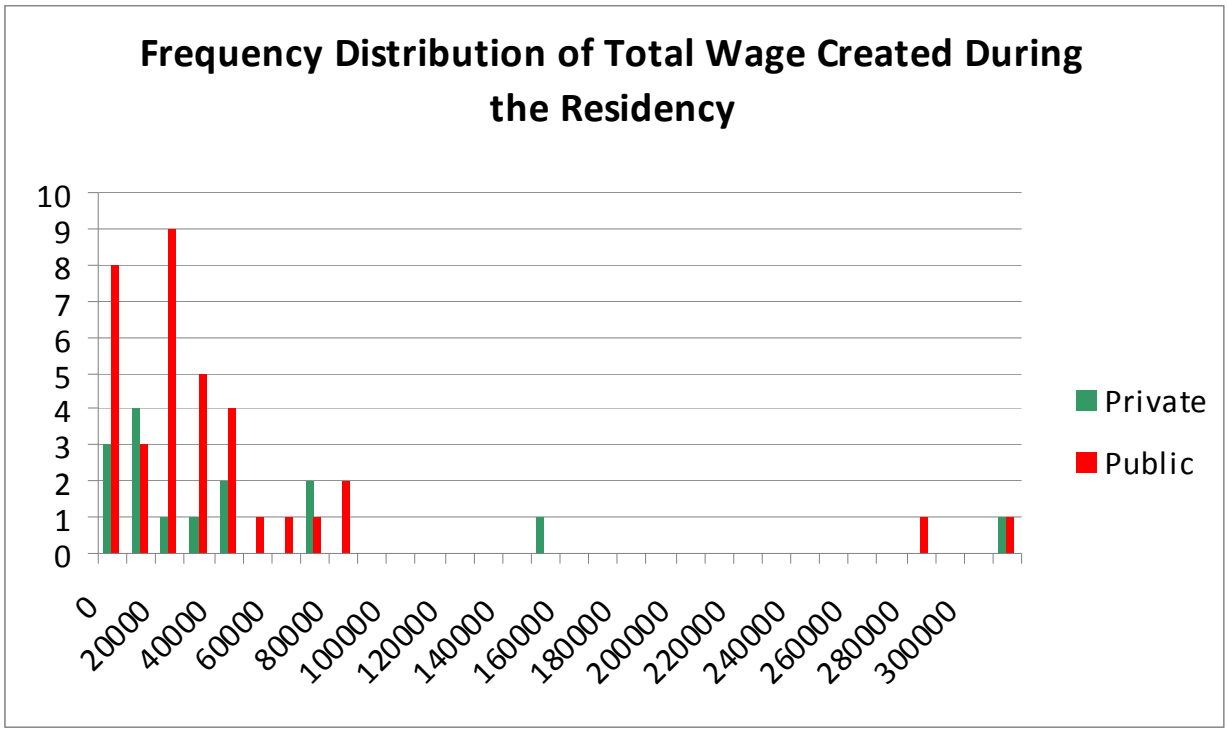

Figure 5-28. Frequency distributions, total wages, before graduation

Table 5-38. Total wages, descriptive statistics, during the residency *

Total Wages Produced During the Residency	Private	Public
COUNT	$749,621	$1,411,512
MAX.	$346,782	$409,065
MIN.	$0	$0
STDEV.	$91,353.17	$79,198.06
MEDIAN	$14,731	$16,806
MEAN	$49,974.73	$39,208.67

* Three sources are used to produce this table. First, year of admission and graduation was necessary and they were obtained from the incubators. Second, average weekly wage was prepared for each industry. This data is available as Quarterly Census of Employment and Wages, in Bureau of Labor Statistics. Third NETS database provides number of employee for each year.

Table 5-39 Mann-Whitney Test results, total wage, before graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	26.20	267.000	933.000	.950
Public	25.92			

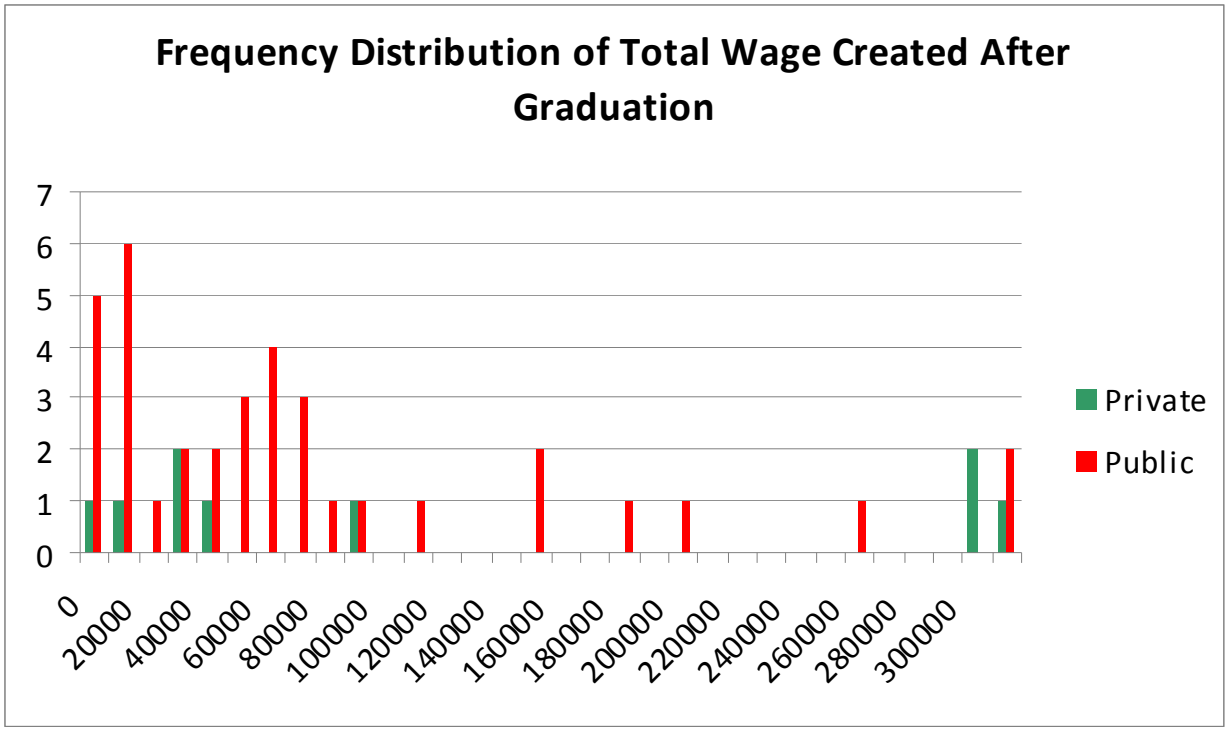

Figure 5-29 Frequency distributions, total wages, after graduation

Table 5-40. Total wages, descriptive statistics, after graduation

Total Wages Produced After Graduation	Private	Public
COUNT	$2,575,678	$2,748,056
MAX.	$1,823,901	$425,724
MIN.	$0	$0
STDEV.	$588,209.93	$102,680.78
MEDIAN	$32,361	$48,340
MEAN	$286,186.44	$76,334.89

Table 5-41. Mann-Whitney Test results, total wages, after graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	24.89	145.000	811.000	.629
Public	22.53			

