Institute for Public Policy and Business Research
University of Kansas

607 Blake Hall
Lawrence, Kansas 66045

PUBLIC RETURNS TO TECHNOLOGY TRANSFER

An Evaluation of the
Kansas Technology Enterprise Corporation
Using the ROPI Methodology

Final Report

Prepared by
David Burress, Associate Scientist
and
Pat Oslund, Research Economist

Prepared for

Kansas Technology Enterprise Corporation

Mohamed El-Hodiri
Acting Co-Director, IPPBR
Principal Investigator

Charles Krider
Acting Co-Director , IPPBR

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Executive Summary I: Study Overview

A. Purpose

Throughout the 1980s, state governments greatly expanded their role in economic development. Individually, states adopted programs that ranged from traditional approaches focusing on business subsidies and tax breaks through "new wave" approaches focusing on resource enhancement and public-private cooperation. As part of a comprehensive economic development initiative in Kansas, the Kansas Technology Enterprise Corporation (KTEC) was established as a nonprofit corporation in 1987. KTEC's legislated mission is to foster technological innovation, and to promote the creation, growth, and expansion of Kansas enterprises. As of June, 1993, KTEC supports over fifteen programs and commands a budget of over $8 million.

As state-level economic development programs have expanded and increased in complexity and funding, so has the call for accountability of these programs. Several states have started to design systems to monitor the results of their development efforts. The ROPI (or Return On Public Investment) system of evaluation was designed by the Institute for Public Policy and Business Research (IPPBR) at the University of Kansas under a KTEC grant during 1991-92. It is applied for the first time in this report. The purpose of the report is to provide information and recommendations in support of three different kinds of evaluation efforts, as discussed below:

1. Evaluation of the Kansas Technology Enterprise Corporation by its "owners" (the citizens of Kansas), and by their elected policy team (the Kansas legislature and the governor). This report is intended to inform public decisions concerning KTEC funding, programs, and policies.

2. Evaluation of the component programs of KTEC by its management team (Board of Directors of KTEC, officers, and others). This report is intended to inform KTEC's internal program management. The information is intended to be useful in helping KTEC to make budget allocation and program design decisions.

3. Evaluation of the new ROPI methodology that was applied in this report. The ROPI project provides lessons and insights on how to evaluate government programs. The report describes a method of evaluation which should be of interest or potential interest to the officers and directors of KTEC, the Kansas legislature, the governor, and the Kansas voters, as well as to policy-makers in other states. The report is intended to inform their decisions on the selection and funding of evaluation studies.

Summary Table 1
Potential Uses of ROPI Report Information

Type of Evaluation	Identity of Potential Evaluators	Types of Decisions
Evaluation of overall KTEC performance	Kansas citizens; elected officials including legislature and governor	Funding and other public policies affecting KTEC
Evaluation of KTEC component programs	KTEC Board of Directors; KTEC officers; KTEC staff	Internal management decisions, including allocation of funds
Evaluation of ROPI methodology	Kansas voters; legislators; governor; KTEC Board, officers, and staff; others interested in evaluation methods	Decisions on the selection and funding of evaluation studies

B. The Nature of KTEC

1. KTEC is governed by a 20-member board of directors composed of financial, academic, and government leaders.

2. To stimulate innovation and its commercialization, KTEC:

   - Finances collaborative research and technology transfer between academic institutions and industry through the Applied Research Matching Fund;
   - Finances five Centers of Excellence at four state universities for basic and applied research and technology transfer;
   - Provides seed capital financing for new and emerging technology-based Kansas industry through the Ad Astra Fund;
   - Provides matching grants for the federal Small Business Innovation Research program;
   - Provides technical information and referral services to new, emerging or mature businesses;
   - Assists community and vocational technical institutions in acquiring state of the art equipment for training and retraining the local workforce;
   - Targets the retention and expansion of current Kansas businesses through a state-wide industrial liaison program; and
   - Intends to accelerate the rate of commercialization of products and processes through Commercialization Corporations throughout the state.

3. The goal of the Applied Research Matching Fund program is to assist Kansas businesses in overcoming technical and financial hurdles in new product development. A product must apply current scientific and technological knowledge and lead to new developments that can have a positive impact upon the Kansas economy. KTEC funds 40 percent of the research, with the participating company covering the remaining 60 percent of the costs. If the product becomes commercially successful, KTEC receives a royalty on product sales.

4. The Centers of Excellence program is a vehicle for meshing expertise, equipment and facilities for basic and applied research and development efforts. Each center offers its own area of expertise, including aviation, manufacturing processes, pharmaceuticals, computer-aided design, and woods, plastics and printing.

5. Early stage or start-up firms in the advanced technology industry have tremendous potential for growth. They also have tremendous needs for capital. Thus in 1988, the state worked through KTEC to develop a private limited partnership with Campbell-Becker Inc., creating a seed capital fund known as Ad Astra. The portfolio is made up of high quality, high return investments whose technology has broad market appeal, and which have been found to have highly motivated management.

6. In 1992, KTEC successfully competed for and won a National Institute of Standards and Technology funded Manufacturing Technology Center. This center is nationally known as MAMTC--the Mid-America Manufacturing Technology Center. MAMTC's focus is technical consultation, training, demonstrations, and assistance to small and medium-sized manufacturers in Kansas, western Missouri, and Colorado.

7. The Applied Research Matching Fund, the Centers of Excellence, and KTEC internal operations account for approximately 75 percent of KTEC expenditures through 1993. To date, the present value of legislated KTEC expenditures is approximately $43 million. This figure consists of legislative allocations ($39 million), plus an allowance for a return at 11.5 percent per year on the public monies invested during 1987-1993.

8. Since fiscal year 1989, KTEC's funding has been entirely from the Economic Development Initiatives Fund, which consists of revenues from the Lottery and Racing Commissions. KTEC currently receives no general fund monies–those monies generally considered to be tax revenues.

C. The ROPI Project

1. Broadly speaking, the ROPI project involved five types of activities: determining the goals of economic development; establishing quantitative indicators of progress on these goals; collecting data related to these indicators; constructing economic models to project

the impacts of development activities on the state economy; and consolidating the information from the data and the economic models into a set of numbers that indicates the relative success of economic development programs.

2. Using a formal process, a representative panel of Kansas citizens determined that the five most important goals of economic development in Kansas include the business climate, the quality of the workforce, the number of "good jobs," the total number of all jobs, and the total amount of income.

3. The goals of economic development were generally stated in broad terms. In order to gauge the impact of KTEC programs on these goals, it was necessary to translate the goals into a set of quantitative indicators. Economists at IPPBR developed fourteen measurable indicators of the five goals. As an example, "number of jobs requiring post-secondary education" was used as one of the indicators for the goal of "good jobs." The indicators were discussed with the representative panel and with the KTEC staff, and a consensus was reached.

4. Economists at IPPBR then compiled raw data concerning KTEC program impacts. Data sources included surveys of the clients of KTEC-supported programs, data from the KTEC internal database, and data from KTEC and associated program budgets.

5. IPPBR economists constructed several economic models that used the raw KTEC data as inputs. In some cases, the models estimated missing data items based on state and national averages. More importantly, the models estimated so-called "multiplier" effects that occur when the income generated in the state is spent and provides a second and third round of income to additional firms and workers.

6. Economists at IPPBR developed a formula for measuring the success of economic development programs. Both the formula and the entire system of evaluation based on this formula are referred to as ROPI. Technically, ROPI is defined as the ratio of weighted "benefits" (actual gains in the indicators caused by KTEC) to weighted "costs" (potential losses in the indicators caused by the burden of taxes that would be needed to support KTEC), minus 1.

