MARYLAND INCUBATOR IMPACT ANALYSIS

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Contents

I. Executive Summary

The Maryland Technology Development Corporation (TEDCO) contracted with RESI to evaluate the economic performance of six Maryland incubators. These incubators include the Technology Advancement Program located in College Park, the Technical Innovation Center located in Hagerstown, the UMBC Technology Center located in Baltimore, the Maryland Technology Development Center located in Rockville, the Emerging Technology Center located in Baltimore City, and the NeoTech Incubator located in Columbia. The objective of the analysis is to estimate the combined economic impact of these six incubators by taking into account the economic impacts of firms that are being served or have been served by one of the incubators under consideration.

The study was initiated in December 2000. To conduct the evaluation, RESI disseminated surveys to 125 incubator tenants and graduates. The survey instrument was designed to elicit responses regarding past and current levels of employment, revenues, and expenditures. The responses form the basis of the evaluation.

When analyzing the survey responses, RESI employed three different approaches. The goal in employing three distinct methods was to yield a range of outcomes. Each methodology considers a different universe of firms. The first approach considered survey respondents only. The second method utilized survey respondent averages and extrapolated these figures to the balance of non-respondent firms. The final approach is similar to the second. Survey respondent averages were calculated using a "trimmed mean" which dampens the effects of extreme responses by considering only the middle 50% of responses when calculating the mean values.

The second step involves the use of a macroeconomic input-output model to evaluate survey results. Literature on incubator evaluations reveal macroeconomic analysis to be most effective in determining the total economic impact of incubators.[1] RESI utilized an IMPLAN model to complete this stage of the analysis.

The model calculates direct, indirect and induced economic impacts to determine the total employment, revenues and fiscal effects of the incubators. The direct economic impacts are generated as new business create jobs and hire workers to fill new positions. The indirect economic impacts are caused as the new firms purchase goods and services from other firms. In either case, increases in employment generate an increase in household income as new job opportunities are created and incomes rise. This enhanced income drives the induced economic impact that results from households increasing their purchases at local businesses. In sum, the model allows economists to measure the full impact of incubator firms by quantifying the impacts of start-up firms.

[1] Chappell and Sherman, p. 10.

Prior evaluations of incubator impacts reveal that the types or classifications of incubators being studied are crucial when analyzing survey results. Incubators vary by type and purpose. Incubators aimed at empowering or revitalizing a neighborhood will have a far different impact on local economies than a for-profit, technology incubator.

According to a recent NBIA study, survey results should be stratified into their particular incubator classification before analysis takes place.[2] All six incubators considered in this analysis classify themselves as "technology" incubators. Thus, for the purpose of this study, the only stratification of data necessary for the analysis involved the desegregation of results into current and graduate incubator firm categories.

Survey results indicate that both current and graduate incubators are heavily concentrated in the Biotechnology sector. According to the first two of RESI's approaches utilized in this analysis, the average current incubator firm size in terms of employment has increased from 4 employees in 1998 to 6 employees in 2000. The third approach shows similar growth from 2 employees in 1998 to 6 employees in 2000. The first two approaches reveal that average firm size among graduate incubator firms has remained relatively steady at 70 employees. The third approach reveals that average employment growth among graduate firms has grown from 13 to 38 employees over the same time period. On average, current incubator firms generate between $240,000 and $400,000 in annual revenues while graduate incubator firms generate between $4 and $7.5 million in revenues.

Through the multiplier effect, the six Maryland incubators under consideration in this study had a total economic impact ranging from roughly 2,200 to 6,800 jobs, paying over $36,000 on average in 2000. This compares to the average annual wage in Maryland of $35,000.[3] Moreover, incubator firms generate between $184 and $530 million dollars in gross state product and between $31 and $96 million dollars in taxes annually.

This analysis also attempts to calculate the value of the combined services provided by the six incubators considered in the study and the economic impact (in terms of annual gross state product, personal income and taxes). To accomplish this, RESI utilized three distinct methodologies to produce a range of results. The resulting 2000 economic impact of the services provided for tenant firms, in terms of gross state product, ranging from three to ten percent of total economic impact generated by the individual incubator firms. The corresponding percentages attributable to the impact of services provided to graduate firms range from less than one percent to roughly four percent. Significant impacts were derived for both personal income and tax receipts attributable to the incubators as well.

[2] Molnar and Grimes, p. 23.

[3] These average figures would be significantly higher were it not for the substantial number of retail and service sector jobs created indirectly by the six Maryland incubators under consideration. Further weighing down wages, is the fact that a significant number of entrepreneurs starting incubated firms work for no or very low wages while the company is in it's infancy and new hires at these firms sometimes are given stock to supplement wages.

II. Introduction

A. Problem Statement / Purpose of Analysis

The purpose of this analysis is to estimate the total economic benefits generated by six Maryland incubators. The incubators under consideration include the Technology Advancement Program, the Technology Innovation Center, the UMBC Technology Center, the Maryland Technology Development Center, the Emerging Technology Center and the NeoTech Incubator.

III. Overview

A. Defining Incubators

Small businesses (i.e., firms with fewer than 500 employees) are vital to the nation's economic strength. These firms employ the majority of U.S. workers and develop the preponderance of process, product and service innovation that takes place in the business world. Small businesses, however, are characterized by a marked tendency to fail within their initial years of operation. According to the Small Business Administration's Office of Advocacy, nearly 53 percent of all firms dropped out of the economy during their first four years of existence.[4]

Contemporary incubators evolved from an appreciation of the economic benefits generated by these smaller firms. In 1980 less than 13 incubators were open in the U.S. By the end of the decade this number grew to an estimated 400 to 500 incubators. Estimates of the number of incubators currently operating in the United States range from 600 to 750.[5]

Incubators are regional economic development tools that offer start-up firms and other newly formed enterprises numerous tangible and intangible benefits in an effort to foster growth among these firms. Tangible services provided by many incubators include lower operating costs through the provision of flexible, sub-market rental space and shared administrative services. Intangible benefits include services such as moral support, networking opportunities and access to advice and information.

A 1998 National Business Incubation Association, (NBIA), study identified the following as progenitors of today's incubators.

Batavia Industrial Center (1959),
University City Science Center (1963),

[4] Chappell and Sherman, p. 1.
[5] Chappell and Sherman, p. 1.

Utah Innovation Center,
Control Data BTC (1979),
Rensselaer Polytechnic Institute Incubation Center (1980),
Advanced technology Development Center, *and*
Fulton Carroll Center for Industry (1980).

Several categories of incubators exist. According to McKinnon and Hayhow, incubators may be classified into the following types: (a) mixed use (b) manufacturing (c) technology (d) service and (e) empowerment and (f) targeted. Though all incubators may provide similar services, each has it's own clientele and goals.[6]

Mixed use incubators support firms from a variety of different industry segments. Firms in these incubators do not fall into a single industry niche. Manufacturing, technology and service incubators on the other hand, focus exclusively on firms classified within the manufacturing, services and technology sectors. Targeted incubators are defined as incubators that focus exclusively on an industry niche such as retail. Empowerment incubators (also known as microenterprise incubators) concentrate on firms in economically distressed areas with the goal of stimulating local economic activity.

B. Maryland's Incubators

All six incubators studied in this analysis are technology-oriented incubators. The industry focuses of these incubators range from information technology to biotechnology to software services. At least three of the incubators receive state funding: UMBC, TAP and the MTDC incubators.[7] According to a 1998 survey distributed by Claggett Wolfe Associates, the following are benefits associated with at least four of these six incubators: access to debt financing (private and public), access to venture capital and to Angel investors, shared-use office equipment, links to SBDC, expert technical advice, access to academic resource network and access to programs facilitating product commercialization.[8] The following section provides a brief overview of each of the incubators under consideration in this study.

(A) Technology Advancement Program (TAP)

The Technology Advancement Program (TAP) was founded in 1984 as a program of the Engineering Research Center of the University of Maryland in College Park. The center focuses on technology firms with commercial potential ranging from biotechnology and information technology to aerospace.[9]

(B) Maryland Technology Development Center (MTDC)

MTDC is a 52,000 square foot building constructed in 1999 in Rockville, Montgomery County. It offers 24 modular wet laboratories for biotechnology businesses, and 15,000-sqare-feet of space for IT businesses. Upon the completion of MTDC in January 1999, Montgomery County closed its first IT incubator (MCTEC) that the County established in 1994, and merged it with MTDC.[10]

[6] McKinnon and Hayhow, p.5.
[7] Claggett Wolfe Associates, p. 17.
[8] Claggett Wolfe Associates, p. 18-19.
[9] Claggett Associates, p. 65-67.
[10] Duc Duong, MTDC Facilities Director.

(C) Technical Innovation Center

The Technical Innovation Center (TIC) was formed in 1994 at the Hagerstown Community College. The center aims to support the growth of technology and manufacturing firms in Western Maryland. Among the services provided by TIC are administrative services, business management services, technical services and access to equipment.[11]

(D) Emerging Technology Center

The Emerging Technology Center (ETC) houses technology start-up firms in three separate locations in Baltimore City. The incubator facilitates company growth in part by supplying fledgling technology firms with high-tech equipment and infrastructure. One on one mentoring in addition to access to advice from a pool of expert business service providers are also available for ETC incubator firms.