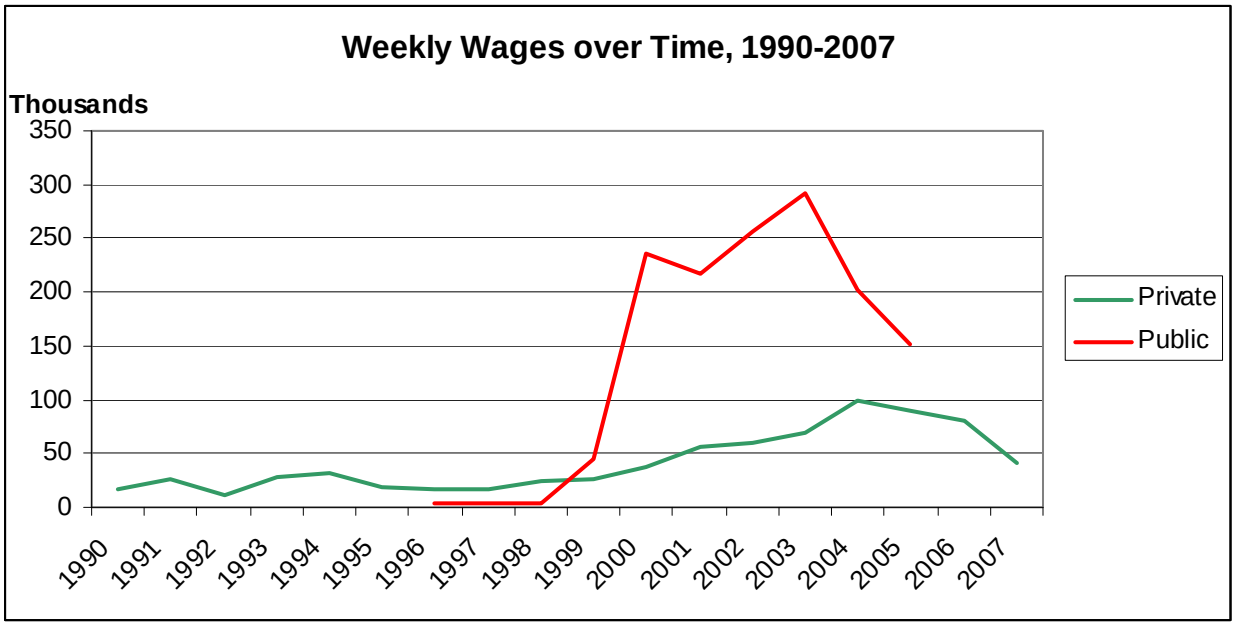

Figure 5-30. Total wages over time, tenants, 1990-2007

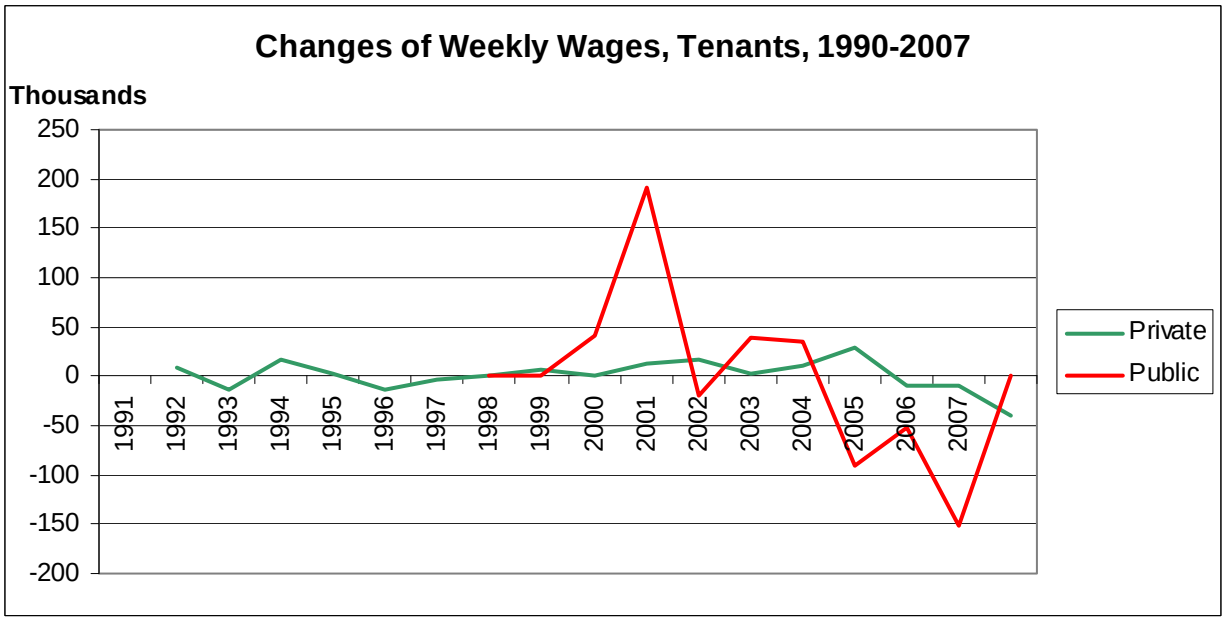

Figure 5-31. Changes of weekly wages, tenants, 1990-2007

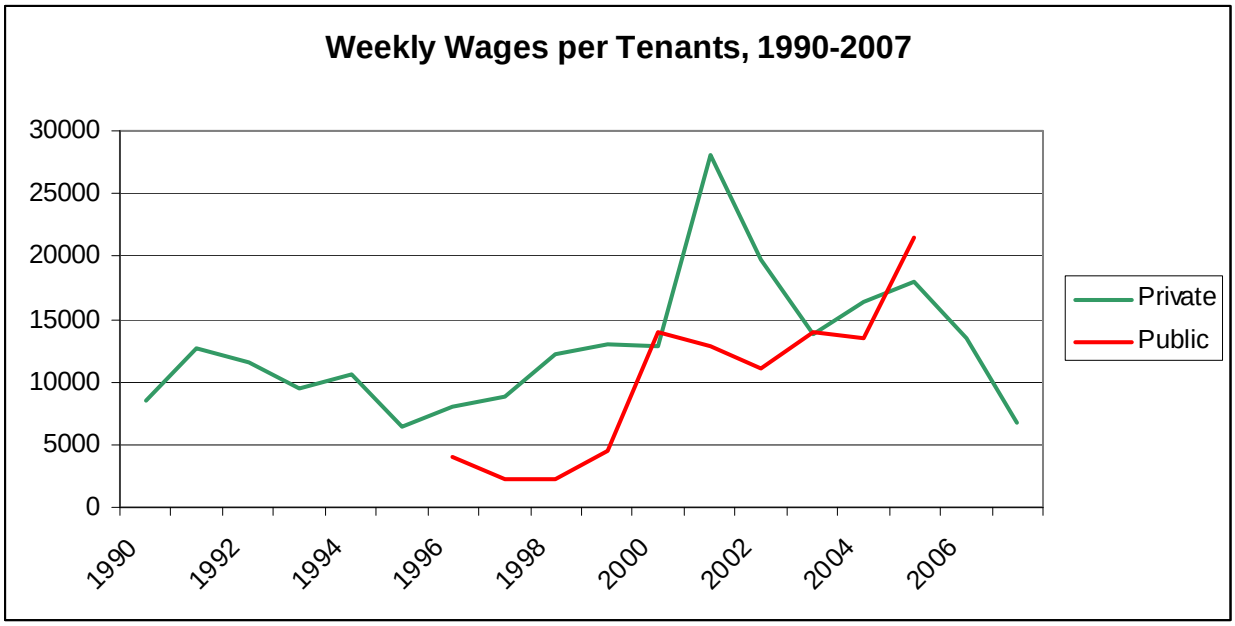

Figure 5-32. Weekly wages per tenant, 1990-2007

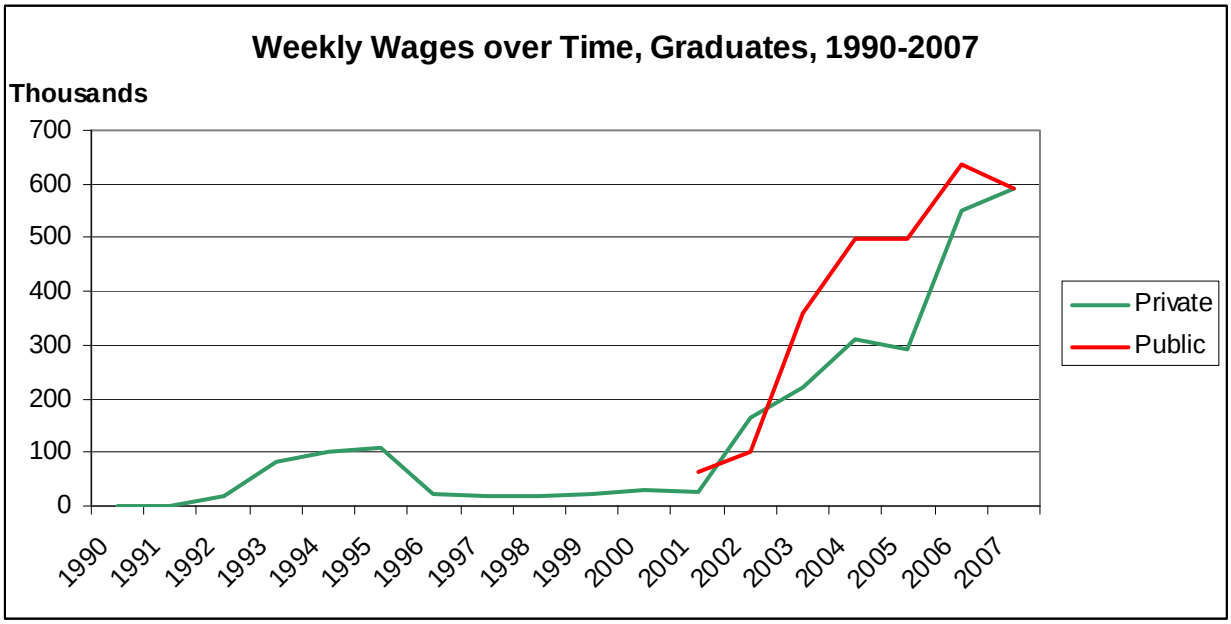

Figure 5-33. Weekly wages over time, graduates, 1990-2007

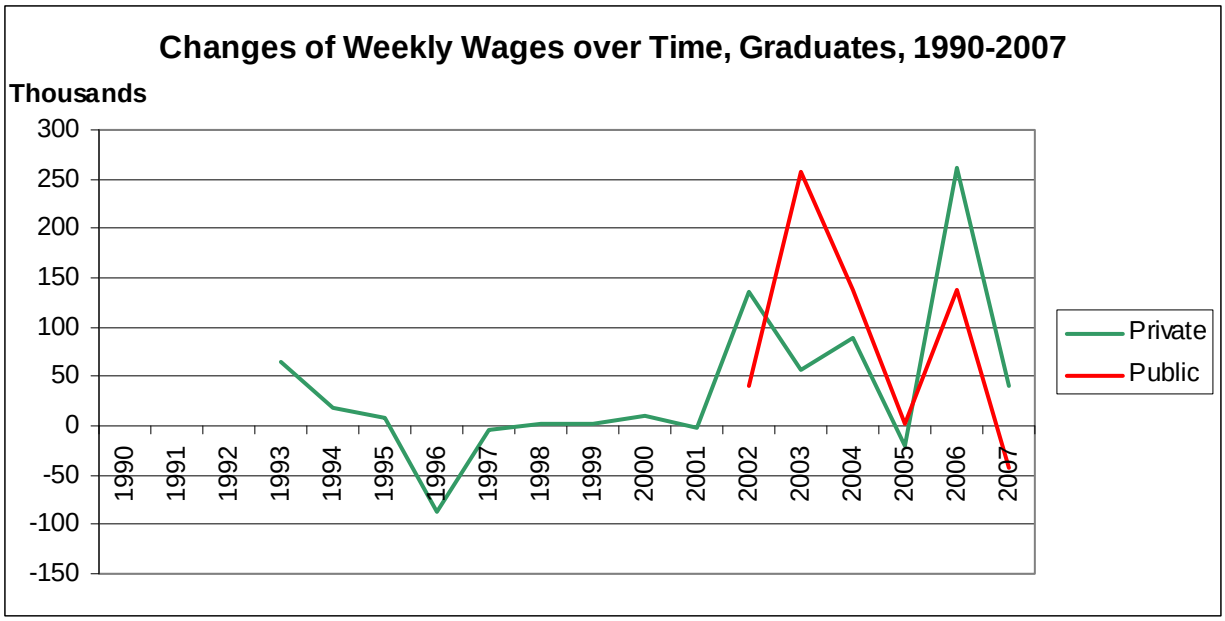

Figure 5-34. Changes of weekly wages over time, graduates, 1990-2007

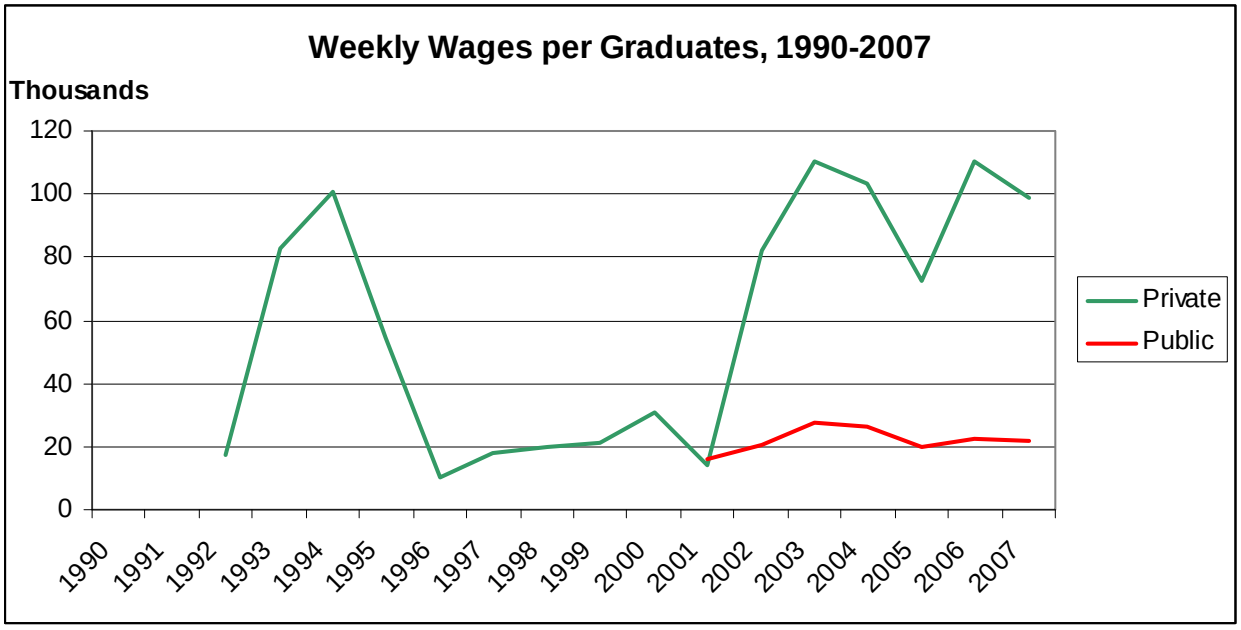

Figure 5-35. Weekly wages per graduates, 1990-2007

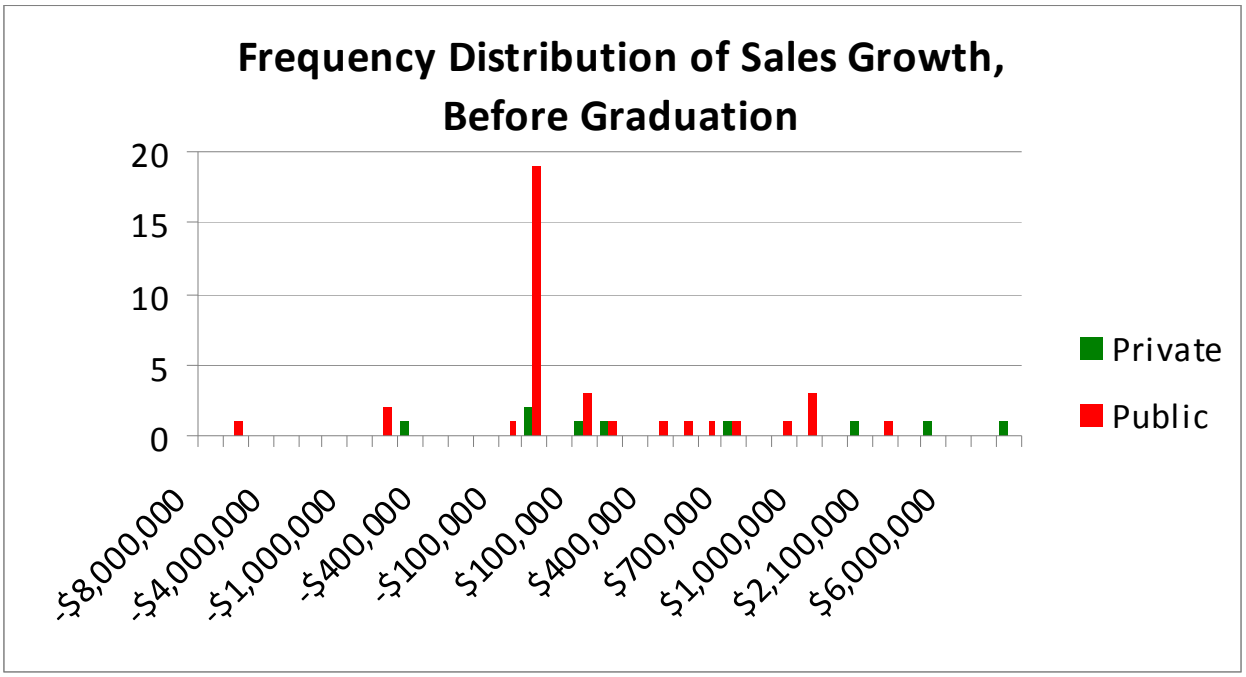

Figure 5-36. Frequency distribution, total wages, before graduation

Table 5-42. Descriptive statistics, sales growth, before graduation

Sales Growth Achieved During the Residency	Incubator GP	Incubator GG
Count	3	36
MAX.	$8,326,100	$2,100,000
MIN.	-$540,000	-$7,815,000
STDEV.	$2,774,295	$1,423,676
Median	$159,800	$0
Mean	$1,389,270	-$36,550

Table 5-43. Mann-Whitney Test results, sales growth, before graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	28.22	115.000	781.000	.180