7. Although the ROPI formula is complicated, the logic behind it is straightforward. The formula is built around two simple concepts:

a) benefit-cost ratio. The benefit-cost ratio compares the gains achieved by a program to the losses induced by the taxes necessary to support the program. Suppose, for example, that an economic development program creates 100 jobs, but that the taxes collected to support the program destroy 25 jobs. Then the benefit-cost ratio is 100 to 25, or 4 to 1.

b) rate of return. The rate of return looks at the benefits of a program over and above the initial investment in the program. Continuing the example above, the program would create 75 jobs more than the 25 jobs lost to taxes. The rate of return would be 75/25, or 3. The rate of return is simply the benefit-cost ratio minus one. In other words, subtracting 1 from the benefit-cost ratio leads to a result which is negative when the project is a complete flop (i.e. costs exceed benefits), and positive when the project shows some success (i.e. benefits exceed costs). Moreover, the greater the success, the higher the rate of return.

8. The actual ROPI formula adds an additional dimension to benefit-cost calculations. ROPI assumes that there is no single indicator of economic development; economic development is many-faceted (multi-dimensional). The formula makes use of a set of economic development weights determined by the representative panel in order to sum together multiple indicators of multiple goals.

D. Results and Conclusions

1. ROPI values were calculated for the six largest programs supported by KTEC: five university Centers of Excellence and the Applied Research Matching Fund. The MAMTC program was not included in the evaluation because the program had been in existence fewer than two years when the evaluation was conducted. The Ad Astra Fund was not evaluated because of concerns about data confidentiality. Smaller KTEC programs were not evaluated because of time and resource constraints, and because their inclusion was unlikely to have major effects on the overall measure of ROPI.

2. The overall ROPI for KTEC was measured to lie between 36 and 141. That is, the weighted benefits of KTEC activities (measured in terms of jobs, income, etc. created directly and indirectly by KTEC) are between 37 and 142 times as large as their weighted costs (measured in terms of jobs, etc. lost due to taxes that would be needed to pay for KTEC).

3. In absolute terms, this result shows that KTEC has been highly effective at promoting economic development. However, KTEC cannot be compared in relative terms to other economic development programs at this time, because no other ROPIs have been measured.

4. Each of the six individual programs evaluated was found to be highly effective. Even so, there was a large amount of variation in ROPI across programs. However, it was shown that blind chance caused a substantial part of this variation. At the same time, the riskiness due to blind chance is likely to cancel out to some extent across programs.

Therefore, KTEC needs to maintain a "portfolio" containing many separate programs, so that the relative riskiness of the whole is less than the relative riskiness of any one part.

5. As a lower bound, KTEC activities are responsible for at least 12,000 job-years (a job-year is a job filled for one year) since 1987. These include direct results as well as the indirect results calculated by our models. As an upper bound, KTEC is responsible for around 100,000 job-years. Similarly, KTEC is responsible for between $500 million and $4 billion in personal income earned in Kansas.

Executive Summary II: Recommendations of the IPPBR Authors

A. Recommendations for Allocation of Funds

1. The ROPI study shows that KTEC has been effective and demonstrates this effectiveness with clear evidence. Therefore, if the Kansas legislature does continue to fund economic development programs, it should give a high priority to continued funding for KTEC.

2. All six programs examined in this report are effective; if KTEC continues to be funded, then all six should continue to be supported. Each program has a significant degree of riskiness, in the sense that economic development results (whether measured by ROPI or by some other terms) are likely to vary substantially across time. However, the portfolio of several programs working together is significantly less risky than would be the individual programs acting separately.

3. State funding for the ARMF program should be increased to the extent that high-quality ARMF applications exceed appropriations. This program seems to be exceptionally productive, has a client pay-back system, and has the potential to become fully client-supported in the long-run.

4. Increasing the fraction of support coming from non-state government sources increases ROPI. It follows that KTEC should create incentives (if possible) to encourage each program to gradually increase its reliance on support from clients as well as on out-of-state grants.

5. KTEC should explore reallocating its budget among the university Centers in the future so as to encourage stronger efforts toward economic development. The Center programs show considerable variation in performance. Since there appears to be a large element of blind chance in the success of different programs, it would probably be a mistake to condition all future funds on past success. At the same time, some degree of conditionality would certainly increase the incentive for the Centers to concentrate their efforts on economic development, as opposed to competing institutional goals. In particular, KTEC action may be needed to strengthen incentives for Centers to do more technology transfer in proportion to training or academic research. KTEC has effectively moved to correct this deficiency by creating Commercialization Corporations which accelerate technology transfer from the Centers and promote more directed research at these Centers.

B. Recommendations for KTEC Operations

1. Contracts between program agencies and clients should provide for periodic economic impact surveys. This approach is currently utilized in the Applied Research Matching Fund program, and could be applied to other programs within the agency.

2. Contracts with clients should provide for pay-backs to the agency when projects are commercially successful. Again, this process is currently employed in the Applied Research Matching Fund program and could be applied to other programs as well.

3. KTEC and the Centers should work together to agree on accounting requirements that would support the attribution of public costs to particular clients, and facilitate program evaluation.

C. Recommendations for Improving the Effectiveness of the ROPI Process

1. Client survey questionnaires should: be standardized across programs to the extent possible; be designed by survey specialists; be brief (two pages is ideal); promise confidentiality; and gather customer satisfaction and program improvement data in the same survey with economic impact data.

2. The client survey should: be repeated at least annually; be administered by an impartial third party; avoid redundant surveying; and be restricted to major clients.

3. Additional ROPI development work should: concentrate on improving the model of causal attribution between KTEC intervention and firm success; seek tighter upper and lower bounds on ROPI; and provide additional goals and indicators.

4. Additional evaluative work should examine whether the differing internal administrative processes followed by the Centers of Excellence and the other semi-autonomous KTEC programs have any impact on results.

Executive Summary III: Technical Aspects of the ROPI Study

A. Macro Approaches to Evaluating Technology Programs

1. During the 1980s, most states in the U.S. greatly expanded their spending on technology programs. In 1988, Kansas state technology spending lagged considerably behind the national average. It is likely that Kansas spending is now closer to the national average, due to the expansion of KTEC and the initiation of the MAMTC program.

2. IPPBR attempted a macro evaluation of KTEC programs, looking at the correlations between state technology spending and economic performance. This effort was largely thwarted by inadequate data.

3. However, information is available on more general questions about technology and economic growth. The academic literature indicates that research and development spending acts as an engine to growth at the national level. IPPBR's data analysis suggests that R&D is an engine of growth at the state level as well.

4. An examination of current Kansas technology indicators shows that the levels of technologically advanced activities in Kansas are similar to the national averages.

B. Client Surveys

1. Surveys of client firms were conducted for each of the five Centers of Excellence and for the Applied Research Matching Fund program. About 90 of the surveys administered by IPPBR and the Centers were returned, with a response rate a little over 45 percent.

2. According to the surveys, projects for which clients received assistance from KTEC created approximately 900 new jobs and over $100 million per year in new sales in Kansas as of 1993. Of course not all of this job and revenue creation can be attributed directly to KTEC's intervention; KTEC was typically one of many factors facilitating growth. On the other hand, many additional jobs and substantial additional revenues were undoubtedly generated by firms that did not respond to the survey. Furthermore, these results exclude any multiplier effects or other impacts calculated by economic models.

3. Most client firms reported a reasonably high degree of satisfaction with the services they received.

C. The Definition of ROPI

1. Standard methods of evaluation such as return on investment (ROI) and ordinary benefit-cost analysis are inappropriate for organizations like KTEC because they assume that the organization has a single goal. ROPI or Return On Public Investment is an evaluation method which generalizes benefit-cost analysis to the case of multiple goals–i.e. the multiple goals of economic development.