(E) UMBC High-Tech Business Incubator

This program, located on the campus of the University of Maryland Baltimore County was founded in 1989. The high-tech business incubator offers space, assistive services, and common equipment to technology-oriented start-up firms. The incubator provides both wet laboratory and office space.[12]

(F) NeoTech Incubator (Howard County EDA)

The incubator is run by the county's Economic Development Authority and is funded by county, state and private money. It offers small technology companies low-cost rent, administrative services, fiber optic wired offices and consulting support to help their businesses grow.

C. Defining the Impact of Maryland's Technology Industries

Technology firms are a coveted commodity. These businesses have a disproportionately large impact on regional and national economies in terms of employment and wage levels. Moreover, technology investment is considered to be the major driving factor that has powered the nation's economic growth over the past few years. Not surprisingly, states with high rates of research and development investment outperform other states in terms of employment growth and opportunity.

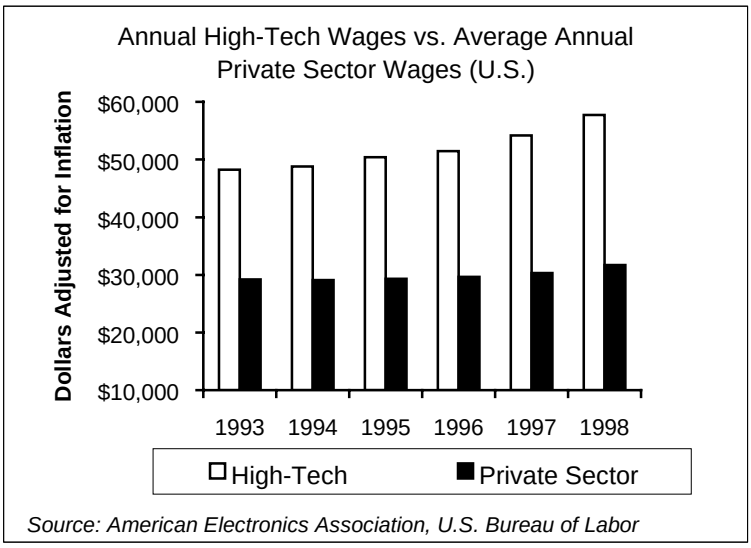
Despite near-universal acceptance of the economic significance of technology industries, there exists no standard definition of the term "high-tech industries", a fact that makes measuring the impact of these businesses difficult. For the purpose of this analysis, RESI relies, in part, upon the definition of high-tech firms developed by the American Electronics Association, (AEA).

The AEA considers the technology sector to be comprised of three main sub sectors: technology manufacturing, software and computer-related services and telecommunications services.

[11] Claggett Associates, p. 59-62.
[12] Claggett Associates, p. 68.

Projections indicate that the U.S. high-technology industry will remain a leader in job creation over the upcoming decade. The industry is projected to create more than 2 million new jobs nationally between 1999 and 2008 with industry employment jumping from 5 million to more than 7 million, according to projections compiled by the Bureau of Labor Statistics (BLS).

The high-tech workforce represented nearly 5 percent of the U.S. private sector workforce in 1999. The 1998 high-technology industry average wage was 82 percent higher than the private sector average wage of $30,000 compared to a 65 percent spread in 1993. According to figures released by the U.S. Department of Labor and the Bureau of Labor Statistics, employment in technology sectors represented 7.7 percent of total private sector employment in 1998. Wages for the technology sector, however, represented 13.3 percent of total private sector wages.



Source: American Electronics Association, U.S. Bureau of Labor

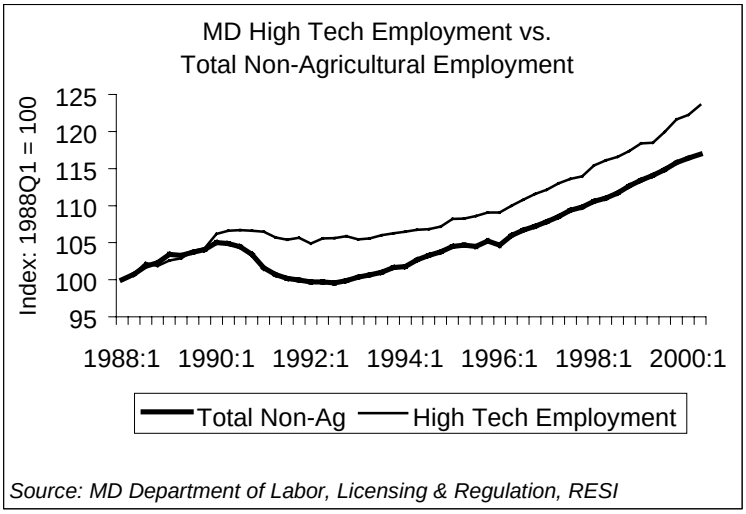
AEA data reveal employment growth and wage levels in Maryland to be impressive as well. In 1998, the growth rate for Maryland's high-tech industries (4.8%) outperformed the total private sector (2.5%) for the third consecutive year, with the widest margin of high-tech gain experienced in 1998.

According to figures released by the U.S. Department of Labor and the Bureau of Labor Statistics, employment in technology sectors represented 7.9 percent of Maryland's total private sector employment in 1998. Wages for the technology sector, however, represented 14.0 percent of total private sector wages.[13]

Although the AEA data are revealing, they do not reflect employment and wage levels in certain industries generally considered to be technology-intensive industries, such as biotechnology. To address this issue, RESI developed its own definition of high-tech employment, which is comprised of the following six main sub sectors: aerospace, information technology, biotechnology, health care, communications and high-tech manufacturing.

According to RESI's definition, the proportion of Maryland's total nonagricultural employment comprised by the state's technology industry is 19.8 percent. As shown in the following graph, in recent years Maryland's technology sector has outperformed the average of other industry sectors in terms of employment growth.[14]

[13] American Electronics Association, P. 10-12, 62.
[14] Chart contains "high-tech" employment data, as defined by RESI.



Source: MD Department of Labor, Licensing & Regulation, RESI

Moreover, wage levels associated with Maryland's technology sectors surpass the average weekly wages of all total nonagricultural industries. The average weekly wage for Maryland's total nonagricultural industry in the second quarter of 2000 was $710. This compares to average weekly wages of $1,164 for the telecommunications industry, $1,211 for the information technology sector and $1,118 for the biotechnology sector.

IV. Literature Review

A. Review of Incubator Impact Analyses

Various studies conducted over the past two decades seek to determine whether or not incubators are effective vis-à-vis alternative economic development tools (i.e. tax credits, the recruitment of corporations, etc.). The answer is dependent on the particular incubator(s) in question, the purpose associated with the incubator(s) and the regional location of the incubator(s).

Incubators vary by type and by purpose. Incubators aimed at empowering or revitalizing a neighborhood will have a far different impact on local economies than a for-profit, technology incubator. Moreover, each incubator is distinct in that it caters to regional specifications and needs. Because of the many different types of incubators as well as the regional specificity associated with each incubator, there is no standard industry model. This makes measuring the economic outcome of incubators challenging.[15]

[15] Molnar and Grimes, p. B1.

Analyses of the effectiveness of incubators are scarce prior to the 1980's. By the mid-1980's, however, several studies had been generated. Most previous studies utilize tenant surveys to evaluate the impact of incubators by examining factors such as the number of firms graduated from an incubator(s), the number of jobs associated with the incubator(s) and firms, and job growth of firms from their entry date to the incubator to the survey date. The following section enumerates results from certain high profile evaluations of incubators.

Evaluation Results

Survival Rates:

According to the Small Business Administration's Office of Advocacy (1997), survival rates for business start-ups as a whole fall between 30 and 60 percent during their first three years of operation (10 to 20 percent annually). The corresponding survival rates of incubated tenants falls between 80 and 87 percent during their first three years away from the incubator. Survival rates attributed to "For-Profit" incubators are as high as 90 to 95 percent.[16]

A separate study conducted in 1996 found that incubators funded by the North Carolina Technological Development Authority (TDA) produced graduate firms with survival rates nearly 10 percent higher than national survival rates for all firms after their third year in business. The TDA study also identified a control group consisting of North Carolina firms that received no form of public assistance and with similar start-up dates as the graduate incubator firms considered in the study. The authors determined that survival rates of the graduate firms exceed survival rates of the control group by roughly 20 percent.[17]

Job Growth:

According to a recent NBIA study, incubator firms register full-and part-time employment growth of 3.7 employees per firm annually. This study focused on three types of incubators, technology, mixed-use, and empowerment. Graduate and current tenants of technology and mixed-use firms saw the greatest annual increases in revenues and employment.[18]

Not only is job growth among incubated firms proven, but the jobs that are created are typically high quality jobs. The same study shows that many incubator firms offer a host of benefits including tuition reimbursement (27.7%) and education and training benefits (49.1%).[19]

Return on Investment:

As economic development tools, incubators produce graduate firms that are likely to remain within the region in which they originate. According to the NBIA “Business Incubation Works” study, an average of 84 percent of the 126 firms surveyed remained within their communities.