Public	21.69			

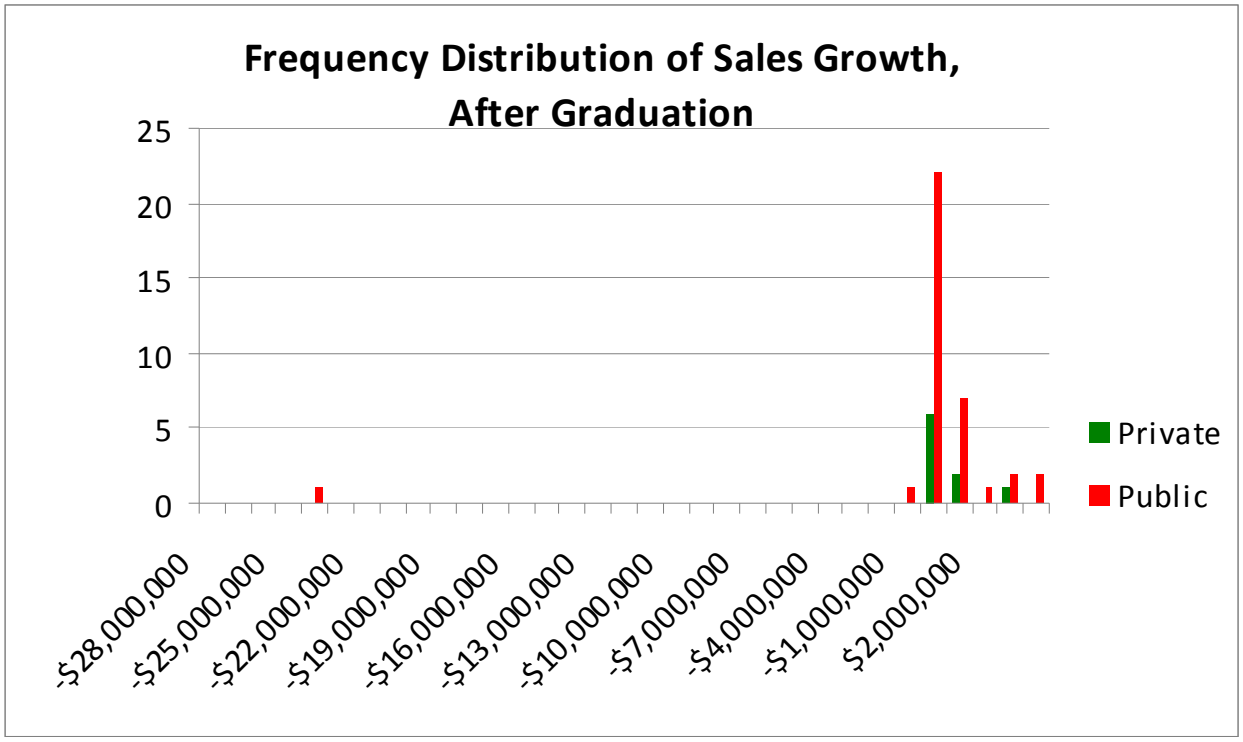

Figure 5-37. Frequency distributions, sales growth, after graduation

Table 5-44. Descriptive statistics, sales growth, after graduation

Sales Growth Achieved During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	$2,745,400	$3,300,000
MIN.	-$136,000	-$24,830,000
STDEV.	$935,505	$4,311,543
Median	$0	-$12,650
Mean	$257,521	-$339,741

Table 5-45. Mann-Whitney Test Results, sales growth, after graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	22.00	153.000	198.000	.798
Public	23.25			

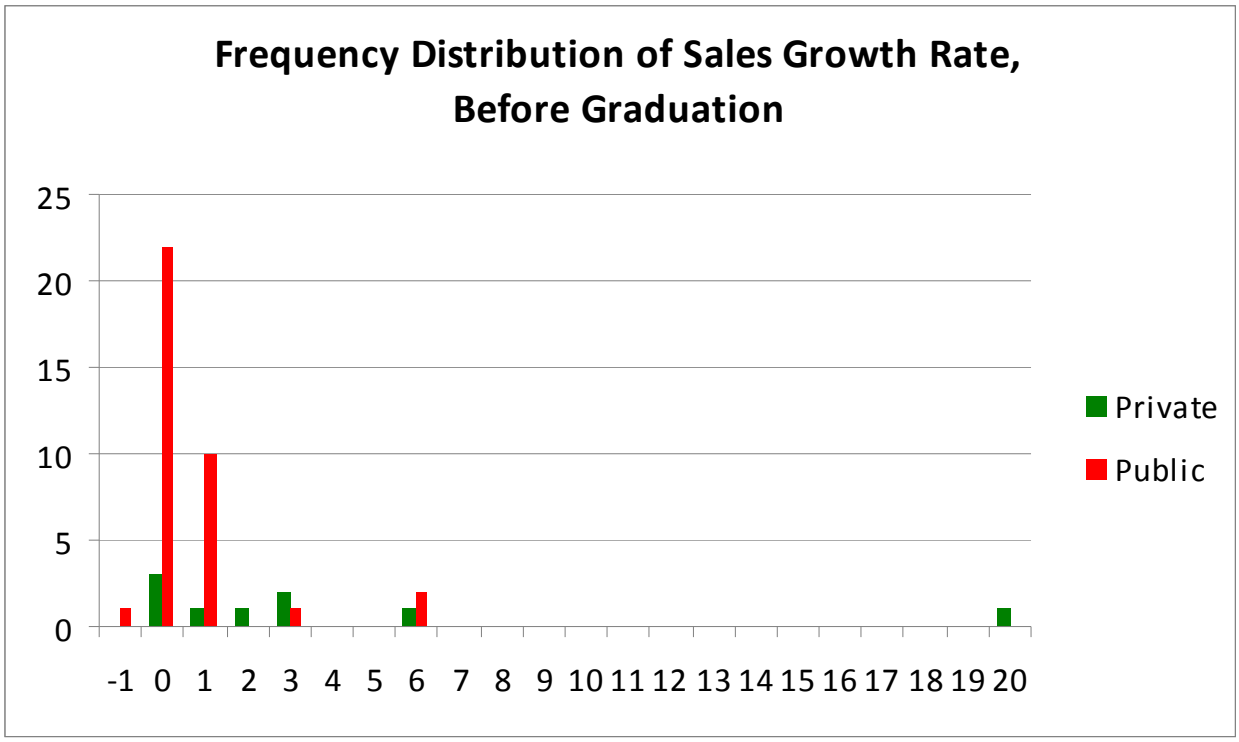

Figure 5-38. Frequency distribution, sales growth rates, before graduation

Table 5-46. Sales growth rates, descriptive statistics, before graduation

Sales Growth Rate Achieved During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	19.642	5.832
MIN.	-0.200	-1.000
STDEV.	6.333	1.356
Median	1.476	0
Mean	3.441	0.491

Table 5-47. Mann-Whitney Test results, sales growth rates, before graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	29.00	108.000	774.000	.123
Public	21.50			