2. ROPI was applied to KTEC using the following steps:

   a. Selecting a representative panel of citizens.

   b. Assisting the panel in determining the general goals of KTEC's economic development efforts and asking the panel to weigh the relative importance of each goal. ROPI panel members adopted a final list of economic development goals, and then developed overall weights for the goals using a method known as the "analytic hierarchy process."

   c. Developing measurable indicators corresponding to each goal. The panel members approved fourteen indicators developed by IPPBR staff as measurable proxies for these five goals.

   d. Estimating the social discount rate. A discount rate simply reflects that most people would rather have a dollar in hand this year rather than waiting until next year. Among other things, the dollar in hand this year could earn interest between this year and next. The *social* discount rate reflects the tradeoff, on average, that people are willing to make between public dollars spent this year and results from the public projects realized next year. The IPPBR researchers estimated a social discount rate of 11.5 percent based on two panel surveys and a panel discussion. This means that, on average, the panel would require a return of at least 11.5 percent on their investment of tax dollars.

   e. Developing economic models and methods to measure the positive effects of KTEC on each indicator (the "benefits"), and developing economic models to measure the negative effects on each indicator due to the taxes needed to pay for KTEC (the "costs").

   f. Calculating ROPI as the ratio of the weighted benefits to the weighted costs, minus one. A separate ROPI was defined for each indicator. A separate ROPI was also defined for each goal (using appropriate weights on data at the indicator level). And an overall final ROPI score was defined using the weighted goals.

3. The ROPI estimated in this report is an appropriate measure of KTEC's success at fostering economic development given the assumed goals of economic development. That is, ROPI is an evaluation of outcomes. ROPI may not be appropriate as a measure

of the quality of the effort put out by KTEC because it is *not* an evaluation of processes. And this ROPI would not be appropriate in the future if the goals of economic development in Kansas shift over time; instead, a new set of goals and indicators would lead to a new ROPI value.

D. Economic Modeling

1. Micro-ROPI is an interrelated set of computer programs that:
   a. process primary data from surveys and budgets to estimate direct KTEC effects;
   b. infer total (= direct plus indirect) KTEC effects;
   c. relate total effects to the goals of economic development; and
   d. calculate comparisons of benefits and costs.

2. KTEC direct costs were defined to include all Kansas tax dollars spent in support of KTEC programs. The ROPI model then estimated the "opportunity cost" of the budget dollars spent for KTEC programs. In other words, it inferred the positive effects on the Kansas economy that would have resulted if the dollars had been spent on lowering taxes instead of on KTEC.

3. Leveraging takes place when the investment of state tax funds results in additional investments from other sources, generally from the federal government or private firms. The economic models incorporate all leveraging effects because the total (state, federal, and private) investment appears in the benefits calculations, while only the state part of the investment appears in the cost calculations.

4. In order to calculate KTEC's direct benefits, the survey and budget data were expanded using a number of models of firm costs, firm investment behavior, and government spending patterns.

5. Indirect benefits and indirect costs (i.e. effects on third parties) were estimated through a detailed model of Kansas economic linkages (named KSSAM2).

6. ROPI calculations were performed for two different scenarios, namely a lower bound and an upper bound. The scenarios differed in their treatment of firms that did not respond to our surveys and in their treatment of future benefits. For the lower bound, only benefits actually reported on surveys were included, and future benefits were ignored. For the upper bound, sampling weights were applied to survey responses and jobs and other variables were assumed to remain at their projected levels until the year 2000.

E. Additional Results and Conclusions

1. The measured ROPI results vary over a wide range, depending on the choice of the upper or lower bound scenario. Nevertheless, under any reasonable assumptions the results for KTEC appear to be quite positive.

2. KTEC's lowest ROPI for an individual goal is between 10 and 82 for "highly skilled workforce." KTEC's highest ROPI for a goal is between 67 and 184 for "supportive business climate." KTEC's ROPI by individual indicator ranges from a low of between 11 and 72 for "infrastructure" to a high of between 238 and 374 for "business start-ups."

3. Results for a given KTEC program may vary a great deal year to year due to chance as well as inherent measurement error in the model. Furthermore, different programs have different time horizons, so the comparisons could look very different ten years from now. Also, outcomes at individual Centers are sensitive to many factors beyond the control of the Centers. Therefore, the initial results do not necessarily provide a fair comparison of performance across programs.

4. At the same time, there are substantial differences in achieved economic development among the KTEC programs. The top three programs in terms of *achieved* returns on public investment are the Center for Technology Transfer, the National Institute for Aviation Research, and the Applied Research Matching Fund program.

5. ROPI is not directly comparable to an ordinary ROI. In technical terms, ROI is an internal rate of return, while ROPI is a benefit-cost ratio. Measured ROPIs turned out to be much larger than measured ROIs in this project; we believe the same result is likely to occur in future applications. Different (and tougher) standards are needed for judging ROPIs than for judging ROIs.

6. In terms of cost-effectiveness, $1 million of state expenditures on KTEC programs generates the equivalent of between $12 million and $98 million in income; between 300 and 2500 jobs-years; between $.5 million and $5 million in additional tax revenues from businesses; and between 2 and 3 manufacturing start-ups.

1. Introduction

Chapter Summary

1. The mission of the Kansas Technology Enterprise Corporation is to foster technological innovation and promote the creation, growth, and expansion of Kansas enterprises.

2. KTEC is structured as a "network organization."

3. Network organizations and economic development organizations have multiple goals because they have multiple bosses and multiple stakeholders.

4. Methods of evaluation such as return on investment (ROI) and ordinary benefit-cost analysis are inappropriate to organizations like KTEC because they assume that the organization has a single goal.

5. ROPI, or Return On Public Investment, is an evaluation method which generalizes benefit-cost analysis to the case of multiple goals.

6. ROPI was applied to KTEC using the following steps:

   a. Selecting a representative panel of citizens or policy-makers.

   b. Assisting the panel in determining the general goals of KTEC's economic development efforts.

   c. Asking the panel to weigh the relative importance of each goal.

   d. Developing measurable indicators corresponding to each goal.

   e. Developing economic models and methods to measure the positive effects of KTEC on each indicator (the "benefits").

   f. Developing economic models to measure the negative effects on each indicator due to the taxes which would be needed to pay for KTEC (the "costs").

   g. Calculating ROPI as the ratio of the weighted benefits to the weighted costs, minus one.

7. The ROPI estimated in this report is an appropriate measure of KTEC's success at economic development given the assumed goals of economic development. It may not be appropriate as a measure of the quality of the effort put out by KTEC. And it may not be appropriate if the goals of economic development shift over time.

ROPI and the Role of KTEC

The Kansas Technology Enterprise Corporation, or KTEC, is a non-profit corporation created by the Kansas legislature in 1987 as part of a major economic development initiative. KTEC's mission is to "foster technological innovation and promote the creation, growth, and expansion of Kansas enterprises." [KTEC, 1992] KTEC is funded by profits from the Kansas Lottery and Kansas Racing Commission as well as by private contributions. KTEC uses that money to help businesses across the state gain new technologies so that they can compete globally, introduce innovative products, and create new jobs in Kansas. KTEC also assists entrepreneurs and inventors.

KTEC operates in the political context of a growing demand for evaluation and accountability of government programs. To promote successful economic development, KTEC depends on the support of business, financial institutions, government, and, most importantly, the general public. That support in turn depends on positive public perceptions about the effectiveness of the KTEC program.