This “staying effect” allows graduate firms to augment local tax bases and, thus, increase the return on investment associated with local incubator programs. According to the same NBIA study, the average return on public investment in terms of tax dollars was $4.96 for every $1 dollar of estimated public operating subsidies.[20]

[16] Molnar and Grimes, p. 17.
[17] Cassidy, p. 1
[18] Molnar and Grimes, p.14.
[19] Molnar and Grimes, p.15.
[20] Molnar and Grimes, p.17.

Methodologies and Challenges

A study jointly conducted by the University of Michigan and the National Business Incubation Association in November of 1998 determined macroeconomic analysis to be the most useful methodology in determining the total economic impact incubator firms have on the local economy. Determining the total economic benefits generated by an incubator(s) allows for the comparison of incubators to alternative economic development tools. This approach involves the utilization of a macroeconomic model, such as REMI or IMPLAN to determine employment and personal income impacts.[21]

Macroeconomic analysis is most relevant in evaluating the six Maryland incubators under consideration, given the scope and purpose of the study.[22] However alternative methodologies could prove useful to TEDCO for future studies. These include longitudinal analysis, cost benefit analysis, and internal evaluations of business incubator programs.

This analysis focuses primarily upon the short-term economic impacts of Maryland's incubators. Future longitudinal studies would perhaps provide a more complete picture of the economic impact incubators have on Maryland's economy. According to a previous analysis reviewed by Markley, incubators are long-term strategies and longer-term impacts should be taken into account whenever possible. [23] RESI has taken this into consideration when examining the impact of incubator services over time. [24]

While this study does generate estimates of the total economic impacts of the six incubators in question, a cost benefit analysis would provide a more complete determination of the effectiveness of Maryland's incubators as economic tools. Such an analysis would simply take the current findings one step further and compare the benefits to start up, operation and maintenance costs of each incubator facility. Public subsidies and services should also be taken into account on the costs side of the analysis. Benefits could be expanded to include facility revenues, and contributions to local charities.

Many prior studies rely on survey responses to evaluate the effectiveness of incubators internally. These surveys do not attempt to quantify measures such as job creation or financial performance, but rather to assess whether or not clients and graduates found their respective incubator to be helpful in supporting the growth of client firms. Studies geared toward internal incubator evaluations could also capture additional subjective measures of incubator effectiveness including access to advice and mentoring programs. Again, these measurements are not within the scope of the current study, but could prove to be beneficial to TEDCO for further studies.

Past evaluations have been criticized for being limited in terms of their ability to reveal the impact of incubators on their local economy. The most common critique of prior studies is that the methodology used to calculate the impacts fails to consider a control group of firms.

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[21] Chappell and Sherman, p. 10.

[22] The IMPLAN model utilized by RESI enumerates employment, income, fiscal and gross state product impacts of incubated firms. It should be noted that there are additional impacts created by the incubators considered in this analysis. Impacts including wealth creation, technology transfers (new products developed from university or federal lab technologies which would otherwise not have been brought to market), joint venture and partnerships (synergistic efforts which bring compounded revenues to both partners) and others are not enumerated in this study due to scope and time constraints.

[23] Markley, p.4.

[24] See methodology explanation of Section IX.

Including a control group would reveal whether incubator client performance represents an improvement over the performance of the average new business startup that does not receive assistance from a business incubator.[25] Finding data to assimilate a control group has proven to be a difficult task, due to the scarcity of data on startup dates and performances of small businesses. Even the National Business Incubation Association was unable to include a control group in its most recent study.[26]

Shortfalls of Prior Incubator Analyses

(1) Lack of a control group

(2) Failure to quantify fiscal impacts

(3) Failure to recognize linkages between incubator firms and the regional economy

(4) Failure to utilize distinct methodologies to calculate the impact of different types of incubators

Additional weaknesses attributed to prior studies include the failure to measure the fiscal impacts of incubator firms as well as the failure to consider linkages between incubator firms and the balance of the regional economy. Furthermore, Chappell and Sherman find that many previous studies are flawed because they fail to utilize distinct methodologies in determining the impacts of different types of incubators.[27]

[25] Cassidy, p.1
[26] Molnar and Grimes, p.25.
[27] Chappell and Sherman, p. 3.

V. Methodology

A. Survey Design

The survey seeks to obtain an understanding of the "linkages" between incubator firms and other firms as well as employment and revenues of incubator firms. The design of the survey was conducted jointly by RESI and TEDCO and was modeled after the 1998 NBIA national incubator study.

B. Survey Robustness

Survey participation rates varied among current tenants and graduate firms. The total universe of firms considered in the study is 125; 79 current incubator firms and 46 graduates. The response rate for current firms is 47 percent (n=37). The corresponding figure for graduate firms is 33 percent (n=15). Although the latter figure constitutes a relatively low response rate, RESI feels that the results derived from this sample are statistically valid.

Listed below is the actual distribution of firms that replied to the TEDCO survey versus the distribution of all firms currently incubated in the six Maryland technology incubators considered in this study.

Table A: Distribution of All Current Incubated Firms versus Current Respondent Firms

	All Incubated Firms		Respondent Incubated Firms	
Industry	**# Firms**	**Percent Distribution**	**#Firms**	**Percent Distribution**
Aerospace	1	1.27%	1	2.70%
Biotechnology	26	32.91%	15	40.54%
Data Collection/Consulting/Bar Coding	3	3.80%	1	2.70%
Engineering	8	10.13%	3	8.11%
Information Technology	21	26.58%	10	27.03%
Marketing/Consulting Services	2	2.53%	-	0%
Pharmaceutical	1	1.27%	1	2.70%
Printing & Publishing	1	1.27%	-	0%
Software & Computer Services	14	17.72%	6	16.22%
Telecommunications	2	2.53%	-	0%
Total Number of Current Incubator Firms	**79**	**100.00%**	**37**	**100%**

Current respondent firms are fairly representative of the actual population of the incubated firms. From the table above, Biotechnology was over-sampled in terms of responses while Engineering

and Data Collection firms were slightly under-sampled in terms of responses. Telecommunications firms, Marketing/Consulting firms and Printing & Publishing firms were not account for at all in terms of current firm responses, however since these firms account for such a small population of all current incubated firms, RESI feels quite comfortable with the respondent sample breakdown.

Since the number of employees, expenditures and revenues are the critical factors in the analysis and not the number of firms, RESI utilized the survey information and the actual distribution of firms to construct the weights used in calculating the estimated employment totals.

C. Impact Methodology

RESI disaggregated the sample of firms into current incubator firms and graduate incubator firms. Within each group, the firms were classified according to their self-reported industry (i.e. software and computer services).[28]

The following chart illustrates the industry distribution of both current and graduate firms that responded to the survey.

Table B: Industry Distribution of Current Respondent Firms

Current Incubated Firms	
Industry	**Percent Distribution**
Aerospace	2.7%
Biotechnology	40.5%
Data Collection/Consulting/Bar Coding	2.7%
Engineering	8.1%
Information Technology	27.0%
Pharmaceutical	2.7%
Software & Computer Services	16.2%
Total Number of Current Incubator Firms	**100%**

[28] RESI assigned an industry classification (based on firm descriptions provided by the incubators) to those respondent firms that did not report an industry classification when filling out the survey.

Table C: Industry Distribution of Graduate Respondent Firms

Graduate Firms	
Industry	**Percent Distribution**
Biotechnology	53.3%
Engineering	6.7%
Health Services	13.3%
Information Technology	13.3%
Software & Computer Services	6.7%
Trade/Exporting Services	6.7%
Total Number of Current Incubator Firms	**100%**

The next step entailed the analysis of the survey response data. RESI analyzed the survey response data of incubated firms by applying three variations of a single, core methodology. This results in a range of outcomes. The first variation, Approach I, yields a narrow interpretation of the impact by restricting the analysis to the pool of current and graduate survey respondents.

Approach II results in the widest interpretation of the economic impact and involves the extrapolation of survey results to the balance of non-respondent firms. The extrapolation was completed by first determining the average employment, revenues and expenditures by firm for survey respondents, then multiplying these numbers by the total universe of current and graduate firms. This approach is based on an underlying assumption that the firms surveyed in each industrial category are representative of the total universe of incubated firms in terms of employment, revenues, and expenditures.

Approach III provides a more modest interpretation of impact results, between that of Approach I and II. This approach follows the same basic methodology employed in Approach II. Approach III differs from Approach II in that the average employment, revenues and expenditures are calculated using a trimmed mean. Thus, when calculating average employment, revenues and expenditures, RESI considered the middle 50 percent of survey responses. This method serves to limit the impact of extreme cases on the mean by removing 25 percent of responses from either end of the distribution.

RESI estimated population parameters by extrapolating responses of the surveyed firms to the balance of the non-respondent firms. For the current incubator firms, this technique produces results that are statistically valid at the aggregate level as well as within each business category.