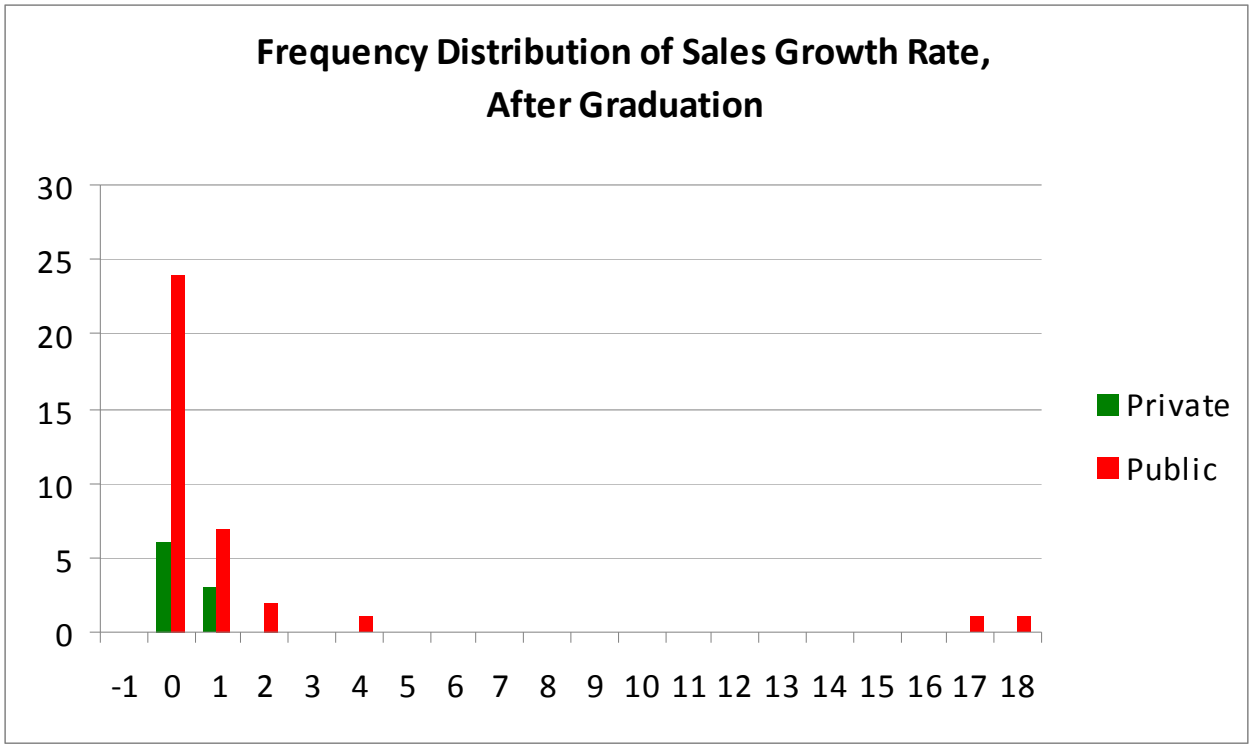

Figure 5-39. Frequency distributions, sales growth rates, after graduation

Table 5-48. Sales growth rates, descriptive statistics, after graduation

Sales Growth Rate Achieved During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	0.314	17.545
MIN.	-0.123	-0.973
STDEV.	0.128	3.994
Median	0	-0.034
Mean	0.004	1.075

Table 5-49. Mann-Whitney Test results, sales growth rates, after graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	24.44	149.000	815.000	.712
Public	22.64			

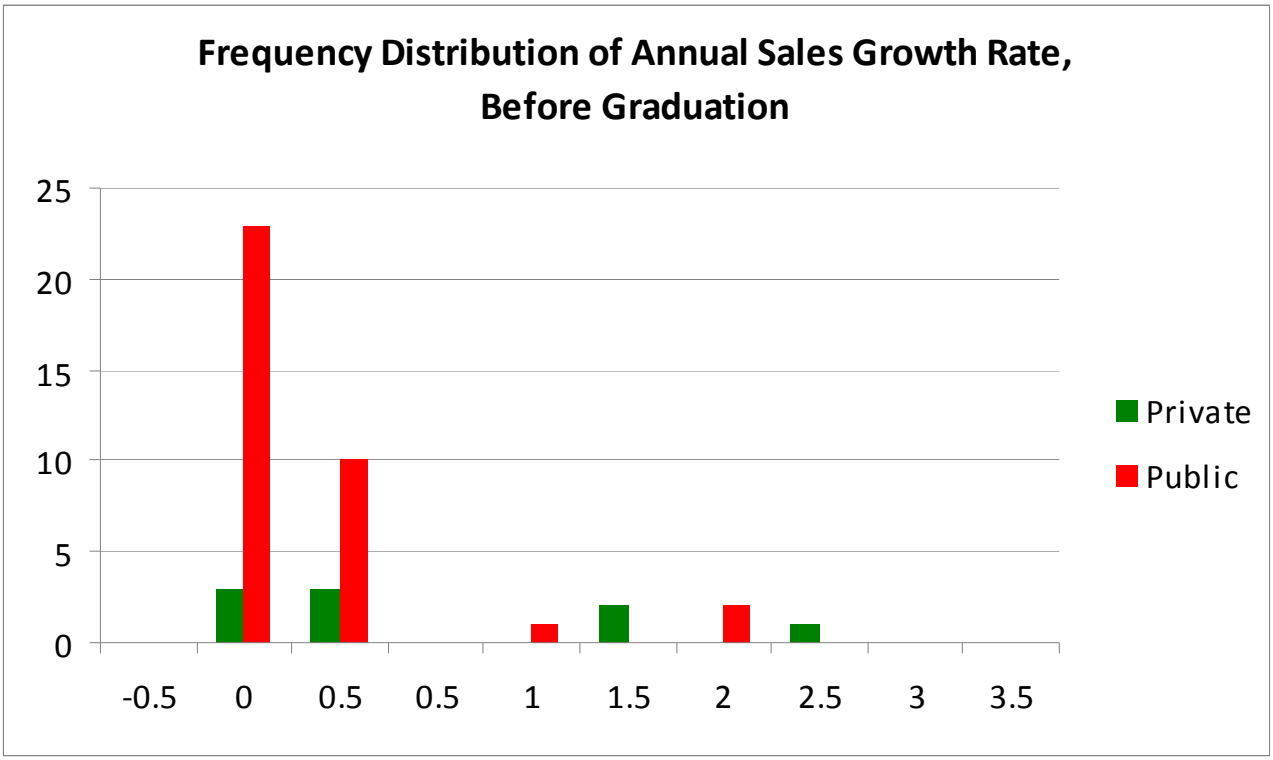

Figure 5-40 Frequency distributions, annual sales growth rates, before graduation

Table 5-50. Annual sales growth rates, descriptive statistics, before graduation

Sales Growth Rate Achieved During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	2.455	1.944
MIN.	-0.040	-0.333
STDEV.	0.853	0.467
Median	0.123	0
Mean	0.571	0.174

Table 5-51.Mann-Whitney Test results, annual sales growth rates, before graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	27.56	121.000	787.000	.242
Public	21.86			

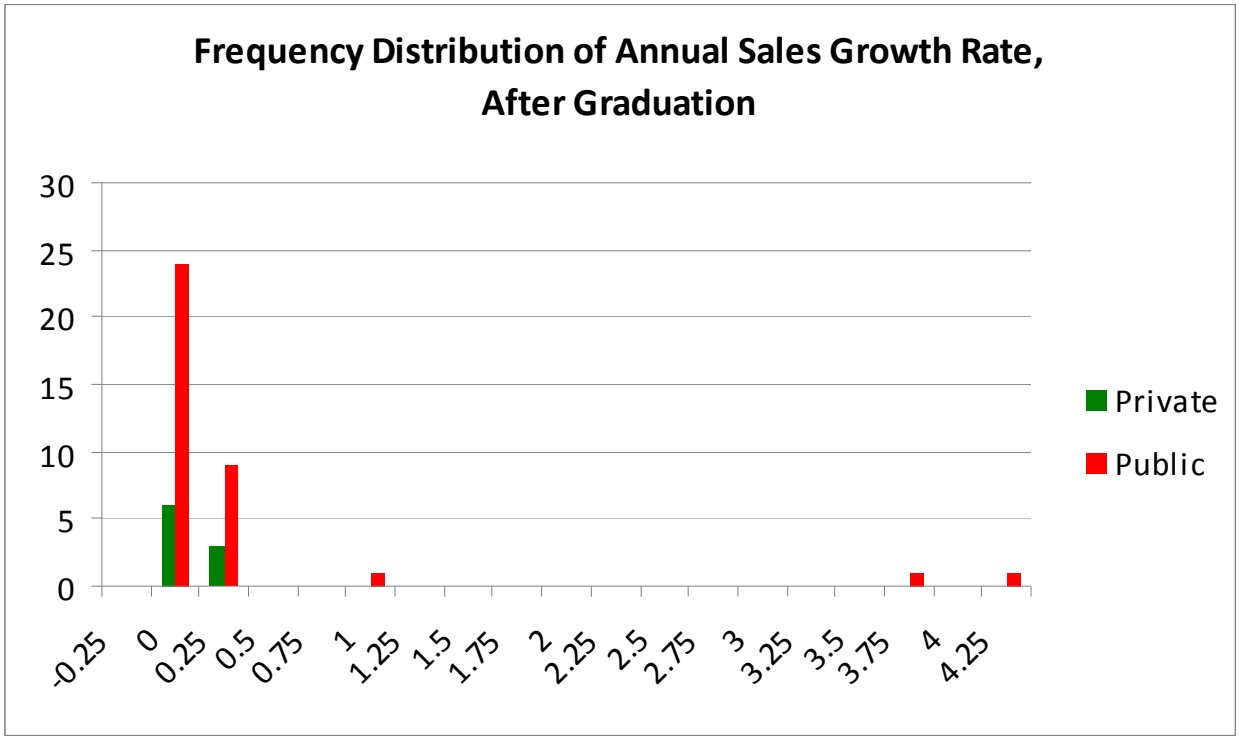

Figure 5-41. Frequency distributions, annual sales growth rates, after graduation

Table 5-52. Annual sales growth rates, descriptive statistics, after graduation

Sales Growth Rate Achieved During the Residency	Incubator GP	Incubator GG
Count	9	36
MAX.	0.045	4.125
MIN.	-0.059	-0.243
STDEV.	0.032	0.902
Median	0	-0.013
Mean	-0.004	0.235

Table 5-53. Mann-Whitney Test results, annual sales growth rates, after graduation

	Mean Rank*	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	24.00	153.000	819.000	.798
Public	22.75			