To meet this demand for accountability, in 1991 KTEC asked the Institute for Public Policy and Business Research to develop a method suitable to the evaluation of KTEC and its several activities. The method which resulted is named ROPI, an acronym for "Return On Public Investment." Technical aspects of the ROPI method are documented in a previous report.[1] The present report applies the ROPI method and provides an evaluation of KTEC.

A Method of Evaluation that Reflects the Structure of KTEC

Even though KTEC is a state agency, it is structured and run in some respects like a private business. It is governed by a 20-member board of directors that includes financial, academic and government leaders. It has a president who acts as CEO and runs a small executive staff. It operates like a small holding company, with a portfolio of ventures. These ventures include the Applied Research Matching Fund; five Centers of Excellence at four Kansas public universities; the Ad Astra venture capital fund; several smaller operations; and joint efforts with other agencies, including the Kansas Agricultural Value-Added Center (KVAC) and the Mid-America Manufacturing Technology Center (MAMTC).

Return on investment, or ROI, is the unified measure of accountability most widely used in private business. ROI relates the goal accomplished by the business (i.e. the profit returned) to the means expended (i.e. the dollars invested). This ratio is

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[1] Burress *et al.* (1992).

meaningful because most businesses do have a unified goal, namely to make profits. This unified goal is reflected in their hierarchical structure. That is, most businesses have a single boss who can be held accountable for producing the bottom-line profit.

But in important respects KTEC is *not* like a private business; therefore, it is not meaningful to evaluate KTEC in terms of its ROI. Government activities such as economic development do not have any natural unified measure of accountability. What makes the difference is that these government activities are inherently political. They are inherently responsive to a common good defined by coalitions of voters who have disparate individual goals and individual interests.

This disparity of goals is reflected in the complex structure of KTEC's organization. KTEC exists within a web of many-sided relationships among Kansas agencies. Organizational theorists would describe KTEC as part of a "network organization." In a network organization, each agency–or each important subunit in the system–is responsible to more than one higher agency. In particular, KTEC is responsible to several agencies, including the legislature, governor, legislative committees, Kansas Inc., the private sector, and the voters. Moreover, the ventures run by KTEC are not responsible solely to KTEC; they are also responsible to other agencies, including the Board of Regents, the administrations of the universities, the MAMTC board, the Ad Astra board, as well as other private firms. A portion of this rather complex network of relationships is diagramed in Figure 1.1.

Being embedded in a network means that KTEC has multiple bosses; therefore KTEC has multiple goals. As a general economic development agency, KTEC seeks to create jobs and income in Kansas. As an agency designed to focus on case-work, KTEC needs to concentrate its attention on a relatively small number of client firms. As the creature of a legislative coalition, KTEC needs to demonstrate positive results in all of the sub-regions of the state. As a partner of the federal government in MAMTC, KTEC seeks to support manufacturing technology in several states.

Moreover, each venture supported by KTEC has its own multiplicities of bosses and goals. The Centers of Excellence, in particular, are responsive not only to KTEC's mission of technology transfer, but also to the universities' missions of education and basic research.

Multiple goals lead to multiple and diffuse measuring rods for KTEC and for its ventures. Moreover, the relative political *weights* that policy-makers place on these different goals may change over time. These factors exacerbate two kinds of problems in evaluation and control experienced by KTEC:

1. KTEC has an *internal* control problem:
   - KTEC needs to make choices between different programs and different projects;
   - KTEC needs to make choices within different programs and different projects.
2. KTEC has an *external* control problem as well:
   - KTEC needs justifications for its internal choices;
   - KTEC needs accountability to the legislature and the public;
   - KTEC has much data on performance but no coherent way to analyze its significance.

Like many other network organizations, the KTEC network addresses these problems of control using the method sometimes called "contingent allocation." In other words, the legislature allocates a budget to KTEC, and KTEC re-allocates it among several sub-programs. Managers at each level then try to make each lower-level budget contingent on meeting specified goals.

Businesses, on the other hand, are ordinarily managed in a more direct "command and control" fashion. That is, the boss just tells the subordinate what to do. Some of the differences between a network organization and a business-type hierarchy are summarized in Table 1.1.

ROPI and Benefit-Cost Analysis

ROPI is an effort to assist the "contingent allocation" control process by making KTEC's multiple and qualitative goals more quantitative. Thus, ROPI is designed as an evaluation and control method for a network organization. In particular, ROPI is a generalization of benefit-cost analysis designed to address the multiplicity of goals.

Benefit-cost analysis is the tool economists most commonly use to evaluate government and public programs. Ordinary benefit-cost analysis assumes that economic markets are imperfect but perfectible. Each government action is viewed as an effort to fix a particular market failure. Benefit-cost analysis guides the actions of government by modeling the way that perfect markets would work. In particular, the degree of market failure is measured by the loss in real income that results from the failure. In other words, benefit-cost analysis is used for evaluating questions about narrow efficiency, using total real income as a unified measure of accountability.

Benefit-cost analysis is generally *not* used for what economists call "distributional" questions, i.e. policy questions about what groups should receive what amount of income. The resolution of distributional questions depends on the type of value judgments which economic markets are ill-suited to decide. Distributional judgments are normally made through votes and politics–mechanisms that some economists like to call "political markets" to distinguish them from economic markets.

Economic development is, quite fundamentally, a distributional problem *as well as* an efficiency problem. For example, it is *not* a goal of Kansas economic development to find the most efficient location for industry; instead, its goal is to locate industry into *Kansas*, so as to make *Kansans* better off. A pure "efficiency" or market approach would consider, as one possible alternative, closing Kansas industry down entirely. But most Kansans will probably agree they do not wish to consider that possibility.

Therefore, most Kansans are probably agreed on the general distributional goal of increasing industry in Kansas. But on more specific distributional questions, there is likely to be much less agreement. *Where* in Kansas should we try to attract industry? *What kind* of industry should we attract? And *who* in Kansas should receive the benefits?

To answer these kinds of questions, we need to augment benefit-cost analysis with a mechanism for making value judgments about income distributions across locations, income distributions across industries, and distributions of new income among occupations and income groups. Moreover, we may need to make value judgments that do not relate only to income: Are total jobs in Kansas more or less important than total income in Kansas? Are ten jobs this year more important or less important than fifteen jobs next year? Is the quality of life more or less important than jobs?

Thus ROPI is based squarely on value judgments, because it necessarily must be. An immediate problem in this kind of analysis is finding a legitimate *source* for these value judgments; i.e. a source that can be accepted by the various stakeholders in Kansas.

The Representative Panel

In general terms, KTEC is a public agency of Kansas, and Kansas is a representative democracy. Therefore, the ROPI method is based on the premise that distributional value judgments should be made through the procedures of representative democracy. In particular, the ultimate value judgments should *not* be made by academics or non-elected officials; they *should* be made by a panel of *legitimate* representatives of Kansas.

The present study employed a method that has been called a "policy jury." This mechanism is similar to a jury in a court of law, but it is focused on a general question of public policy rather than on a particular case. To form the panel used in this study,

KTEC invited a group of seven Kansas citizens who represent a variety of points of view. This "representative panel" consisted of three men and four women. They included a state senator and a state representative; several business people; a teacher; a city administrator; a community volunteer; and residents of several parts of the state. Their names and affiliations are listed in Chapter 2.

In some respects, the policy jury used in this study was necessarily somewhat short of being fully representative. The panel was chosen neither by the voters, nor by their elected representatives, nor through a method set out by law. Rather, they were chosen through an *ad hoc* procedure motivated by practicality. Moreover, members of the general public received no opportunity to express their opinions to the panel. For future applications of ROPI, it is a recommendation of this report that the Kansas legislature and the governor should institutionalize ROPI by means of legislation, resolution or executive order, and should provide a definite method for selecting the representative panel. The legislature and governor may want to provide for a public hearing procedure as well.