For the graduate incubator firms, the estimated population parameters are statistically valid only at the aggregate level. The sample size is insufficient to infer within business category behavior. Consequently, our analysis of within business category performance is limited to current incubated firms.

The next step involved determining the economic impact of the incubated firms under consideration. Employment, revenue and expenditure data were entered into RESI's modified

IMPLAN model. RESI weighted the survey responses by industry distribution and applied the weights to the IMPLAN model for all three approaches. RESI used IMPLAN to measure total employment, personal income and fiscal impacts of the current and graduate incubator firms. Detailed below is an explanation of the IMPLAN model.

VI. Analysis and Synthesis of Survey Data

A. Statistical Analysis

RESI collected survey data from 47% (n=37) of the current incubated firms (N=79) and from 33% (n=15) of the graduated incubated firms (N=46). The vast majority of the firms that responded to the survey were in the Biotechnology field. This was true of both the current incubated firms as well as the graduated incubator firms. The following tables illustrate the average figures calculated using RESI's three approaches.[29]

Approach I: Respondent Universe & Approach II: Extrapolated Universe

Table Di: Average Number of Employees

	1998	1999	2000
Current Incubator Firms	4	5	6
Graduated Incubator Firms	65	48	70

Source: 2000/2001 TEDCO survey

Table Dii: Average Revenues

	1998	1999	2000
Current Incubator Firms	$234,600	$240,936	$376,244
Graduated Incubator Firms	$2,149,167	$2,514,267	$7,475,189

Source: 2000/2001 TEDCO survey

Table Diii: Average Grants/Investments

	1998	1999	2000
Current Incubator Firms	$208,881	$304,251	$532,549
Graduated Incubator Firms	$266,667	$208,750	$511,875

Source: 2000/2001 TEDCO survey

[29] Approach II utilizes the averages used in Approach I, thus these figures are the same.

Table Div: Average Cash Purchases

	1998	1999	2000
Current Incubator Firms	$275,519	$425,719	$530,997
Graduated Incubator Firms	$4,132,717	$4,618,138	$6,021,429

Source: 2000/2001 TEDCO survey

Approach III: Extrapolated (Middle 50%) Universe

Table Ei: Average Employees

	1998	1999	2000
Current Incubator Firms	2	3	6
Graduated Incubator Firms	13	25	38

Source: 2000/2001 TEDCO survey

Table Eii: Average Revenues

	1998	1999	2000
Current Incubator Firms	$69,684	$63,654	$243,739
Graduated Incubator Firms	$1,498,750	$2,149,500	$4,024,544

Source: 2000/2001 TEDCO survey

Table Eiii: Average Grants/Investments

	1998	1999	2000
Current Incubator Firms	$26,200	$40,333	$269,410
Graduated Incubator Firms	$0	$13,125	$380,000

Source: 2000/2001 TEDCO survey

Table Eiv: Average Cash Purchases

	1998	1999	2000
Current Incubator Firms	$59,010	$108,991	$311,364
Graduated Incubator Firms	$526,236	$669,633	$941,667

Source: 2000/2001 TEDCO survey

RESI also calculated total employment levels by industry for current and graduate incubator firms. These employment totals differ according to which of the three RESI approaches was utilized in calculating the figures. The tables below list the employment levels used in the IMPLAN model for each of RESI's approaches, broken down by industry classification for both current and graduate firms.

Approach I: Respondent Universe

Table Fi: Current Incubator Firms Employment Levels

	2000
Aerospace	6
Biotechnology	64
Data Collection/ Consulting/ Bar Coding	4
Engineering	12
Information Technology	30
Pharmaceutical	21
Software & Computer Services	18
Total	**155**

Source: TEDCO 2000/2001 Survey and RESI calculations

Table Fii: Graduate Incubator Firms Employment Levels

	2000
Biotechnology	958
Engineering	37
Health Services	25
Information Technology	20
Software & Computer Services	3
Trade/Exporting Services	2
Total	**1,045**

Source: TEDCO 2000/2001 Survey and RESI calculations

Approach II: Extrapolated Universe

Table Gi: Current Incubator Firms Employment Levels

	2000
Aerospace	13
Biotechnology	192
Data Collection/ Consulting/ Bar Coding	9
Engineering	51
Information Technology	128
Pharmaceutical	45
Software & Computer Services	64
Total	**502**

Source: TEDCO 2000/2001 Survey and RESI calculations

Table Gii: Graduate Incubator Firms Employment Levels

	2000
Biotechnology	2,952
Engineering	114
Health Services	77
Information Technology	62
Software & Computer Services	9
Trade/Exporting Services	6
Total	**3,220**

Source: TEDCO 2000/2001 Survey and RESI calculations

Approach III: Extrapolated (Middle 50%) Universe

Table Hi: Current Incubator Firms Employment Levels

	2000
Aerospace	13
Biotechnology	185
Data Collection/ Consulting/ Bar Coding	9
Engineering	49
Information Technology	114
Pharmaceutical	45
Software & Computer Services	58
Total	**472**

Source: TEDCO 2000/2001 Survey and RESI calculations

Table Hii: Graduate Incubator Firms Employment Levels

	2000
Biotechnology	1,586
Engineering	61
Health Services	41
Information Technology	33
Software & Computer Services	5
Trade/Exporting Services	3
Total	**1,730**

Source: TEDCO 2000/2001 Survey and RESI calculations

VII. IMPLAN Model Overview

A. Employment

In order to help quantify the economic impact of each Maryland incubator, RESI used an Implan input/output model designed specifically for incubators. The model enumerates the employment and income impact of each dollar earned and spent by the following: employees of the new business, other supporting vendors (business services, retail, etc.), each dollar spent by these vendors on other firms and each dollar spent by the households of the new business' employees, other vendors' employees, and other businesses' employees.

To quantify the economic impact of a new business entering into an area, economists measure three types of economic impacts: direct, indirect, and induced impacts. The direct economic effects are generated as new business create jobs and hire workers to fill new positions. The indirect economic impacts occur as new firms purchase goods and services from other firms. In either case the increases in employment generate an increase in household income, as new job opportunities are created and income levels rise. This drives the induced economic impacts that result from households increasing their purchases at local businesses.

Consider the following example. A new firm opens in a region and directly employs 100 workers. The firm purchases supplies, both from outside the region as well as from local suppliers, which leads to increased business for local firms, thereby creating jobs for say, another 100 workers. This is called the indirect effect. The workers at the firm and at suppliers spend their income mostly in the local area, creating jobs for hypothetically another 50 workers. This is the induced effect. The direct, indirect, and induced effects add up to 250 jobs created from the original 100 jobs. Thus, in terms of employment, the total economic impact of the hypothetical firm in our example is 250.[30]

B. Personal Income

The IMPLAN model estimates the annual flow of personal income, (defined as the sum of salaries and wages, other labor income and proprietors' income less transfer payments, dividends interest and rent).

C. Fiscal Impact

[30] Total economic impact is defined as the sum of direct, indirect and induced effects.

The fiscal impacts created by the incubator firms are primarily driven by income tax revenues, sales tax revenues and additional real property tax revenues generated by new households moving into the state or county. These figures are generated at the local, state and federal levels.

D. Multipliers

Economists rely on industry multipliers to determine indirect and induced effects of industry segments or firms. Multipliers represent the relationship between direct effects and the sum of the direct, indirect and induced effects. For example, if the employment multiplier for a specific industry is 2.4, then for every job created in that industry a total of 2.4 jobs will be created.

One of the critical issues facing researchers in this area has been the extent to which existing multipliers from the Bureau of Economic Analysis (BEA) and other sources underestimate the true multiplier impact of technology firms on a region's economy. Three noteworthy studies address this issue directly and attempt to reconcile the differences between standard input-output model estimates and the empirical results.

Beyers and Nelson (1997) determined that technology industries in Washington State have a greater impact on the regional economy than the average industry does.[31] This is due to the large multiplier effects associated with high-tech industries. The Washington State input-output model utilizes multipliers associated with specific technology sectors (which are aggregated from the SIC level). Multiplier levels are influenced by labor income levels and in-state purchases associated with each industry. Because of the high wage payments per worker associated with technology industries (average labor income per technology-based job was $52,201 compared to the statewide average of $29,447), these industries have a larger multiplier effect and therefore create a broader impact on the local economy. According to their study, the average technology-based industry multiplier is 3.36 compared to the average multiplier of 2.86 for all Washington industries.[32]

A study completed in Texas on the business climate determined that for every one million dollars in high-technology sales in one year leads to a 3.8 million dollar increase in economic activity in the following year implying an economic multiplier of 3.8 which is well above the average industry multiplier. The spending by technology firms also supports growth in the local economy by providing the community with high wage jobs, attracting and supporting local technology and supply businesses, and spending money within the region.

Charney and Leones (1995) found that the IMPLAN model tends to underestimate induced effects for high-technology and other high wage industries in their study of high-technology businesses in Arizona. The curent method used to calculate these effects does not reflect the difference in average wages across industries. The authors of this analysis developed a method to use IMPLAN to account for this challenge.