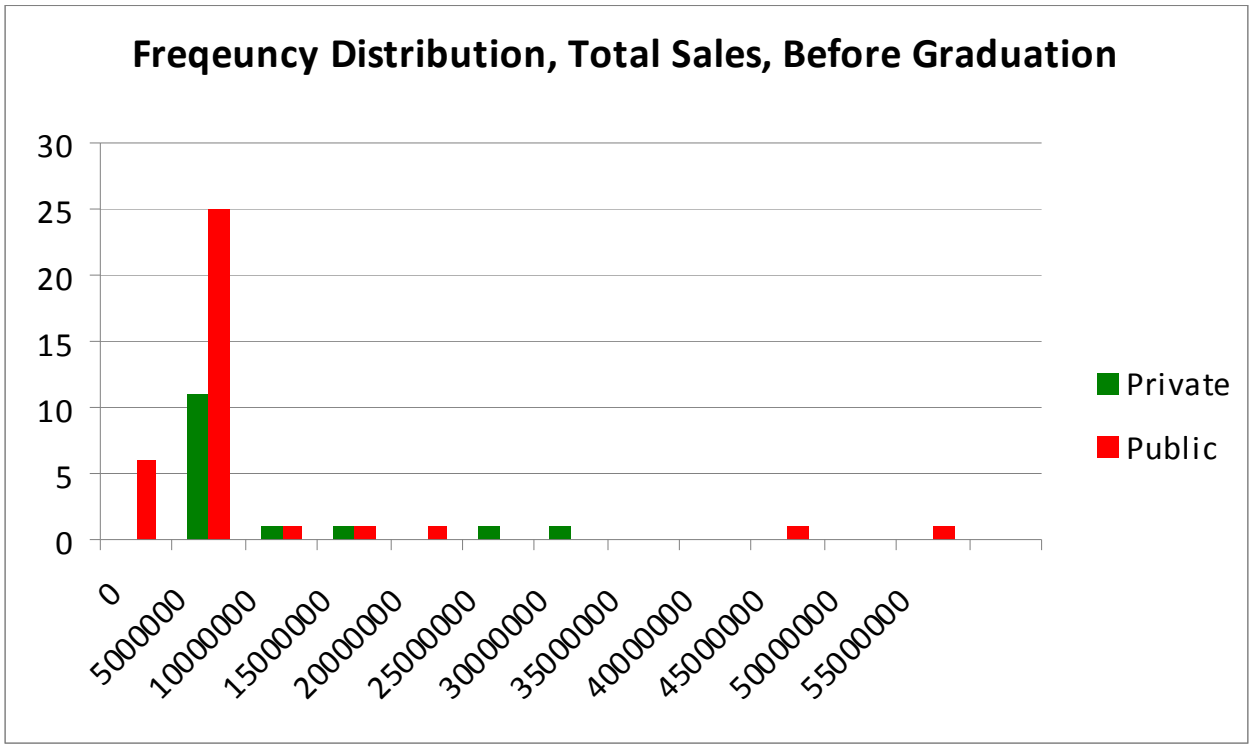

Figure 5-42. Frequency distributions, total sales, before graduation

Table 5-54. Total sales, descriptive statistics, during the residency

Total Sales Produced During the Residency	Private	Public
Total	$106,178,359	$237,721,364
MAX.	$28,779,070	$51,685,000
MIN.	$80,000	$0
STDEV.	$8,638,161.14	$11,040,462.82
MEDIAN	$1,458,900	$1,365,850
AVERAGE	$5,715,693.13	$4,689,955.56

Table 5-55. Mann-Whitney Test results, total sales, before graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	27.73	244.000	910.000	.591
Public	25.28			

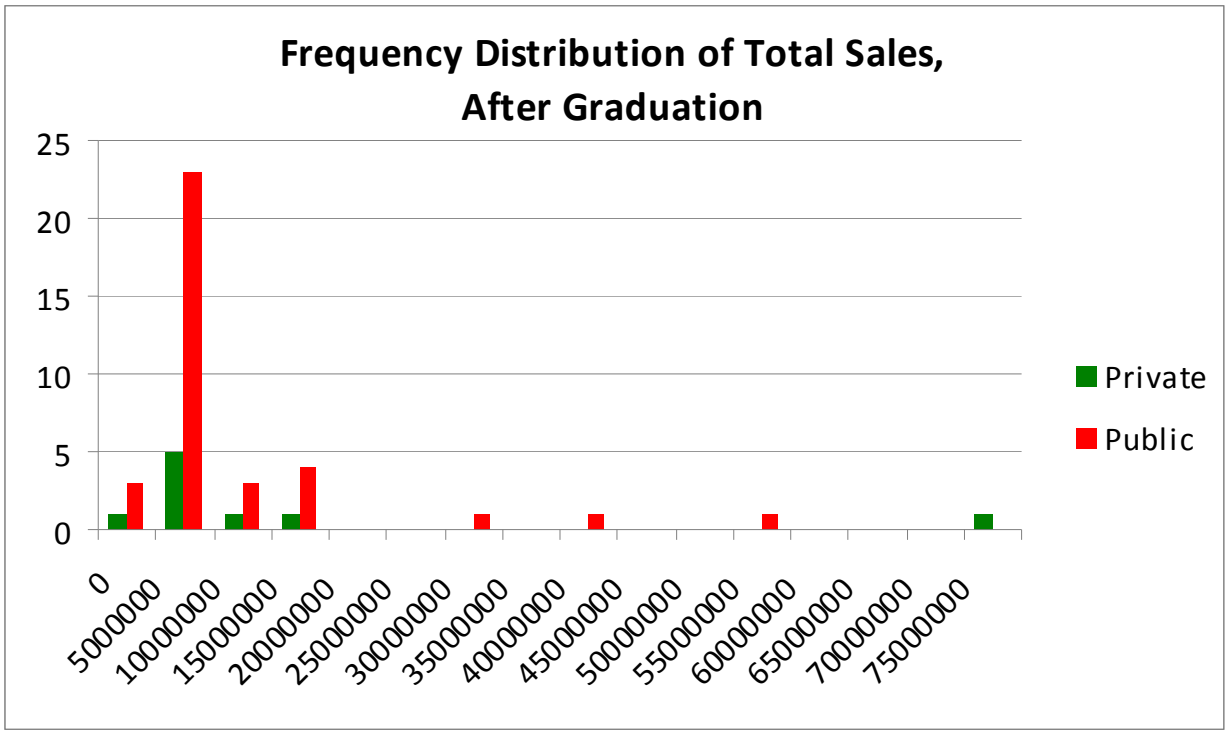

Figure 5-43. Frequency distributions, total sales, after graduation

Table 5-56.Total sales of the public and private incubator, after graduation, 1990-2007

Total Sales Produced After Graduation	Private	Public
Total	$106,178,359	$237,721,364
MAX.	$73,169,707	$52,585,000
MIN.	$0	$0
STDEV.	$23,310,820.96	$11,045,933.91
MEDIAN	$3,908,000	$2,603,007
AVERAGE	$11,797,595.44	$6,603,371.22

Table 5-57. Mann-Whitney Test results, total sales, after graduation

	Mean Rank	Mann-Whitney U	Wilcoxon W	Sig.(2tailed)
Private	25.28	141.500	807.500	.561
Public	22.43			