Goals and Weights

After agreeing to serve on the panel, panel members were led through a structured process. In the first stage, they were educated about ROPI and about the mission and organization of KTEC. In the second stage, they were presented with an initial list of possible economic development goals for the state of Kansas. The initial list was drafted by the IPPBR and KTEC staff based on a survey of many documents. The panel was asked to discuss, modify and augment the list. The modified list included goals such as having a good business climate in Kansas; increasing total income and wealth in Kansas; and increasing the number of "good" jobs in Kansas. For a complete list of the goals, see Chapter 2.

In the third and most critical stage, the panel members were asked to rank and weigh the various goals on the modified list using the analytic hierarchy procedure; this procedure is described in more detail in Chapter 2. The weights that resulted were applied in the calculation of ROPI.

In subsequent stages of the project, the panel members were asked to provide supplementary value judgments. They were asked to provide a preferred rate of trade-off between future jobs and present jobs (what economists call a "social discount rate"). They were asked to review the economic modeling work described below, and they were asked to review and comment on this report.

Indicators and Models

The IPPBR staff accepted the top five goals chosen by the panel as the basis for their subsequent work. As a first step, the staff defined one or more "indicators" of success for each goal. Each indicator consisted of a measurable economic quantity; moreover each indicator could be measured in Kansas, at least approximately, at an affordable cost. Some examples of the chosen indicators are: business start-ups (for the goal of business climate); jobs in Kansas paying more than $18,000 per year (for the goal of good jobs in Kansas). Fourteen indicators were chosen in all.

Second, with respect to each indicator, the staff developed measurement techniques for estimating three quantities:

1. the positive direct effects of KTEC operations on that indicator (e.g. the jobs created by the firms helped by KTEC);

2. the positive indirect effects of KTEC operations on that indicator (e.g. the jobs created by the firms selling to the firms helped by KTEC); and

3. the total negative effects on that indicator that result from spending those dollars on KTEC rather than on reducing taxes (e.g. the jobs that could have been created by a tax cut).

These measurement techniques are based on economic surveys and economic models described in Chapters 3, 4, and 5. The measurement results are given there and in Chapter 6.

The positive effects (1) and (2) above are referred to as "benefits"; the negative effect is referred to as the "cost" or "opportunity cost."[2] For each indicator, a ROPI can be calculated in terms of that indicator as:

[(total benefits for that indicator) / (total costs for that indicator)] - 1.

More importantly, an average ROPI over all indicators is calculated as:

[(total weighted benefits for all indicators) / (total weighted costs for all indicators)] - 1.

This ROPI measure is positive if and only if the benefits exceed the costs (that is why we have subtracted 1). Moreover, it is reasonable to believe that success in economic development corresponds to a high value of ROPI. It is also reasonable to compare the

[2] When these costs and benefits differ over time, we normalize them by calculating a present value (at the social discount rate).

relative success of different economic development programs in terms of their measured ROPIs.

Outcome Evaluation versus Process Evaluation

The ROPI method addresses two main tasks:

1. it provides a formal method to determine the goals of economic development, as well as their relative political weights; and
2. it provides a quantitative measure of KTEC's success at reaching those goals.

ROPI (like ROI as well as benefit-cost analysis) is a method for evaluating the *outcomes* or results of an economic activity (the "black box" approach). It does not provide much information about the *process* or the quality of the effort put forth under the activity (i.e. it does not try to look inside the black box).

An evaluation of outcomes is logically independent from an evaluation of processes. For example, in the case of a private business, a high ROI signifies that things are going well, and a low ROI indicates that things are going badly; but ROI does not explain *why* things are going as they are. For that kind of diagnosis, you need to look inside the operation of the business.

Similarly if a ROPI study indicated that outcomes are not satisfactory, then a follow-up evaluation of KTEC processes might be needed for diagnostic purposes. And even if the ROPI outcome is found to be highly satisfactory, a separate evaluation of KTEC operations might uncover some possible improvements. So ROPI by design cannot answer all of the relevant questions the public or the policy-makers might ask about KTEC. However, ROPI does seek to answer the single most important question about KTEC: does the KTEC program work? That is, is KTEC successful at what it does?

Shifting Goals

In any public policy environment, agency goals do tend to shift over time. That makes it hard to define what is meant when one asks whether an agency is succeeding. The necessary first step in any evaluation of success is to identify the goals that are to be considered important or salient. Different outcome evaluations might reflect very different views on which types of goals are salient. It may be useful to classify evaluations along a scale between two polar types, depending on the degree of generality of the goals that are considered to be salient.

The most specific type of standard is one which evaluates a program only with respect to those goals the program was originally intended to serve. This kind of evaluation would be appropriate when all of the following conditions hold true:

1. the program is being evaluated without direct comparison to other programs;
2. the original goals of the program were explicitly stated; and
3. the original goals are still accepted by the current decision-makers.

The most general type of standard would be one that evaluates every program of government with respect to the widest possible range of government goals. This kind of evaluation might be appropriate when:

1. one program is being compared to all other government programs, or
2. when the goals of a program are uncertain or have changed over time, or
3. when the goals are politically contested.

ROPI could be applied to either the specific or the more general form of outcome evaluation. ROPI could be applied using any set of goals, provided that measurable indicators can be identified for each goal. Moreover, the ROPI approach provides a formal method to select the goals that drive the evaluation.

However, there can still be a problem when goals shift over time. For example, KTEC might be performing very well in terms of its original goals; it might at the same time be performing poorly in terms of the goals of a newly elected administration. This raises a political problem, not a technical problem. In technical terms, it is entirely feasible to calculate two values of ROPI, one using the original goals and the other using new goals. The political problem for the legislature is to decide which ROPI value is more relevant.

More generally, when goals shift over time, there needs to be a political decision on how much time to allow agencies for shifting their operations (if they can shift) so as to succeed under the new set of goals. From the point of view of an agency trying to comply with political goals, it is an important advantage of the ROPI method that any shift in political goals is made perfectly explicit.

This problem of shifting goals may not be too serious in practice. Among the five goals and fourteen indicators of economic development developed for the present application of ROPI, simulations of the model indicate that the ROPI values are rather positively correlated. This suggests that any policy conclusions based on ROPI may be at least moderately insensitive to shifts in the relative weights of the goals.

In the present study, we tried to identify the *current* goals for all Kansas economic development programs in general. Thus, KTEC is being compared in this report to a standard that could be considered appropriate for all economic development programs run by the state of Kansas at the present time. It would not be an appropriate standard for other state programs such as education or income maintenance or crime prevention. And it may not be appropriate in the future if the goals of economic development are perceived to shift.

Conclusion

The steps we followed in applying ROPI to KTEC are summarized in Tables 1.2 and 1.3. These steps fall into two separate streams of activity. In the organizational stream of activity, IPPBR staff worked with KTEC and the panel to establish the value framework. In the technical stream of activity, IPPBR gathered data from KTEC and other sources and created computer models to determine numeric values for ROPI. (See Tables 1.2, 1.3)

In this chapter, we have tried to argue that these steps have a kind of inevitability–they follow directly from the nature of the problem of evaluating an organization like KTEC. The remaining chapters of this report describe how we implemented this procedure and what lessons we believe we have learned along the way.