According to the authors, the indirect effects appear to be lower than what might be expected. This is due to the fact that high-technology firms purchase large amounts of goods and services from other technology firms, thus the purchases are included in the direct effects. The authors define high-tech industries by considering "consensus" definitions of high-technology for manufacturing sectors and employing "professional judgment" in defining high-technology service sectors. This is especially true for the industry as a whole. The employment multiplier for the high-technology industry is 1.9, however for a sub-sector such as computers, the

[31] The study defined high-tech industries by utilizing a measure of R&D employment. Industries with 10 percent or greater employment in research and development occupations were considered, for the purpose of this report, to be technology-based industries.
[32] Beyers and Nelson, p. 21-26.

multiplier may be in the 2.2 to 2.8 range. Larger industries tend to include a greater percentage of intra-industry purchases. Thus, the direct effects increase and the indirect effects decline.[33]

VIII. Economic Impact of Incubator Firms

A. Employment Impacts

Through the multiplier effect, the six Maryland incubators under consideration in this study had a total economic impact ranging from roughly 2,200 to 6,800 jobs, paying over $36,000 on average in 2000.[34]

Approach I: Respondent Universe

Table I: Employment Impacts, Incubator Firms 2000

	Direct	Indirect	Induced	Total
Current	155	60	119	334
Graduate	1,045	258	573	1,876

Source: IMPLAN and TEDCO Survey

Approach II: Extrapolated Universe

Table J: Employment Impacts, Incubator Firms 2000

	Direct	Indirect	Induced	Total
Current	502	185	378	1,065
Graduate	3,221	796	1,770	5,787

Source: IMPLAN and TEDCO Survey

Approach III: Extrapolated (Middle 50%) Universe

[33] Charney and Leones, p.9-11.

[34] The majority of the current firms' direct employment effects are concentrated in the biotechnology and information technology sectors. The bulk of the indirect economic impacts are concentrated within the services industry (i.e., firms engaged in business support services). The induced economic impacts are concentrated in both the services and the retail sectors resulting from the increased household expenditures experienced as the direct and indirect economic impacts boost household income. Most incubator graduate firms are biotechnology firms. As in the case of current incubator firms, indirect impacts are heavily comprised of service sector firms. The induced economic impacts are dominated by the retail and service sectors in response to increased household expenditures. For a more detailed breakdown of the industry composition of employment impacts, see Appendix B.

Table K: Employment Impacts, Incubator Firms 2000

	Direct	Indirect	Induced	Total
Current	473	175	356	1,004
Graduate	2,439	601	1,338	4,378

Source: IMPLAN and TEDCO Survey

B. Output, Personal Income and Fiscal Impacts

The presence of both graduate and incubator firms generates additional gross state product, personal income and tax revenues. The tables below detail the additional output, personal income and taxes supported by the incubator firms.

Output

According to the RESI/IMPLAN data, incubator firms generated between $184 and $530 million dollars in gross state product and between $31 and $96 million dollars in taxes in 2000.

Approach I: Respondent Universe

Table L: Gross State Product, Incubator Firms

	Direct	Indirect	Induced	Total
Current	$18,852,646	$5,988,620	$9,129,265	$33,970,531
Graduate	$84,513,788	$21,767,971	$43,832,597	$150,114,358

Source: IMPLAN and TEDCO Survey

Approach II: Extrapolated Universe

Table M: Gross State Product, Incubator Firms

	Direct	Indirect	Induced	Total
Current	$56,587,027	$17,411,198	$28,988,143	$102,986,367
Graduate	$260,517,993	$67,096,737	$135,118,788	$426,733,505

Source: IMPLAN and TEDCO Survey

Approach III: Extrapolated (Middle 50%) Universe

Table N: Gross State Product, Incubator Firms

	Direct	Indirect	Induced	Total
Current	$53,668,412	$16,541,140	$27,399,978	$97,609,531
Graduate	$197,296,270	$50,812,956	$102,213,940	$350,423,163

Source: IMPLAN and TEDCO Survey

Income

Personal income estimates for current incubated firms range from $15 to $49 million according to RESI's three scenarios. The corresponding personal income range for graduate incubator firms falls between $73 and $225 million. The average quality of each job added in both current and graduate firms is projected to be quite high given the high-tech nature of the incubator firms.

Approach I: Respondent Universe

Table O: Personal Income, Incubator Firms

	Direct	Indirect	Induced	Total
Current	$9,100,302	$2,671,985	$3,529,293	$15,301,580
Graduate	$45,690,731	$10,578,118	$16,945,322	$73,214,171

Source: IMPLAN and TEDCO Survey

Approach II: Extrapolated Universe

Table P: Personal Income, Incubator Firms

	Direct	Indirect	Induced	Total
Current	$29,305,749	$7,995,297	$11,206,578	$48,507,624
Graduate	$140,849,477	$32,605,117	$52,235,841	$225,690,435

Source: IMPLAN and TEDCO Survey

Approach III: Extrapolated (Middle 50%) Universe

Table Q: Personal Income, Incubator Firms

	Direct	*Indirect*	*Induced*	*Total*
Current	$27,679,159	$7,582,983	$10,592,611	$45,854,754
Graduate	$106,650,619	$24,692,771	$39,553,764	$170,897,154

Source: IMPLAN and TEDCO Survey

Taxes

Based on the TEDCO survey and the IMPLAN model, RESI estimates that the current incubator firms contribute between $5 million (of which roughly $4 million is funneled to federal tax obligations, while the balance is split between state and local tax obligations) and $17 million (of which roughly $12 million of which is funneled to federal tax obligations, while the balance is split between state and local tax obligations). Graduate incubator firms generate between $25 million (of which roughly $18 million is funneled to federal tax obligations, while the balance is split between state and local tax obligations) and $79 million (of which roughly $56 million is funneled to federal tax obligations, while the balance is split between state and local tax obligations) per year in tax revenues.

Approach I: Respondent Universe

Table R: Taxes, Incubator Firms

	Federal	State	Total
Current	$3,798,512	$1,528,798	$5,337,697
Graduate	$18,339,997	$7,211,172	$25,601,985

Source: IMPLAN and TEDCO Survey

Approach II: Extrapolated Universe

Table S: Taxes, Incubator Firms

	Federal	State	Total
Current	$11,915,797	$4,774,778	$16,723,437
Graduate	$56,334,416	$22,229,408	$78,920,466

Source: IMPLAN and TEDCO Survey

Approach III: Extrapolated (Middle 50%) Universe

Table T: Taxes, Incubator Firms

	Federal	State	Total
Current	$11,270,682	$4,518,213	$15,819,959
Graduate	$42,810,794	$16,833,369	$59,762,777

Source: IMPLAN and TEDCO Survey

C. Multipliers

The multipliers utilized for the model are listed in the following table. The employment multipliers range from 1.64 to 2.15 for current incubator firms and from 1.79 to 1.80 for graduate firms. The interpretation of the multiplier is straightforward. For example, if the employment multiplier for a specific industry is 2.4, then for every job created in that industry a total of 2.4 jobs will be created in the economy.

Approach I: Respondent Universe

Table U: Multipliers

	Current	Graduated
Employment	2.15	1.80
Gross State Product	1.80	1.78
Personal Income	1.68	1.60

Source: IMPLAN and TEDCO Survey

Approach II: Extrapolated Universe

Table V: Multipliers

	Current	Graduated
Employment	2.12	1.80
Gross State Product	1.82	1.64
Personal Income	1.66	1.60

Source: IMPLAN and TEDCO Survey

Approach III: Extrapolated (Middle 50%) Universe

Table W: Multipliers

	Current	Graduated
Employment	1.64	1.79
Gross State Product	1.82	1.78
Personal Income	1.66	1.60

Source: IMPLAN and TEDCO Survey

IX. Economic Impact of Incubator Services

In addition to enumerating the total economic impact of the incubator firms surveyed, RESI sought to determine the impact of the services provided by the incubators themselves. As stated previously, incubators provide tenants with a variety of services that foster growth among incubated firms. Tangible services provided by many incubators include lower operating costs through the provision of flexible, sub-market rate rental space and shared administrative services. Intangible benefits include services such as networking opportunities and access to advice and information.

For many of the novice entrepreneurs assisted by incubator staff, the intangible benefits of an incubator location may vastly exceed the more tangible benefits. The intangibles include the provision of management guidance, technical assistance and consulting. In short, the incubator can help offset the inexperience of many young entrepreneurs who possess brilliant ideas, insights into process and technological prowess, but who have never (or infrequently) fulfilled the demands of a comprehensive business plan. The impact of these incubator services can be measured in a variety of ways, but perhaps shows up most directly in the data regarding the heightened prospects for long-term growth and survival that characterizes incubated firms vis-à-vis their non-incubated counterparts. The provision of these intangible incubator services therefore correlates to real economic impact, a notion RESI has attempted to quantify in this study.