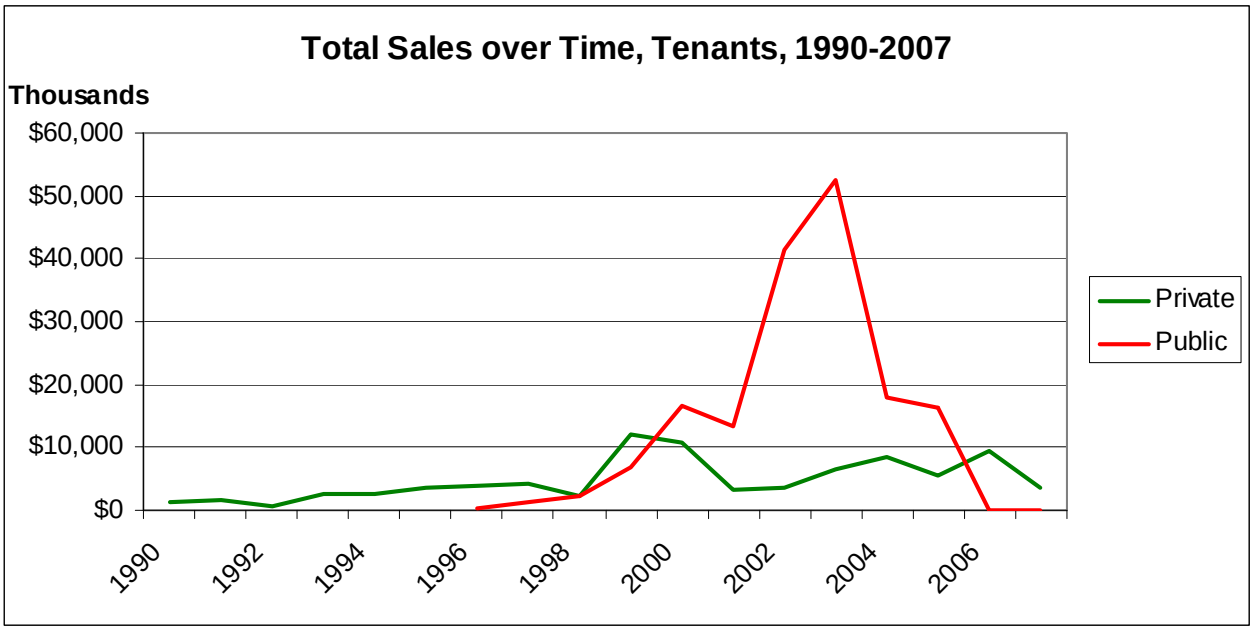

Figure 5-44. Total sales over time, tenants, 1990-2007

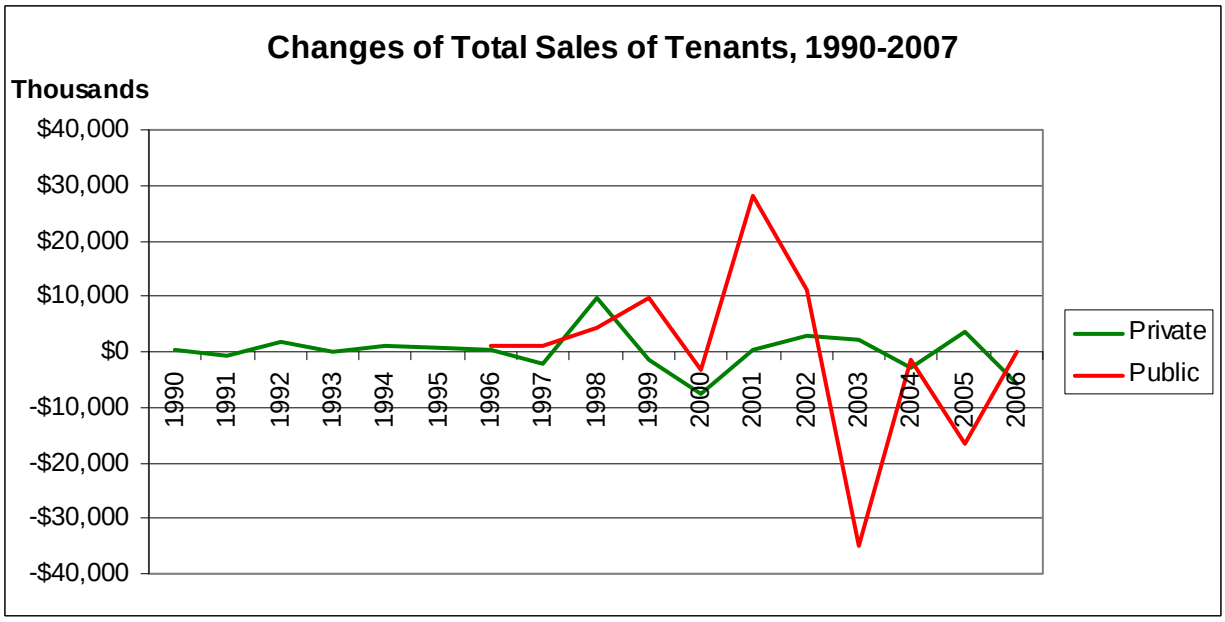

Figure 5-45. Changes of total sales of tenants, 1990-2007

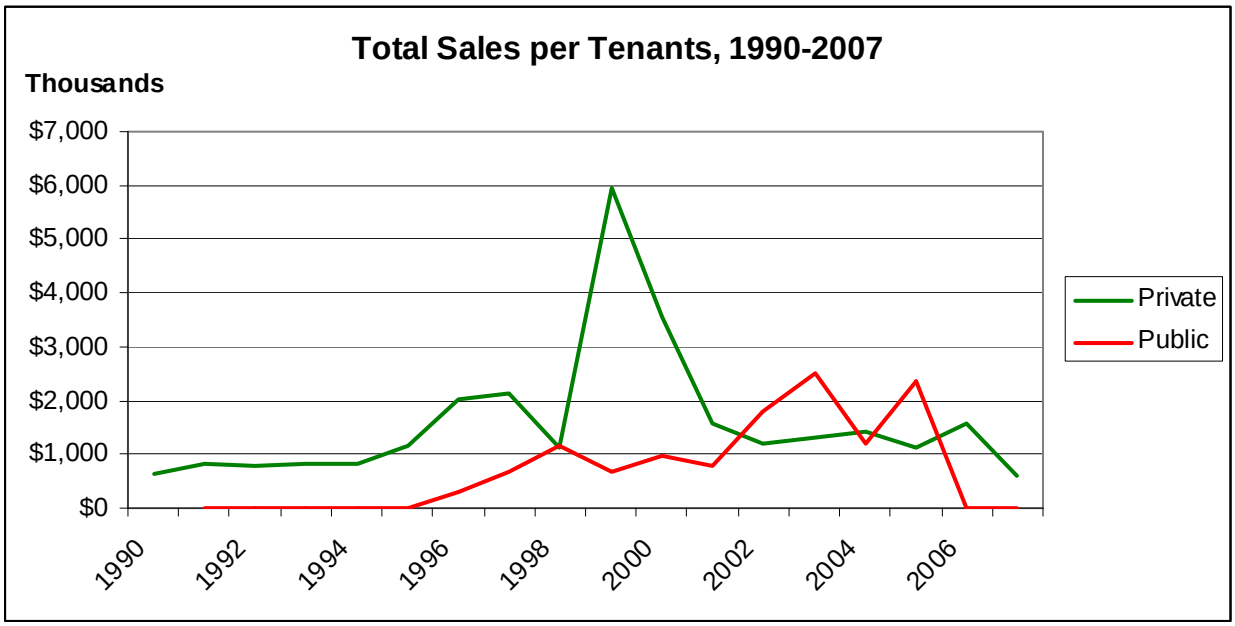

Figure 5-46.Total sales per tenant, 1990-2007

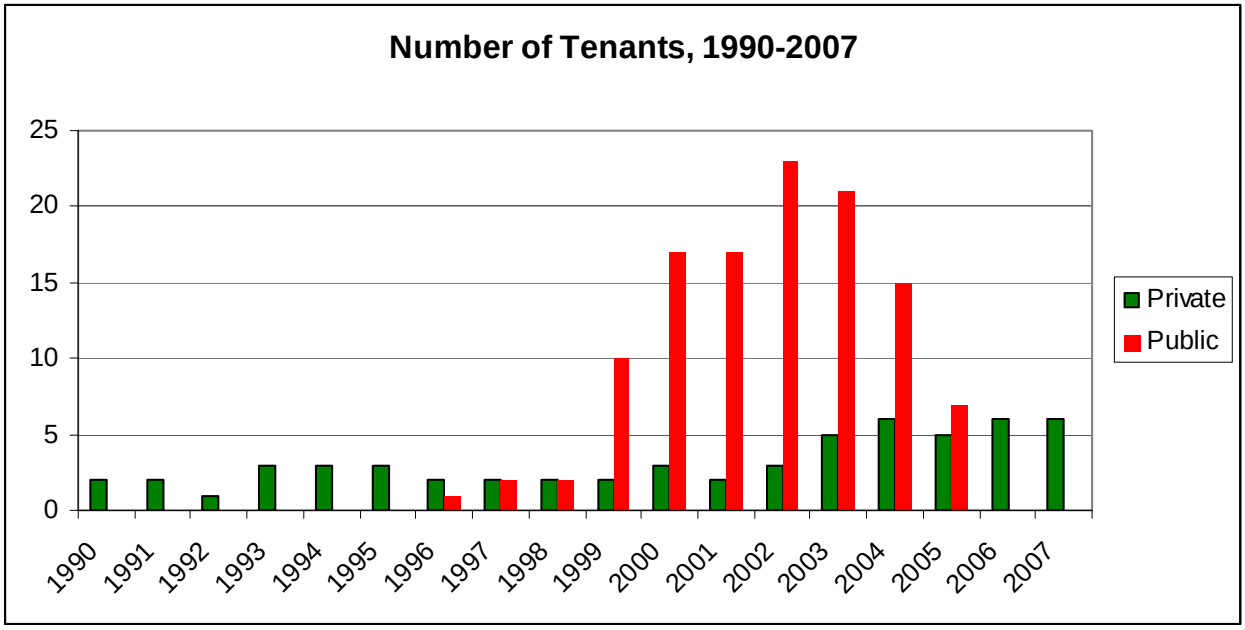

Figure 5-47. Number of tenants, 1990-2007

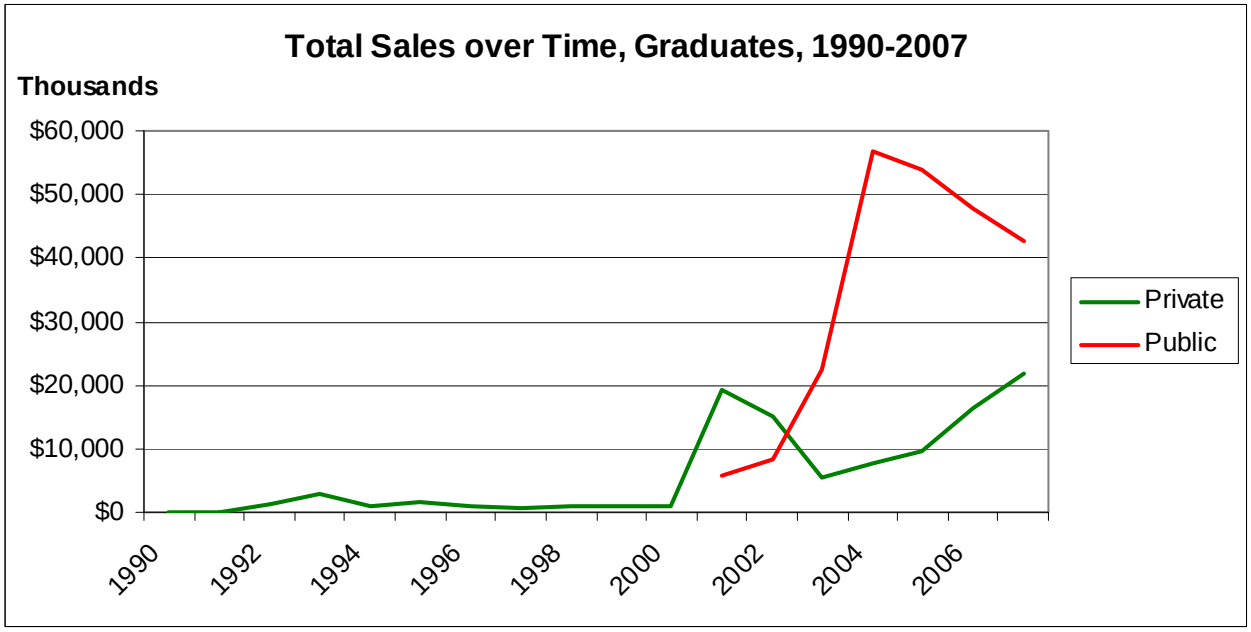

Figure 5-48. Total sales over time, graduates, 1990-2007

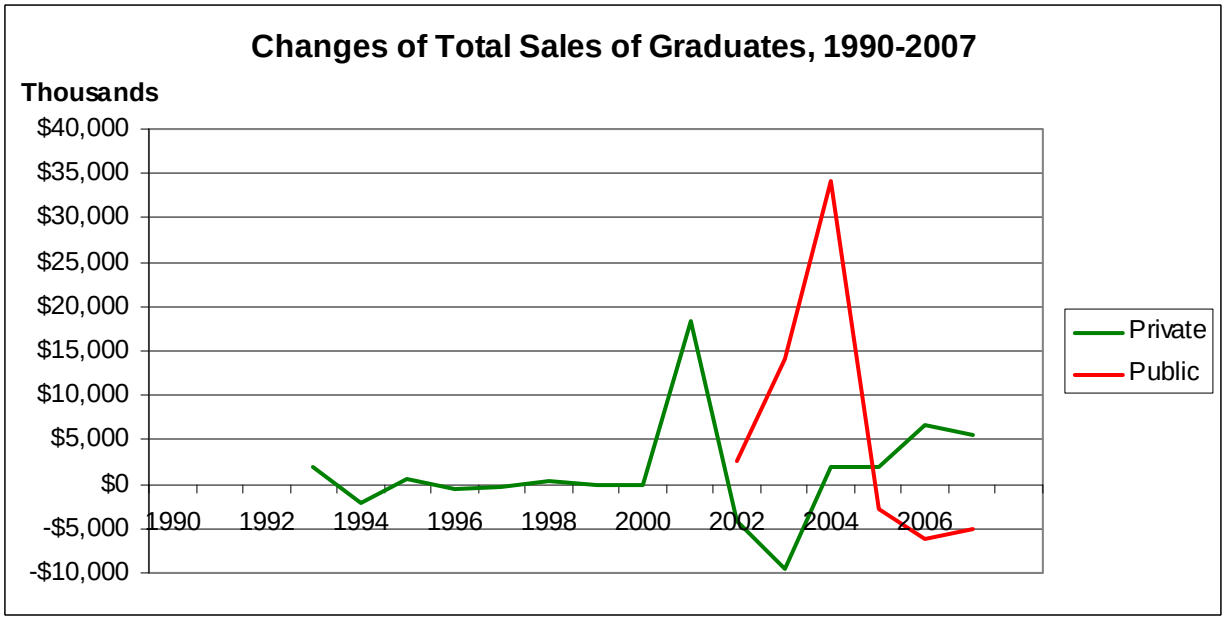

Figure 5-49. Changes of total sales over time, graduates, 1990-2007

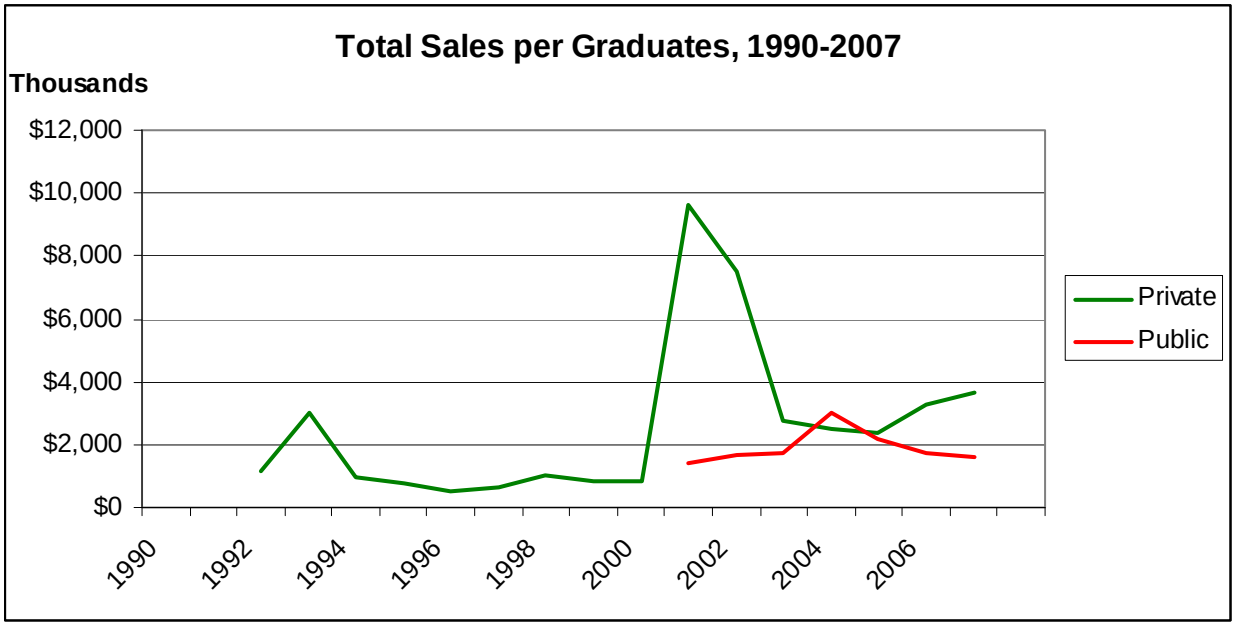

Figure 5-50. Sales per graduates, 1990-2007

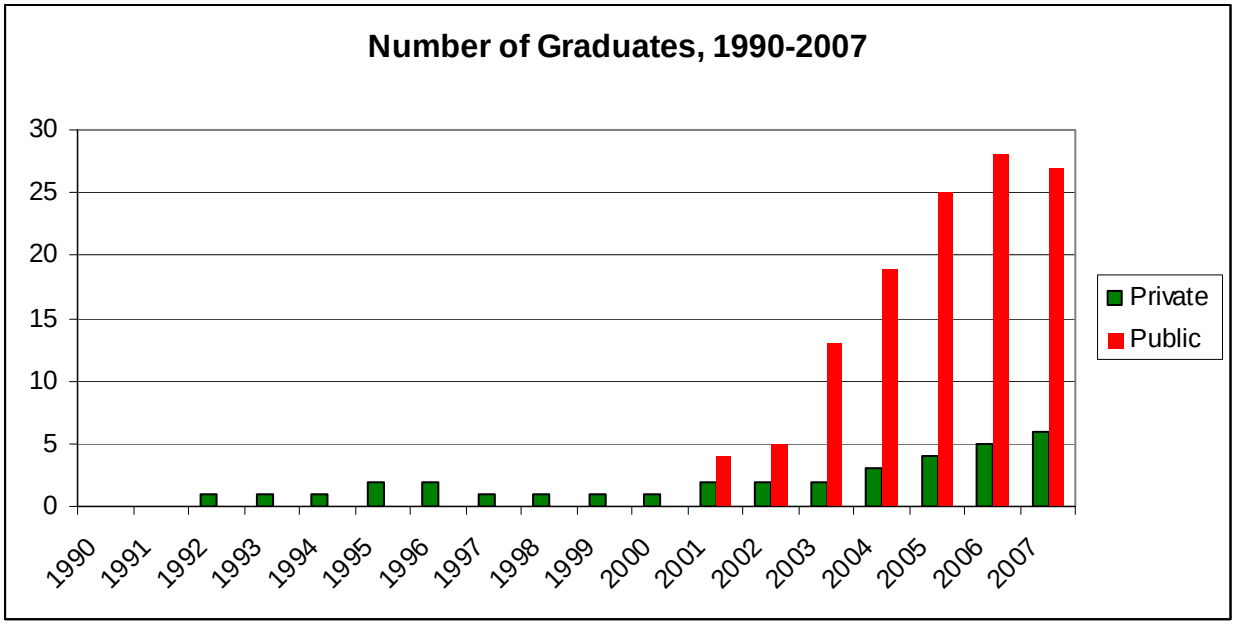

Figure 5-51. Number of graduates, 1990-2007

CHAPTER 6
DISCUSSION AND POLICY IMPLICATION

Discussion

Due to serious methodological difficulties, most of the evaluation studies on LED have remained anecdotal or descriptive, rather than scientific. Evaluation studies are still important since the information produced by these studies is used as a source to influence the status of funding and to set up lists of the necessary amendments. This evaluative study is an attempt to enrich our understanding of incubators that are operated under different sponsorships. Using a comparative framework, this study provides scientific insight into the comparisons of the input side aspect and the outcomes which are potentially affected by the different circumstances constrained by sponsorships. Case studies on the input side aspects focused on three groups of factors that make TBIs work. To investigate the differences between outcomes, this study conducted a comparison using business data from the client groups of two incubators, in which the external correlations with geographic factors were inherently controlled.

The major goal of this research is to investigate whether there is an impact of government intervention on the efficiency of TBI. This study utilized the case study methodology to study the differences between the input side aspects of the incubators sponsored by different organizations; specifically, public non-profit incubators were compared with private for-profit incubators. One private incubator and one public incubator were recruited and studied in order to examine the possible differences in the input side aspects.

The first hypothesis was that differences may be observed in the cost-reduction strategies employed by the incubators. The service provision and managerial strategies of both incubators seemed to be largely predefined, along with the capacities and conditions of the sponsorship. Different directions were chosen, in regards to cost-reduction strategies, in accordance with the

different s economies of scale constrained by sponsorship. The private incubator, working with a tighter budget and a smaller infrastructure, suggests providing clients with sources of funding, recruiting, and technology in order to either save costs or to shorten the lag time for independence. The public incubator, on the other hand, provided large-scale real estate property as a source of cost savings. The difference, which lies in the scale of the capital given to the founders, leads to another difference in managerial approach. The strategy of the private incubator to recoup the investment by taking an equity stake after the client is successful may actually reduce the initial costs for the client: they can save money on rent which they would otherwise have to pay. In addition, these savings can be utilized as investments in sales and production. By requiring rents and fees, the old fashioned approach of the public incubator can reduce expenditures by clients who would otherwise have to pay the market rate.

The second hypothesis was whether the thoroughness of the intervention process may be associated with sponsorship; which can be determined by looking at the selection process, monitoring activities, and graduation policies. As briefly mentioned above, for the private incubator, the selection process implied the choosing of business partners; while the process seems to be to choose program partners for the public incubator. Consequently, the private incubator is strongly motivated to realize the potential of working together to achieve success. The public incubator is also concerned with the potential of being successful. Thoroughness can be witnessed in the standardized selection criteria and process. When the private incubator intervenes in business activities with the aim of helping the client to grow and be successful, it employs informal daily monitoring activities; rather than the formal, periodical ones that can be observed in the public incubator. This difference seems also to be due to the different characteristics of the two sponsors. First of all, the private incubator does not have any