Table 1.1
Characteristics of Two Types of Organization

Organizational Characteristic	Network Organizations	Hierarchies
Stakeholder Groups:		
Number of individuals per group:	few to many	few to many
Number of groups:	several groups (nodes)	many groups (levels)
Internal Coordination:		
Main method:	contingent allocation	command/control
Main orientation:	vertical (patronage)	vertical (traditional authority)
Structure of Internal Authority:		
Number of "bosses":	several	one
Legitimacy:	contested	accepted
Measures of Organizational Accountability:		
Number:	many	few
Consistency:	conflicting	unitary
Credible units:	perceptions of worth	profits revenues membership

Table 1.2
The ROPI Organizational Stream

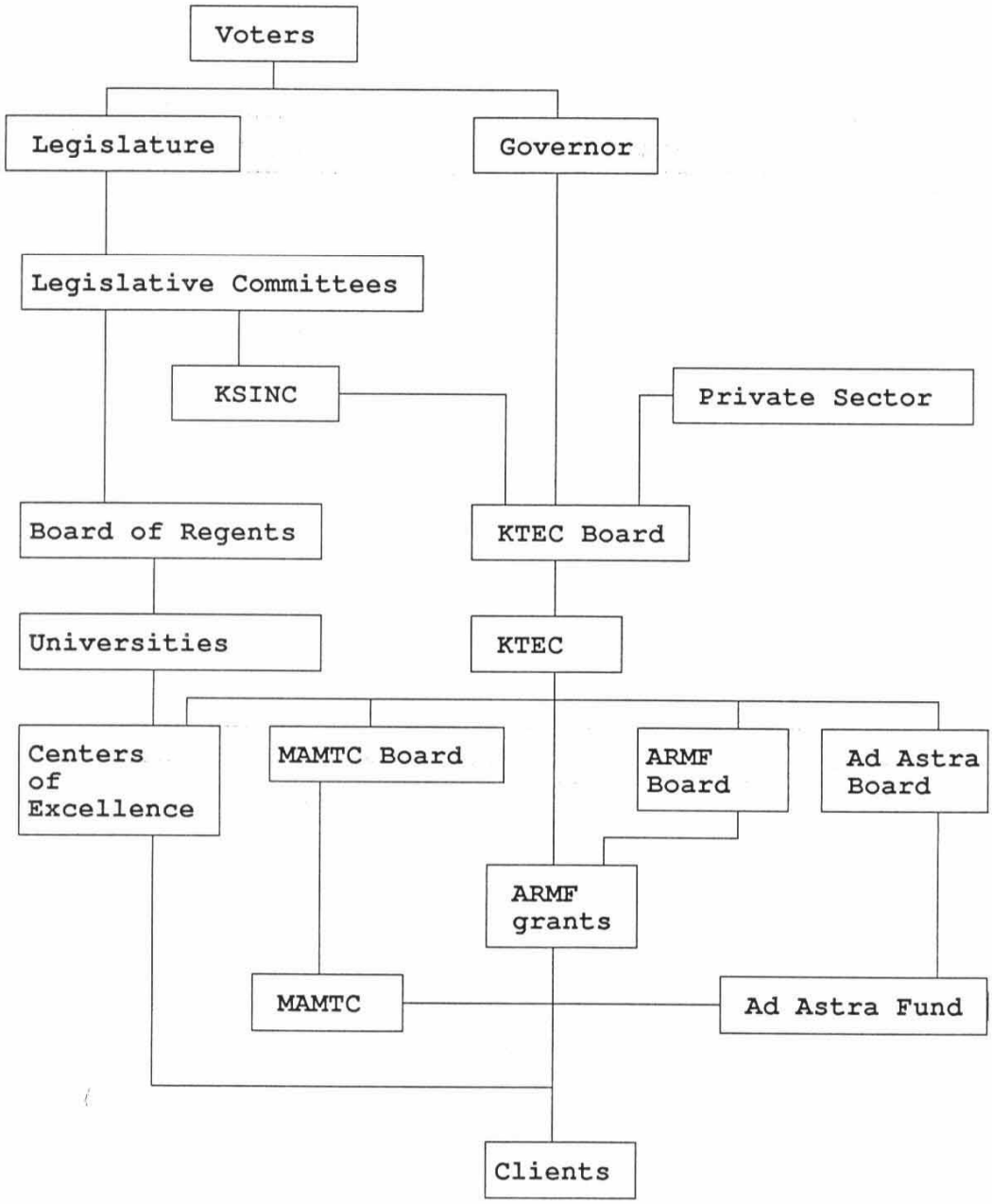
Actors	Actions
KTEC	Recruits panel of representative citizens
{Legislature}	{Selects new panel}
KTEC, IPPBR	Educates panel
IPPBR	Provides draft list of goals
Panel	Amends list of goals
Panel	Ranks goals
IPPBR	Calculates weights
Panel	Approves weights
IPPBR	Performs weighted impact study
Panel	Reviews impact study
{Panel}	{Makes recommendations to legislature}

{ } denotes proposed future activities

Table 1.3
The ROPI Technical Stream

Process	Actions
Analytic Hierarchy Process:	Define goals Interview Panel Calculate weights
Impact Modeling:	Define measurable indicators for each goal Build a Social Accounting Matrix Model for Kansas (KSSAM2) Calculate impact multipliers for each pair of KTEC activity/proxy indicator
Impact Study:	Estimate present value of losses of each proxy due to KTEC (mainly from taxes) Estimate present value of gains in each proxy due to KTEC
ROPI Estimation:	Calculate weighted losses, weighted gains Calculate ROPI = Gains/Losses - 1
ROPI Evaluation:	Compare ROPI: project selection (across sub-projects) KTEC accountability (across agencies)

Figure 1.1
The KTEC Network



2. Defining ROPI

Chapter Summary

1. ROPI panel members adopted a final list of economic development goals and then developed overall weights for the goals using the analytic hierarchy procedure.

2. The top five goals selected by the panel were concerned with the business climate; the quality of the workforce; the number of "good jobs"; the total number of all jobs; and the total amount of income (in each case, with respect to Kansas).

3. The panel members approved fourteen indicators developed by IPPBR staff as measurable proxies for these five goals.

4. Panel members accepted a social discount rate of 11.5 percent in the absence of any uncertainty.

5. Subsequent technical work of the IPPBR staff was determined by the list of indicators. The staff developed ways to measure:

- the positive effect of KTEC activity on each indicator
- the negative effect of Kansas state taxes on each indicator; and
- the multiplier effects.

These measurement methods are described in subsequent chapters.

6. A separate ROPI can be defined for each indicator. A separate ROPI can also be defined for each goal (using appropriate weights on data at the indicator level). And an overall final ROPI score can be defined using the weighted goals.

Introduction

This chapter focuses on the ROPI conceptual and value framework used in this study and focuses especially on the role of the ROPI panel in determining that framework. ROPI panel members were recruited by KTEC in early 1993. The members and their affiliations are listed in Table 2.1. Framework assumptions for the ROPI study were adopted by the panel over several months using a structured approach that relied on several written surveys. These framework assumptions included a careful statement of economic development goals; the adoption of the corresponding economic development

weights; and the adoption of a social discount rate. The appendix to this chapter contains the complete set of written surveys used with the panel.[3]

Proceedings of the ROPI Panel

The seven panel members met together with IPPBR and the KTEC staff for a total of five meetings. Each meeting was two to three hours in length and occurred in Topeka or Wichita. While some panel members missed some meetings, a majority were present at each meeting. Each survey was completed by all or nearly all of the panel members.

At the first meeting in April, 1993, IPPBR and KTEC staff presented descriptive materials on KTEC and ROPI. Panel members were also given copies of the vision statement recently developed by Kansas Inc. for Kansas economic development programs. Panel members were then led into a discussion of the particular goals of KTEC and the ultimate goals of Kansas economic development. This discussion continued over the course of the next two meetings and was assisted by a mail survey. The panel settled on a revised set of goals.