One of the less frequently mentioned but more important contributions of incubators is the provision of networking opportunities. Technology, like virtually all industries, is about people and relationships. To the extent that incubators can help innovators find potential financing sources, customers, service providers and others, incubated firms enjoy greater prospects for success. It is well known that technology is distinguished in particular by so-called network externalities. These externalities exist in technology industries because these industries are driven more by ideas and insight than they are by capital and infrastructure (though these are certainly also important to technology growth). Because of the central role of ideas, entrepreneurs and innovators seek to be next to one another. Nationally, this is reflected in the clustering of tech firms in Silicon Valley, Route 128, I-270, Austin, Northern Virginia, Seattle and elsewhere. Incubators support this dynamic by placing the incubated entrepreneur at the epicenter of a region's technology web, allowing parties to benefit from one another's presence in

the region, and helping to stimulate a dynamic that generates substantial benefits for the region. Again, the impact of this positive factor is reflected in a number of ways, including sharper revenue growth, accelerated product development and enhanced survivability.

The Universe of Potential Methodologies

Because there is no one existing model for calculating the economic impact of the services provided by individual incubators, RESI considered three different methodologies that yield a range of estimates of the value of services provided by the six Maryland incubators considered by this study. Significantly, these values can then be translated into overall economic impact.

The three methodologies RESI used to estimate the value of incubator services are: 1) survival rate differential; 2) public works evaluation approach; and 3) equity percentage. These approaches are described in the following pages.

Additionally, there are several methods that RESI was unable to utilize because of data limitations. Of these, three were particularly compelling conceptually. The first of these is the level of investment (e.g., angels, venture capital) in incubated firms. The notion of this method is that venture capitalists and other equity financiers will only invest in companies with high predicted, prospective value. If it is true that incubated firms attract higher levels of equity financing than their non-incubated counterparts, it is a reflection of the value of services provided by the incubator. Conceptually, this is a powerful approach. Unfortunately, RESI was unable to utilize this approach because of a lack of data on equity participation by these types of financiers.

Another potential approach revolves around the return on capital invested. Specifically, this methodology analyzes the rate of return on public investment in incubators. This return can be measured in a number of ways, including jobs, income and taxes. For an analyst to utilize this approach, incubator operating subsidy data are required. These data currently do not reside at RESI for the six incubators considered by this analysis, and hence RESI was unable to calculate the public rate of return.

A final possible approach measures intellectual property augmentation among tenant and graduate firms. Intellectual property takes many forms, including copyright (pertinent to software), patents (pertinent to hardware, pharmaceuticals, etc.) and trademarks (pertinent to technology commercializing and marketing). To the extent that incubator services lead to greater generation of intellectual property, an affirmative value can be placed on the contributing services. This methodology is highly appealing conceptually since intellectual property can conceivably be valued. However, the data on intellectual property value are scant, and hence this represented the third possible methodology RESI was unable to employ.

Three Methodologies Utilized[35]

Methodology I: Survival Rate Differential

This approach compares the survival rates of firms that have been incubated versus national survival rates of small businesses. The differential in the number of firms and subsequent economic activity represents the impact of the valuation of the incubator services and infrastructure. A University of North Carolina study found that graduate incubator firms had survival rates ten percent in excess of national survival rates for all firms after their third year of business.[36] If we consider the ten percent figure to be representative of all incubated firms, we can conclude that ten percent of the total number of graduate firms would not be currently operating were it not for the provision of incubator services. This ten percent figure was also used with respect to currently incubated firms, which not only have enhanced survival prospects going forward, but currently enjoy enhanced survival prospects due to the range of services provided by incubators.

In order to determine the impact of the value of the services provided by the incubators, the ten percent figure was applied to the economic impact (in terms of Gross State Product) of incubator firms. For tenant firms, this calculation is fairly straightforward and represents ten percent of the total economic impact of the incubator firms.

The impact of services provided to graduate firms is more complicated, however. When considering graduate firm impacts, RESI assumes that the economic impact of services provided in the past erodes over time. Moreover, we assume that there exists a three-year lag period from the date of a firm's graduation to the dissipation of the economic impact of incubator services provided and that the distribution of the fall-off of the impact is evenly spread over each of the three years.[37]

The results indicate that the economic impact of the services provided by the six incubators to tenant firms ranges between $3.4 and $10.3 million in Gross State Product in 2000. The impact of services provided to graduate firms falls between roughly $6.5 million and $18.5 million in Gross State Product in 2000. The portion of the total economic impact, in terms of personal income, of incubator tenant firms attributable to incubator services ranges from $1.5 million and $4.9 million in 2000. The corresponding figures for graduate firms range from $3.1 million to $9.8 million. The generation of federal, state and local tax receipts attributable to the incubator services for tenant firms lies between $0.5 million and $1.7 million. The corresponding figures attributable to incubator services for graduate firms range from $1.1 million to $3.4 million in 2000.[38]

[35] Please see page 31 for charts comparing the results of the three different methodologies considered in this section.

[36] Cassidy, Glenn D. and Ross, Steven. *They Incubate, But Do They Hatch: Survival Rates for Incubator Firms. Pittsburgh*; 1996.

[37] For example, if a firm graduated in 2000, RESI assumes that the economic impact of incubator services would be three percent of the impact of incubated firms; if the firm graduated in 1999, however, the three percent figure would be reduced by one-third.

[38] See Appendix A for a comparison of the gross state product, personal income and tax impacts associated with the services provided by Maryland's incubators.

Methodology II: Public Works Evaluation Approach

A 1998 Rutgers University study prepared on behalf of the Economic Development Administration (EDA) Public Works Program evaluated the impact of the economic contribution to public infrastructure.[39] One approach utilized in the study involved the use of either a production function or a cost function to estimate the contribution of the EDA's spending on the local economy. RESI relied on this approach as an alternative methodology for determining the economic impact of the services provided by the six Maryland incubators considered in this analysis.

According to the EDA findings, between seven and ten jobs are created for every $10,000 spent on economic development infrastructure, the category of endeavor into which incubators fall. For the purpose of this analysis, RESI assumes that the same relationship applies to funds allocated to Maryland's incubators. In a single year, TEDCO grants a total of $150,000 to the six incubators. To determine the economic contribution using the approach outlined in the Rutgers study, RESI made one key assumption. Since the amount of grant monies provided by TEDCO went to all incubators and all tenant firms (past and present), the basis for the evaluation should be the total population of currently incubated and graduate firms. In calculating the economic contribution, RESI used the lower bound (i.e., seven jobs per $10,000 spent) of estimated jobs created due to TEDCO expenditures. Based on this assumption and TEDCO's disbursement of grants, approximately 105 jobs were created due to the presence of incubators. That translates into a paltry $1,428.57 for every job created.

RESI then applied the proportion of these 105 jobs to total jobs created by incubated firms (in a given year) to the Gross State Product impact of incubated firms to determine the dollar value of the incubators' contribution. For tenant firms, this calculation is fairly straightforward and represents a flat percentage of the total economic impact of the incubator firms. When considering graduate firm impacts, however, RESI assumes that the economic impact of services provided in the past erodes over time. Moreover, we assume that there exists a three-year lag period from the date of a firm's graduation to the dissipation of the economic impact of incubator services provided, and moreover that the distribution of the fall-off of the impact is evenly spread over each of the three years.[40] Admittedly, this figure is conservative because it only includes TEDCO's portion of public investment in Maryland's incubators. Were all public subsidies and grants taken into consideration, RESI suspects that the resulting figures would be significantly larger.

The results associated with this methodology indicate that the economic impact of the services provided by the six incubators to tenant firms ranges from $3.3 million and $10.2 million in Gross State Product in 2000. The impact of services provided to graduate firms falls between roughly $1.2 million and $3.4 million in Gross State Product in 2000. In terms of income generation, incubator services to tenant firms constitute between $1.5 million and $4.8 million. The corresponding figures for incubator services for graduate firms range from roughly $575,000 to $1.8 million. Tax receipts generated as a result of the impact of incubator services to tenant firms range from roughly $526,000 to $1.6 million in 2000. The corresponding figure for incubator services for graduate firms fall between $201,000 and $620,000.[41]

[39] U.S. Department of Commerce, Rutgers University Center for Urban Policy Research. Public Work Program: Multiplier and Employment-generating Effects. 1997.
[40] Refer to footnote 37.
[41] See Appendix A for a comparison of the gross state product, personal income and tax impacts associated with the services provided by Maryland's incubators.

Methodology III: Equity Percentage (Baseline)

For this approach, RESI looked to the six incubators considered in the study. Two incubators, TAP and UMBC, require remuneration from incubated firms in the form of equity. Both incubators require one percent of a firm's equity for every partial year/year the firm remains in the incubator. The average length of stay at each of these incubators is three years. Putting these numbers together, RESI concluded that three percent of the economic activity generated by the incubator tenant firms would not have occurred were it not for the provision of incubator services. This three percent equity value can be translated into total economic impact since a company three percent larger than it would otherwise be (due to incubator services) will generate more economic spin-off than a smaller firm.