motivation to conduct formal monitoring processes; while the formal monitoring process is required for the public incubator to produce objective evidence to secure continuous support and funding from the public sector. Also, formal monitoring is used as a reference by the incubators to judge the progress of their client businesses. Second, the role of the private incubator as a business partner seems to be a factor that motivates the managers to work closely with their clients. Since they work together as if they were in the same company, the periodical monitoring process may become redundant. On the other hand, the public incubator defines itself as an external assistant that provides corporate style services for its clients and takes on the responsibility of managing the facilities. Since the incubator managers are not involved in the daily operations of their client businesses, periodical monitoring is necessary for them to learn what is going on. Finally, the monitoring processes and graduation policies of both incubators reflect the organizations' goals. The private incubator places less emphasis on job creation, but stresses sales growth. The public incubator, on the other hand, is very concerned with job creation; while it also agrees with the premise that increased employment will follow sales growth.

The third focus of the case study was to examine the different ways that the incubators take advantage of surrounding resources; such as universities, local capital, and other institutions. Hypothetically, this study assumed that the private incubator might have difficulty with getting support from those resources; an assumption which turned out to be correct. Geographically, the private incubator complained about the lack of research universities in the area. Although the incubator continuously reached out for help, it was not readily available. Consequently, lab facilities and student labor were also in high demand. Among these issues, a major difficulty for the private incubator seems to be working with a public sector that is less motivated about

encouraging technology incubator businesses as a tool of local development. The government seems to be preoccupied with the development of physical infrastructure as they believe that this helps a larger number of people. The public incubator obviously seems to have an advantage in this respect: it is itself a government agency, and therefore it is very easy to acquire the support of the public sector. Also, the location of the public incubator in a research park allows greater access to abundant research facilities and human resources. Within this setting, the park, the incubator, the innovative local community, local universities, and the local government are all encouraged to work together.

Based on the assumption that the public sector is more concerned with job creation than the private sector, the fourth hypothesis is that the public sector would generate more jobs than he private sector. None of the measurements of the impact on employment turned out to be statistically significant, however. The premise that the public incubator produces more employment opportunities is not in question. Rather, it seems that the clients of private incubators tend to hire more employees, regardless of whether they show better employment growth or not. Also, the clients of the public incubator are more extensively engaged in the activities of hiring and firing than the public incubator itself. Another interesting finding is that the total number of employees hired by the tenants of the private incubator tends to remain stable. On the other hand, the total number of client companies of the public incubator seemed to have fluctuated throughout their life time. This may mean that the clients of the private incubator are more reluctant to hire or fire employees than the clients of the public incubator. Over the entire period, the number of jobs produced by the private incubator seemed to be larger, even though they might have been more cautious with expanding their employment opportunities.