At the second meeting in May, panel members were asked to weight the relative importance of the revised goals. The idea of social time preference or a social discount rate was then explained to the panel members. This discussion was a lead-in to a mail survey of the panel on time preference.

At the third meeting in July, panel members discussed and approved the results of the survey on weights. IPPBR staff presented a list of possible indicators for the top five goals. Panel members discussed the indicators and proposed several additional indicators. The results of the first survey on time preference were presented. Then after a presentation on the effects of uncertainty on time preference, panel members were surveyed on social discount rates with and without "uncertainty."

In September, a trial run of ROPI on the Center for Technology Transfer at Pittsburg State University[4] was presented to the panel. The panel accepted the results of the social discount rate corrected for uncertainty. The panel also discussed policy questions related to the measurement of ROPI: Should recipients of KTEC assistance be required to

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[3] The procedures described in this chapter are referred to the "preference elicitation procedure" in Burress *et al* (1992).

[4] This Center was recently renamed the Center for Design, Development, and Production. We will refer to it by its older name of CTT throughout this report.

provide follow-up information on the economic impacts of their project? What agencies should evaluate this impact information?

In January, 1994, the panel members reviewed a draft of this report and provided their own additional comments.

Economic Development Goals

The most important task assigned to the panel was to determine the goals against which KTEC would be evaluated. At the April meeting, panel members were given an initial list of the possible goals of the Kansas economic development effort (reproduced in Table 2.2). Panel members asked to discuss and criticize these goals.[5] In the course of interviews with individual panel members and during the second panel meeting in May, the goals were redefined by the panel into the final economic development goals shown in Table 2.3. The number of goals on each list was restricted to ten, simply because a larger number of goals is difficult to handle in the analytic hierarchy process that we used in this study.

Economic Development Weights

The whole point of this study was to condense a large mass of data into a single number that provides an overall evaluation of the efficiency of KTEC activities. To accomplish this, we needed relative weights measuring the importance placed on each economic development goal by representative Kansas citizens. These weights were provided by the panel members.

At the second meeting in May, panel members were asked individually to compare each possible pair of goals out of the ten final goals (with 10 goals, there are 45 distinct pairs). Each panel member ranked the relative importance of the two goals in each pair, and then evaluated the difference in importance of the two goals using a scale of 1 to 10. Using the analytic hierarchy process model developed by Saaty (1980), these pair-wise comparisons were analyzed so that a final set of overall weights for the ten goals (with different weights for each panel member) was determined. The median weights were then used as economic development weights for this study. These weights are listed in Table 2.4.

The five top-weighted goals were concerned with the business climate; the quality of the workforce; the number of "good jobs"; the total number of all jobs; and the total

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[5] An earlier version of this list was developed during the first ROPI Project, as described in Burress *et al.* (1992).

amount of income (in each case, with respect to Kansas). Because of limited resources, the ROPI study concentrated on those five goals.

Overtly distributional goals were generally not included among the top five goals. The exception is "good jobs," which has to do with the opportunity for a social improvement in the distribution of income.

The Kansas Social Discount Rate

Another kind of weighting problem has to do with time. To form a unified measure of benefits from KTEC, we need a way to compare benefits occurring at different points in time (and similarly for costs).

In general, social benefits such as new jobs are likely to be perceived as more valuable when they occur sooner, and less valuable when they occur later. That is, just like private decision-makers, political decision makers are likely to place decreasing values on benefits as the waiting time before enjoying the benefits increases. This leads to the problem of weighting future benefits relative to present benefits (and similarly for costs). Weights of this kind for comparing benefits across time are referred to as "social discount rates." The panel members were asked to provide these rates.[6]

At the May meeting, the idea of social time preference or a social discount rate was explained to the panel members in terms of the value judgments that decision makers (e.g. the legislature) should make when trading off goals in the future against goals achieved in the present. To illustrate this idea, consider a choice between creating 1000 jobs during 1993, versus creating 1200 jobs during 1994. A choice of this type might arise, for example, in comparing a public jobs program which puts people to work immediately for one year, to a highway improvement project which would encourage industry later. Suppose that the two programs have the same cost to the state budget. If decision makers view the two programs as equally valuable, we would say that the decision makers have a social discount rate of .2 (i.e. 1200/1000 - 1). But if they prefer 1200 jobs later over 1000 jobs now, then their social discount rate is less than .2; and conversely.

This discussion was a lead-in to a mail survey of the panel. Results of the mail survey showed that the median discount rate supported by panel members was around 18 percent. Results for individual panel members varied from around 6 percent to 35 percent. The measured discount rate was also compared across several different social

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[6] Technically, the weights or discount factors are related to the discount rates by $R = 1/(1 + r)$, where R is the weighting factor and r is the social discount rate.

and personal goals (jobs, aggregate income, social taxes, personal taxes); the rates generally differed across goals by less than five percentage points.

To introduce a second survey on time preference, the effects of uncertainty on the social discount rate were explained to the panel. After viewing the survey results (contained in Table 2.5), panel members accepted a social discount rate of 11.5 percent in the absence of any uncertainty; and 18 percent in the presence of uncertainty about the effectiveness of government. Because the social discount rates appeared to differ only a little across economic development goals, a single average rate of 11.5 percent under perfect certainty was used for all goals in this study.

Indicators for the Goals

In this study, "goal" refers to one of the general purposes intended for an economic development program by policy makers or by citizens. Goals are supposed to be clearly defined, but they may or may not be easily measurable. "Indicator" refers to specific quantities which by definition are measurable at an affordable cost.

The ROPI method requires that one or more indicators be selected that correspond to each goal. An indicator "corresponds" to a goal if an average citizen is likely to believe that increases in the indicator imply that the Kansas economy is moving towards that goal. However, indicators do not necessarily correspond *perfectly* to the goal. Therefore several indicators may be assigned to a given goal; each indicator then reflects one aspect of the goal, or else represents one independent measurement of the goal.

The process of measuring an indicator needs to be affordable. That depends on finding two things:

- a method is needed (usually a survey of client firms) to measure KTEC's direct effects on that indicator
- a method is needed (usually an economic model based on published data sources) to measure KTEC's indirect effects and tax-cost effects on that indicator.

Consequently, the selection of valid indicators required a collaboration between IPPBR economists, KTEC staff, and panel members. All three parties suggested potential indicators; economists and staff then examined the measurability of each proposed indicator; panel members then determined whether each proposed indicator validly corresponded to an economic development goal. The indicators adopted for this study are listed in Table 2.6.

Some Variations of ROPI: The Point of View

KTEC's Return on Public Investment can be measured from different points of view:

- From a forecasting point of view, anticipated ROPI (or A-ROPI) measures the returns that are predicted by administrators of the KTEC program.
- From a backward-looking point of view, retrospective ROPI (or R-ROPI) measures the returns to KTEC that actually happened in the past.
- From a whole-economy point of view, macro R-ROPI attempts to measure the extent to which results of KTEC activities show up noticeably at the state-wide level.
- From a close-up point of view, micro R-ROPI measures the directly observable effects of KTEC activities, and estimates the indirect effects using an economic model.

This study evaluates KTEC outcomes, not KTEC plans. Therefore, it generally falls within the R-ROPI or retrospective framework. However, in any investment activity there is an asymmetry between the timing of costs and benefits. That is, some of the benefits from costs sunk in the past are likely to lie in the future. In particular, some of the benefits of past KTEC activities still lie in the future. To omit these future benefits would be to understate KTEC's ROPI. Therefore, we will provide variant ROPI measures which omit expected future benefits (i.e. a strict R-ROPI), and other variants which include them (i.e. a mixture of R-ROPI and A-ROPI).