This method should be viewed as generating a substantial underestimate of incubator service value impact. Participating firms agree to the required remuneration, suggesting that from the firm's viewpoint the agreement reflects a net positive. That is, the value of services provided by the incubator is, at a minimum, three percent of the firm's equity, but is likely to be far greater. To the extent that a firm is actually receiving more value than this three percent figure, the actual economic impact of incubator services is greater.[42]

In order to determine the impact of the value of the services provided by the incubators, the three percent figure was applied to the total economic impact of incubator firms. For tenant firms, this calculation is fairly straightforward and represents three percent of the total economic impact of the incubator firms. The calculation of the impact of services provided to graduate firms is more complicated, however. When considering graduate firm impacts, RESI assumes that the economic impact of services provided in the past erodes over time. Moreover, we assume that there exists a three-year lag period from the date of a firm's graduation from the incubator to the dissipation of the economic impact of incubator services provided, and that the distribution of the fall-off of the impact is evenly spread over each of the three years.[43]

The results indicate that the economic impact of the services provided by the six incubators to tenant firms ranged from $1.0 million to $3.1 million in Gross State Product in 2000. The impact of services provided to graduate firms falls between roughly $2.0 million and $5.5 million in Gross State Product in 2000. Moreover, between $0.46 million and $1.5 million in personal income can be attributed to the impact of services provided by the incubators to current firms. The corresponding figures for graduate firms range from roughly $1.0 million and $2.9 million. Further, incubator services to tenant firms are responsible for the generation of between roughly $160,000 and $500,000 in federal, state and local tax receipts in 2000. Incubator services to graduate firms are responsible for an additional $330,000 to $1.0 million in tax receipts.[44]

[42] UMBC and TAP did not introduce the three percent figure as an accurate measure of the value of services provided to incubated firms, but rather as a discretionary figure. Consequently, this three percent figure represents the baseline value of services provided by the incubators, because it does not capture consumer surplus, (the price that firms would be willing to pay for these services had the three percent level not been pre-determined by the incubators).

[43] Refer to footnote 37.

[44] See Appendix A for a comparison of the gross state product, personal income and tax impacts associated with the services provided by Maryland's incubators.

The following tables summarize the results RESI derived using the three, distinct methodologies.

Table X: Gross State Product

	Methodology I	Methodology II	Methodology III[45]
	Survival Rate Differential	Public Works Evaluation	Equity Percentage (Baseline)
Gross State Product			
Approach I	$9,902,009	$9,529,474	$2,970,603
Approach II	$28,790,422	$13,508,756	$8,637,127
Approach III	$24,945,957	$12,378,660	$7,483,787

Table Y: Personal Income

	Methodology I	Methodology II	Methodology III
	Survival Rate Differential	Public Works Evaluation	Equity Percentage (Baseline)
Income			
Approach I	$4,702,772	$2,084,249	$1,410,831
Approach II	$14,630,681	$6,556,922	$4,389,205
Approach III	$11,991,018	$5,864,561	$3,597,306

Table Z: Taxes

	Methodology I	Methodology II	Methodology III
	Survival Rate Differential	Public Works Evaluation	Equity Percentage (Baseline)
Taxes			
Approach I	$1,643,189	$727,546	$492,957
Approach II	$5,092,231	$2,269,298	$1,527,669
Approach III	$4,171,716	$2,029,596	$1,241,515

[45] Please see footnote 42.

X. Assumptions/Difficulties Encountered

Two of the three approaches (Approach II and III) employed by RESI in determining the total economic impact of current and graduate firms assume that respondent firms are representative of the total population of current and graduate incubator firms in terms of average number of employees, revenues and expenditures.

Difficulties encountered during the course of the study include a low overall survey response rate as well as unanswered questions among received responses. Additional difficulties arose due to the fact that there is no standard model in terms of estimating incubator impacts (for both the incubated firms and the services provided by incubators). Specific assumptions are outlined in the methodologies presented in Sections V. Methodology and IX. Impact of Incubator Services.

XI. Conclusions

A. Survey Results

Survey results indicate that both current and graduate incubators are heavily concentrated in the Biotechnology sector. According to the first two of RESI's approaches utilized in this analysis, the average current incubator firm size in terms of employment has increased from four employees in 1998 to 6 employees in 2000. The third approach shows similar growth from 2 employees in 1998 to 6 employees in 2000. The first two approaches reveal that average firm size among graduate incubator firms has remained relatively steady at 70 employees. The third approach reveals that average employment growth among graduate firms has grown from 13 to 38 employees over the same time period. On average, current incubator firms generate between $240,000 and $400,000 in revenues while graduate incubator firms generate between $4 and $7.5 in revenues. Over 85% of workers employed by both current and graduate incubator firms reside in Maryland.

B. Impact Results

Through the multiplier effect, the six Maryland incubators under consideration in this study had a total economic impact ranging from roughly 2,200 to 6,800 jobs, paying over $36,000 on average in 2000. This compares to the average annual wage in Maryland of $35,000. Moreover, incubator firms generate between $184 and $530 million dollars in gross state product and between $31 and $96 million dollars in taxes annually.

This analysis also attempts to calculate the value of the combined services provided by the six incubators considered in the study and the economic impact (in terms of annual gross state product) of the provided services. To accomplish this, RESI utilized three distinct methodologies to produce a range of results. The resulting 2000 economic impact of the services provided for tenant firms, in terms of gross state product, ranging from three to ten percent of total economic impact generated by the individual incubator firms. The corresponding percentages attributable to the impact of services provided to graduate firms range from less than one percent to roughly four percent. Significant impacts were derived for both personal income and tax receipts attributable to the incubators as well.

C. Policy Implications

According to various technology alliances, the United States owes its position of world leadership in technology-intensive industries to the critical links that have been facilitated by the close physical proximity between nationally renowned research universities and nearby business and government agencies as well as other technology firms. These firms tend to form clusters for a variety of reasons including access to a pool of qualified workforce candidates, access to a stock of industry suppliers and because of the increased flow of human and technical resources industry clusters provide.

Successful technology incubators greatly enhance the potential for the formation of future high-tech industry clusters. Studies have shown that an important factor associated with incubator firms is their heightened tendency to form networks with other firms located both within and outside of the incubator. Moreover, incubator firms are highly likely to remain in the region of the incubator after graduating.

In addition to providing substantial economic impacts, the presence of technology incubators in Maryland complements the state's substantial stock of federal research labs and facilities. These facilities are vital to ongoing and future formations of technology clusters throughout the state's regions. The resulting technology clusters will help to ensure that Maryland is positioned at the forefront of technology research and commercialization going forward.

Appendix A: Impact of Incubator Services

GROSS STATE PRODUCT

Methodology I: Survival Rate Differential

This approach compares the survival rates of firms that have been incubated versus firms with similar start-up dates. The differential in the number of firms and subsequent economic activity represents the impact of the valuation of the incubator services and infrastructure. In order to determine the impact of the value of the services provided by the incubators, the ten percent figure was applied to the economic impact (in terms of Gross State Product) of incubator firms.

Methodology II: Public Works Evaluation

To determine the economic contribution using this approach, RESI made one key assumption. Since the amount of grant monies provided by TEDCO went to all incubators and all firms, the basis for the evaluation should be the total population of incubated firms. In calculating the economic contribution, RESI used the lower bound of estimated jobs created due to TEDCO expenditures. Based on the results and TEDCO's disbursement of grants, approximately 105 jobs were created due to the presence of incubators. RESI then applied the proportion of these jobs to the total jobs created to the Gross State Product impact of individual firms to determine the dollar value of the incubators' contribution.

Methodology III: Equity Percentage (Baseline)

RESI looked to two of the six incubators considered in the study. Both incubators require one percent of a firm's equity for every partial year/year the firm remains in the incubator. The average length of stay at each of these incubators is three years. RESI assumes that three percent of the economic activity generated by the incubator tenant firms would not have taken place without the services provided by the incubators. In order to determine the impact of the value of the services provided by the incubators, the three percent figure was applied to the economic impact (in terms of Gross State Product) of incubator firms.

	Methodology I		Methodology II		Methodology III	
	Tenant	Graduate	Tenant	Graduate	Tenant	Graduate

Income						
Approach I	$3,397,053	$6,504,956	$3,349,207	$1,180,267	$1,019,116	$1,951,487
Approach II	$10,298,637	$18,491,785	$10,153,585	$3,355,171	$3,089,591	$5,547,536
Approach III	$9,760,953	$15,185,004	$9,623,475	$2,755,185	$2,928,286	$4,555,501
Services as % of Total Economic Impact						
Approaches I-III	10.00%	4.33%	9.86%	0.79%	3.00%	1.30%

PERSONAL INCOME

Methodology I: Survival Rate Differential

This approach compares the survival rates of firms that have been incubated versus firms with similar start-up dates. The differential in the number of firms and subsequent economic activity represents the impact of the valuation of the incubator services and infrastructure. In order to determine the impact of the value of the services provided by the incubators, the ten percent figure was applied to the economic impact (in terms of income) of incubator firms.

Methodology II: Public Works Evaluation

To determine the economic contribution using this approach, RESI made one key assumption. Since the amount of grant monies provided by TEDCO went to all incubators and all firms, the basis for the evaluation should be the total population of incubated firms. In calculating the economic contribution, RESI used the lower bound of estimated jobs created due to TEDCO expenditures. Based on the results and TEDCO's disbursement of grants, approximately 105 jobs were created due to the presence of incubators. RESI then applied the proportion of these jobs to the total jobs created to the personal income impact of individual firms to determine the dollar value of the incubators' contribution.