The fifth hypothesis was that the private incubator may be better at wage creation. Both incubator companies showed positive increases in weekly wages. However, the private incubator tended to be better at increasing wages; while clients of the public incubator tended to pay higher wages to only a few people, resulting in a moderate overall increase. Another interesting finding is that the private incubator showed higher wage growth rate, without statistical significance, when clients were in the incubator. However, after graduating from the incubator, clients of the public incubator tended to expand faster; a pattern which was accompanied by greater annual wage growth rate. Although higher wages overall should not necessarily be interpreted as positive growth, in that it is also sensitive to changes in the number of employees; it is a good indicator of the degree of contribution to the local economy. Also, in reality, it is hard to change program capacities given to sponsors, as in a hypothetical situation. First, higher wages imply a positive contribution to improving the level of income. Second, higher wages also mean that companies have increased local tax revenues, in that the wage eventually returns as income tax. Third, higher wages are likely to stimulate the circulation of wealth within the local area. One possible application is that industries with higher wages may have a greater multiplier effect than industries with lower wages. This may lead to the formulation of local capital stocks that are another potential source of stimulation for further development.

The last hypothesis is whether the incubator in the private sector would produce more sales revenue. This was only moderately supported. The difference was explicit, especially while the clients were in the facility. It became less explicit after they graduated from the incubators. Greater sales growth during the residency was observed from clients of the private incubator. Changes in the total amount of sales effectively illustrate the quantified implication of the economic contribution. Better sales growth, in terms of the number of dollars, reappeared in the

analysis of growth rate that accounted for the sales revenue of the initial year. During the residency, sales growth rates of the Incubator P once again turned out to be superior that of the Incubator G. In summary, clients of companies produce more sales than clients of public incubators; and they also grew faster than the clients of the public incubator while they were in the incubator. However, this analysis does not account for the length of the residency. It may imply, nevertheless, that the private incubator is unlikely to release clients until their success has been fully confirmed. The growth pattern during the post-graduation period did not appear to significantly differ in any measure.

Policy Implications

Input Side Aspects

Cost-reduction strategies

In regards to the input side aspect, the private sector can complain about the lack of physical infrastructure, especially space for offices and laboratories. The public sector, on the other hand, might develop a program that connects this demand with local supply, including surplus real estate and research facilities. The public sector should, however, be patient while waiting for the benefits to be realized; as the profits from technology businesses are often produced over the long term.

The public sector might also improve access to venture capital. One way seems to be making public funding available for private venture capitalists, either with very low interest rates, or with a very long period of return, as a means of sharing the risk of investment of early stages.

The last suggestion is to copy the business model observed in the private incubator: recouping benefits in the long term. Intuitively, matching skills and expertise is very important for the success of an incubator. The public sector may consider refining the selection process to include this principle. Basically, client companies can receive the service in the early stages

nearly free of charge. This strategy may improve the motivation of managers since it ties the destiny of the incubator to the success of the clients. This may also offset the chronic problem of the public sector being accused of being a less efficient provider; while improving the autonomy of the incubator program by making profits from client businesses. Finally, government's becoming an equity holder would mitigate political resistance to the program, in that the program would generate profits for the investor, namely the government. If the public sector incubator could promote the intellectual property developed by universities or other third parties, this could also be an effective method for the commercialization of technology. As a matter of fact, this strategy is better suited for the public incubator in that it requires a great amount of money in reserve. If that money is available, and a public incubator is not present in the area, that money could help a private incubator to stabilize during the early stages of development until the incubator makes a profit later on.

Intervention mechanism

One of the important findings is that the public sector realizes that employment growth follows sales growth. Seemingly, the public sector does not push client companies to hire more people or increase the number of jobs as evidence of progress or proof of graduation. It is likely that many public sector incubators have already moved on to become a hybrid type of incubator. These alternatives are employed to integrate managerial and technological expertise from the public sector. However, a private agent may feel redundant while working with the public sector because of the limitations. During the pilot study, some interviewees complained about the difficulties of working with public managers that request formal reports in a bureaucratic manner. To a certain degree, political pressure that requires proof of progress or investment is the reason that these processes are very formal and strict. One suggestion is again that the public sector may have to stay back and be run autonomously. Again, for government, becoming an equity

holder seems to be an answer here, in that it binds the destinies of managers and clients together; while also partially freeing the managers from public subsidies that are an essential condition for the managers to be more responsive.

Surrounding resources

In addition, the old premise that stresses the importance of regional networks of innovation is reaffirmed. The subject private incubator seems to be isolated from this type of network, and therefore is having a hard time establishing itself, although it is a member of Florida Business Incubator Association. On the other hand, the public incubator is surrounded by abundant resources. In the case of Maryland, the private incubator is seemingly included as a member of the local community of innovators. In any case, the local or regional community should make an effort to be a source of knowledge and institutional support which all of the members could easily access. The public sector agent may find a leading role by making the provision of these networking activities one of their responsibilities.

Efficiencies in Outcomes

Another interesting observation of this study is that the initial scale of businesses may have a strong correlation with the rate of growth. As widely accepted, bigger companies tend to be sluggish. Should private incubators then be more supportive of the smaller companies since they tend to grow faster? This may be a political decision. Serving larger companies, including the NTBFs, would obviously generate a greater impact in terms of quantity, although with slower growth. If the public sector wants to increase the magnitude of the economic impact, larger firms may serve to achieve this goal. On the other hand, such a policy would result in reducing the chances for smaller companies to receive incubator services, since private incubators do not have special motivation to serve small firms only for their fast marginal growth when the gross return is relatively small. If the public sector wanted to demonstrate fast growth (obviously political

pressure is likely to force them to prove fast growth as evidence of support) so that they decided to offer more chances to smaller companies among the NTBF; the public sector incubator would have a smaller impact on the economy of the local area. One question is whether serving micro companies is in the public interest. If this is not the case, the public sector should consider an expansion of the TBIs to enlarge the service capacity. One attractive approach is increasing the number of branches which are networked together in order to serve different technology segments, rather than building a larger site that can host many clients at one location.

Other Implications

Research Implications

Most of the findings of this study reaffirm the findings of existing studies (e.g., this study observed more efficient sales increase from private agents). One challenging finding of this study, however, is the validity of the existing paradigm for the research framework. The existing paradigm for the study framework is justified under an assumption that measuring efficiency is a valid approach for evaluative study; i.e., comparative superiority of unit productivity indicates betterment in performance. However, the assumption of this approach is only valid when the two subject agents, for instance, private incubators and public incubators, have the equivalent chance to start a technology business incubator when none are currently available in a market. One question is whether researchers can validly assume that private agents could indeed jump in the technology incubator business if public agents withdraw from the program. Realistically, this is very unlikely based on the large amount of capital that is required to establish and operate a business. For this reason, a private incubator may be more productive, but this finding may not necessarily justify a withdrawal by the public sector due to the relatively small likelihood for a private technology incubator to take over the business. In this sense, counting only on efficiency may dismiss the realistic implication that a private agent is less likely to engage in the business.

One alternative perspective is to revisit the implication of the magnitude of impact rather than focusing only on efficiency. This research incorporated investigations of the magnitude of impact by measuring growth of sales, wages, and employment. The magnitude of impact is measured in terms of quantity rather than unit change, which is usually employed to indicate efficiency. One justification for the use of this approach is that it considers the reality that the capital capacity of the public sector cannot be easily obtained by private agents. Moreover, this study indicated some inconsistency between the measurement of magnitude and the measurement of efficiency, which may imply that counting only on proportional growth may not fully deliver the actual meaning of a technology business incubator to a region. In other words, when public agencies show stronger magnitude, even if they show relatively poor efficiency, the public sector may still have reason to continue the technology business incubator program. If so, evaluative research also has reason to revisit the implication of the program's impact.

Implications for Public Finance

Another finding of this research, which reinforces an existing perspective, is that technology incubators are not very good producers of jobs, but they are likely to increase local tax revenue. From the perspective of public finance, one concern derived from this finding is identifying who should then bear the cost to operate this costly program. Obviously, local tax payers ideally should not burden the cost since the benefit of the program to the region seems to be limited in terms of job generation. Poor job generation is also listed as a reason why the local government of one of the subject technology business incubators of this study was not very motivated. Also, the benefit returns in the long run further justify shifting the cost to the upper tier government rather than the local government because upper tier governments are usually more efficient in terms of utilizing long term investments. However, this approach may be undesirable if a state or national government takes initiative for the program. Thus, good

coordination is required between the local and upper tier governments in terms of cost and planning.

Role of Upper Tier Government

Another reason to stress active roles for regional or state governments is that the success of the TBI program hinges on the quality and quantity of surrounding resources, which may vary over regions. The local government may be motivated to host a technology business incubator when large amounts of financial support are proposed from a central government. In this situation, as competition among local governments becomes stronger, regional suitability may be disregarded. In addition to acting in the role of financial supporter, the central government should actively coordinate the program in order to deploy programs to regions that have abundant resources such that a TBI program is likely to prosper.

CHAPTER 7
CONCLUSION

This research was undertaken to respond to a policy question: whether the public sector should withdraw financial support from the technology business incubators. Critics have argued that the TBIs in the public sector are not as efficient as the private agents. However, little is known about the structure and operation of these two different types, or the actual impact of any differences. This study has tried to fill the gap in knowledge. To answer the question, this research attempted to observe differences in (1) the input side aspect of incubators by different sponsors, and (2) the outcomes of the two types of incubators.

The differences in the input side aspect were well observed, as hypothesized. In regards to the differences in the input side aspect, the differences in the status and capacity of the resources provided to each sponsor may drive the differences in services and strategies. Private incubators are likely to suffer from limited resources and capacities, but are also likely to respond to these challenges with a more flexible approach. Another factor that creates these differences is the limited sources of capital which forces private incubators to narrow down the range of target businesses to only those matching their skills and expertise.

Based on the findings about primary performance outcomes observed from every possible angle, none of the type of the two sponsorships dominates in terms of efficiency, while several differences are observed. The only hypothesis reaffirmed by this research is that private incubators may be better at producing sales revenue. However, public incubators seem to offset the productivity issue with larger capacities. Neither does the evidence support the simple argument that the public sector should withdraw from the TBIs, or regard public TBIs as being superior to the private ones. Rather, the findings imply that the old fashioned private-public framework might not be appropriate for this subject.

An alternative perspective based on the findings is that the roles of TBIs may need to be diversified. The public sector may find an active role in utilizing large-scale capital. Obviously, a large amount of capital is useful in securing an incubator's self-reliance. It also means that the public sector may step back from operating tasks for the TBIs, as the private sector may respond to the market dynamics more effectively.

The only shortcoming of this research is that it shies away from investigating the correlation between inputs and outcomes, thus making for relatively poor predictability. This is largely due to methodological limitations, and the fact that the number of cases was very low, while the number of variables was considerable.

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BIOGRAPHICAL SKETCH

Yongseok Jang started his academic career with earning Bachelor of Arts in. political science at Inha University in Korea. During his undergraduate work, he was honored two consecutive times. After he finished his military service in Korean Army, he resumed his academic career in political science at University of Florida since 2001. Starting doctoral work in urban and regional planning at year 2004, his new life has continued his dedication to social issues, by specializing economic development (2004-2009). He has been married for 8 years and he is a father of one daughter; Grace, age 6 and one son; Timothy, age 3