Methodology III: Equity Percentage (Baseline)

RESI looked to two of the six incubators considered in the study. Both incubators require one percent of a firm's equity for every partial year/year the firm remains in the incubator. The average length of stay at each of these incubators is three years. RESI assumes that three percent of the economic activity generated by the incubator tenant firms would not have taken place without the services provided by the incubators. In order to determine the impact of the value of the services provided by the incubators, the three percent figure was applied to the economic impact (in terms of income) of incubator firms.

	Methodology I		Methodology II		Methodology III	
	Tenant	Graduate	Tenant	Graduate	Tenant	Graduate
Income						

Approach I	$1,530,158	$3,172,614	$1,508,606	$575,643	$459,047	$951,784
Approach II	$4,850,762	$9,779,919	$4,782,442	$1,774,480	$1,455,229	$2,933,976
Approach III	$4,585,475	$7,405,543	$4,520,891	$1,343,670	$1,375,643	$2,221,663
Services as % of Total Economic Impact						
Approaches I-III	10.00%	4.33%	9.86%	0.79%	3.00%	1.30%

TAXES

Methodology I: Survival Rate Differential

This approach compares the survival rates of firms that have been incubated versus firms with similar start-up dates. The differential in the number of firms and subsequent economic activity represents the impact of the valuation of the incubator services and infrastructure. In order to determine the impact of the value of the services provided by the incubators, the ten percent figure was applied to the economic impact (in terms of taxes) of incubator firms.

Methodology II: Public Works Evaluation

To determine the economic contribution using this approach, RESI made one key assumption. Since the amount of grant monies provided by TEDCO went to all incubators and all firms, the basis for the evaluation should be the total population of incubated firms. In calculating the economic contribution, RESI used the lower bound of estimated jobs created due to TEDCO expenditures. Based on the results and TEDCO's disbursement of grants, approximately 105 jobs were created due to the presence of incubators. RESI then applied the proportion of these jobs to the total jobs created to the fiscal impact of individual firms to determine the dollar value of the incubators' contribution.

Methodology III: Equity Percentage (Baseline)

RESI looked to two of the six incubators considered in the study. Both incubators require one percent of a firm's equity for every partial year/year the firm remains in the incubator. The average length of stay at each of these incubators is three years. RESI assumes that three percent of the economic activity generated by the incubator tenant firms would not have taken place without the services provided by the incubators. In order to determine the impact of the value of the services provided by the incubators, the three percent figure was applied to the economic impact (in terms of taxes) of incubator firms.

	Methodology I		Methodology II		Methodology III	
	Tenant	Graduate	Tenant	Graduate	Tenant	Graduate
Taxes						
Approach I	$533,770	$1,109,419	$526,252	$201,294	$160,131	$332,826

Approach II	$1,672,344	$3,419,887	$1,648,790	$620,508	$501,703	$1,025,966
Approach III	$1,581,996	$2,589,720	$1,559,714	$469,882	$474,599	$766,916
Services as % of Total Economic Impact						
Approaches I-III	10.00%	4.33%	9.86%	0.79%	3.00%	1.30%

Appendix B: Employment Impacts [46]

Approach I: Respondent Universe

Table I: Employment Impacts, Current Incubator Firms 2000.

	Direct	Indirect	Induced	Total	Avg. Wages
Agriculture/Mining	0	0	1	1	$15,128
Construction	0	2	2	4	$38,383
Manufacturing	27	5	2	34	$74,743
Aerospace	6	0	0	6	$105,650
Transportation, Communications, Public Utilities	0	3	4	7	$42,429
Communications	0	1	1	2	$42,660
Wholesale	0	4	3	7	$49,932
Retail	0	1	39	40	$17,605
FIRE	0	3	9	12	$34,091
Services	128	41	57	226	$40,895
Information Technology	52	8	1	61	$63,001
Engineering Services	12	3	0	15	$40,581
Biotechnology	64	3	0	67	$39,094
Government	0	1	2	3	$47,296
Total	**155**	**60**	**119**	**334**	**$41,479**

Table Iii: Employment Impacts, Graduate Incubator Firms 2000.

	Direct	Indirect	Induced	Total	Avg. Wages
Agriculture/Mining	0	2	4	6	$11,044
Construction	0	7	11	18	$35,256
Manufacturing	0	7	14	21	$47,233
Aerospace	0	0	0	0	N/A
Transportation, Communications, Public Utilities	0	12	20	32	$40,380

[46] Due to differences in the detailed industrial composition of current and graduate firms (not shown in tables), wage figures for current incubator firms listed at the aggregate level differ from wage figures for graduate firms.

Communications	0	3	4	7	$55,533
Wholesale	0	6	16	22	$47,044
Retail	0	6	188	194	$17,370
FIRE	110	23	43	176	$41,096
Services	935	187	270	1,392	$37,434
Information Technology	77	35	5	117	$63,240
Engineering Services	3	21	2	26	$38,838
Biotechnology	846	9	2	857	$39,059
Government	0	8	7	15	$55,169
Total	**1,045**	**258**	**573**	**1,876**	**$36,012**

Source: IMPLAN and TEDCO Survey

Approach II: Extrapolated Universe

Table J: Employment Impacts, Current Incubator Firms 2000.

	Direct	Indirect	Induced	Total	Avg. Wages
Agriculture/Mining	0	1	3	4	$11,465
Construction	0	5	8	13	$34,849
Manufacturing	58	13	9	80	$70,954
Aerospace	13	0	0	13	$105,658
Transportation, Communications, Public Utilities	0	8	13	21	$42,826
Communications	0	2	2	4	$68,406
Wholesale	0	10	10	20	$49,358
Retail	0	4	124	128	$17,409
FIRE	0	10	28	38	$33,679
Services	444	130	178	752	$42,198
Information Technology	201	27	3	231	$63,438
Engineering Services	51	10	1	62	$39,740
Biotechnology	192	7	1	200	$39,163
Government	0	4	5	9	$50,799
Total	**502**	**185**	**378**	**1,065**	**$41,089**

Source: IMPLAN and TEDCO Survey

Table Jii: Employment Impacts, Graduate Incubator Firms 2000.

	Direct	Indirect	Induced	Total	Avg. Wages
Agriculture/Mining	0	6	13	19	$10,751
Construction	0	21	35	56	$34,932
Manufacturing	0	21	46	67	$45,641
Aerospace	0	0	0	0	N/A
Transportation, Communications, Public Utilities	0	36	62	98	$40,645
Communications	0	9	11	20	$59,920
Wholesale	0	19	48	67	$47,622
Retail	0	19	580	599	$17,342
FIRE	339	71	131	541	$41,205
Services	2,882	578	832	4,292	$37,425
Information Technology	238	108	15	361	$63,299
Engineering Services	9	64	5	78	$39,760
Biotechnology	2,607	29	7	2,643	$39,028
Government	0	25	23	48	$53,144
Total	**3,221**	**796**	**1,770**	**5,787**	**$35,986**

Source: IMPLAN and TEDCO Survey

Approach III: Extrapolated (Middle 50%) Universe

Table K: Employment Impacts, Current Incubator Firms 2000.

	Direct	Indirect	Induced	Total	Avg. Wages
Agriculture/Mining	0	1	3	4	$10,862
Construction	0	5	7	12	$35,824
Manufacturing	56	13	8	77	$71,374
Aerospace	13	0	0	13	$102,614
Transportation, Communications, Public Utilities	0	8	13	20	$42,616
Communications	0	2	2	4	$64,658
Wholesale	0	10	10	19	$49,476
Retail	0	4	118	121	$17,410
FIRE	0	9	26	35	$34,585
Services	417	123	168	708	$42,172
Information Technology	189	25	3	218	$63,338
Engineering Services	48	9	1	57	$40,376
Biotechnology	180	7	1	187	$39,223
Government	0	3	5	8	$53,957
Total	473	175	356	1,004	$41,203

Source: IMPLAN and TEDCO Survey

Table Kii: Employment Impacts, Graduate Incubator Firms 2000.

	Direct	Indirect	Induced	Total	Avg. Wages
Agriculture/Mining	0	4	9	13	$11,897
Construction	0	16	27	43	$34,448
Manufacturing	0	16	34	50	$46,307
Aerospace	0	0	0	0	N/A
Transportation, Communications, Public Utilities	0	27	47	74	$40,760
Communications	0	7	8	15	$60,494
Wholesale	0	14	36	50	$48,317
Retail	0	15	439	454	$17,326
FIRE	257	54	99	410	$41,206
Services	2,182	437	630	3,249	$37,433
Information Technology	180	82	11	273	$63,329
Engineering Services	7	48	4	59	$39,937
Biotechnology	1,974	22	5	2,001	$39,033
Government	0	18	17	35	$55,195
Total	2,439	601	1,338	4,378	$36,020

Source: IMPLAN and TEDCO Survey

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