Conclusion

The following chapters attempt to provide both micro-ROPI and macro-ROPI measures. However the macro-ROPI measure was intended to be experimental; it faced severe difficulties in data gathering and also in the small size of the KTEC program relative to the Kansas economy. Therefore, the main effort relies on a micro-ROPI approach.

Chapter 2 Appendix Follows

Table 2.1
ROPI Panel Members

Name	Affiliations	Address
Cheri Orth	Assistant City Administrator, City of Great Bend	Great Bend, KS
Carol Swinney	Kansas Teacher of the Year, Hugoton School District	Hugoton, KS
Sandra McMullen	Community Volunteer, Hutchinson Community Foundation	Hutchinson, KS
Othello Curry	Business owner, Southwest Manufacturing, Wichita	Wichita, KS
David May	Business owner, MayTech, Overland Park	Overland Park, KS
Pat Ranson	State Senator, R-Wichita	Wichita, KS
Richard Lahti	State Representative, D-Wichita	Wichita, KS

Table 2.2
Initial Economic Development Goals

Goals Proposed by KTEC

Stimulate technological innovations
Develop a formal process to commercialize technologies
Generate new and/or improved career and job opportunities in technical fields
Establish measurement systems for return on investment
Enhance effective communication among the private sector, academia and government
Promote technical education and training

Goals Proposed by Kansas Inc.

Existing Kansas businesses compete successfully
Kansas has a highly skilled workforce
Kansas has a supportive business climate
Kansas relies on competent public and private organizations

Goals Proposed by the IPPBR ROPI Team

Kansas has high non-monetary quality of life
Kansas has high totals of income and wealth
Kansas creates and maintains jobs
Kansas provides benefits to its citizens
Kansas provides benefits to diverse geographic areas

Table 2.3
Final Economic Development Goals

Goal Statement	Goal Focus
Kansas has a supportive business climate (rank 1)	Increasing the number and success rate of new businesses; supporting new markets; encouraging commercialization of R&D; attracting seed and venture capital; developing a stable and consistent tax policy supportive of economic development
Kansas creates and maintains middle-income and high-skilled jobs (rank 2)	Creating jobs with income above 40th percentile; creating jobs that require technical, professional or managerial skills; creating jobs that require post-secondary education
Kansas creates and maintains jobs (rank 3)	Increasing the total number of jobs in the state, as well as opportunities for self-employment
Kansas has a highly skilled workforce (rank 4)	Enhancing the technical skill and educational level of people in Kansas; providing training and retraining
Kansas has high totals of income and wealth (rank 5)	Increasing the real income received by Kansans; increasing the tax base in Kansas

Table 2.4
Economic Development Weights

Goal	Rank	WT1	WT2	WT3	WT4	WT5	WT6	WT7	Average
Jobs	3	0.0930	0.0083	0.1994	0.1259	0.0958	0.1090	0.2422	0.1248
Income	5	0.0308	0.2400	0.0416	0.0632	0.1911	0.0996	0.1340	0.1143
Quality of Life	7	0.0395	0.0124	0.0373	0.1591	0.0811	0.0996	0.0682	0.0710
High Skilled Jobs	2	0.1907	0.3088	0.0887	0.0569	0.1756	0.0996	0.1410	0.1516
Upward Mobility Opportunities	9	0.0730	0.0326	0.0392	0.0908	0.0460	0.0996	0.0193	0.0572
Benefiting Diverse Regions	8	0.1334	0.0725	0.0186	0.0573	0.0549	0.0996	0.0573	0.0705
Improving Public-Private Organizations	10	0.0099	0.0276	0.0418	0.1212	0.0116	0.0942	0.0222	0.0469
Highly Skilled Workforce	4	0.2835	0.0162	0.0433	0.1235	0.1913	0.0996	0.1050	0.1232
Increasing Competitiveness	6	0.0437	0.0553	0.1198	0.0834	0.0414	0.0996	0.0754	0.0741
Business Climate	1	0.1026	0.2262	0.3704	0.1186	0.1114	0.0996	0.1354	0.1663

Note: The seven weights represent the responses of the seven panel member.

Table 2.5
Social Time Preference Rate

Panel Member	With Uncertainty	Without Uncertainty
1	12.5	12.5
2	30.0	7.5
3	30.0	12.5
4	--	(22.5)
5	30.0	17.5
6	30.0	7.5
median	30.0	12.5
mean	26.5	11.5

Table 2.6
Economic Development Indicators

Goal Statement	Indicators
Kansas has a supportive business climate (rank 1)	1. Number of business start-ups 2. Number of new businesses that survived 5 years 3. Federal funds for research and development 4. Non-federal funds for seed and venture capital 5. Tax characteristics for established firms 6. Kansas patents issued 7. Kansas physical infrastructure
Kansas creates and maintains middle-income and high-skilled jobs (rank 2)	8. Number of jobs with income above 40th percentile 9. Number of jobs with titles in technical, professional, and managerial groups 10. Number of jobs requiring post-secondary education
Kansas creates and maintains jobs (rank 3)	11. Total number of jobs
Kansas has a highly skilled workforce (rank 4)	12. Human capital, measured in years of experience 13. Workforce training
Kansas has high totals of income and wealth (rank 5)	14. Total personal income

Survey 2.1
Final Goals of Economic Development

The "final goals" represent a range of reasons why ordinary citizens of Kansas may be willing to support economic development programs in Kansas. That is, these goals list the *ends* or ultimate purposes of economic development, as they might be defined in an ideal democracy. Of course, different citizens may have different goals in mind. So we need a comprehensive list. At the same time, we need goals that are relatively general, so that there are no more than 9 or 10 "final goals" all together. However, we are seeking your help at this stage in order to *expand* the list, not reduce it.

As a ROPI Panel member, you will be representing the citizens of Kansas in this project. In that capacity, we ask that you answer three questions about the list of "final goals":

1. Do any of these final goals seem so large or inclusive that it would be helpful to *break them up* into two or more sub-goals?

__ NO __ YES If yes, please explain:

2. Are there any important goals that should or might be *added* to this list?

__ NO __ YES If yes, please explain:

3. In particular, do some of our lower-level or "instrumental" goals seem to you more like "final" goals than "underlying" goals? That is, are some of them important ultimate goals for significant numbers of Kansans?

__ NO __ YES If yes, please explain:

Survey 2.2
ROPI Objectives

The following survey is designed to help KTEC establish Kansas economic development objectives on a systematic basis. You and other members of the ROPI Panel are being tapped to respond to the survey because we believe that, as representatives of Kansas citizens, you can provide informed opinions about the proper role of economic development in the state of Kansas.

We will present to you a list of ten final objectives of economic development. This list is based partly on our previous work and partly on feedback received from the ROPI panel. This survey will ask for your beliefs about the relative priorities that Kansas government should set among various objectives.

ROPI OBJECTIVES: PART I

Instructions: Listed below are some commonly accepted goals of Kansas economic development and their meanings.

A. **KANSAS CREATES AND MAINTAINS JOBS:** increasing the total number of jobs in the state, as well as opportunities for self employment.

B. **KANSAS HAS HIGH TOTALS OF INCOME AND WEALTH:** increasing the real income received by Kansans, and increasing the tax base in Kansas.

C. **KANSAS HAS A HIGH NON-MONETARY QUALITY OF LIFE:** reducing pollution and crime, protecting the environment, and increasing the quality of medical services.

D. **KANSAS CREATES AND MAINTAINS MIDDLE-INCOME AND HIGH SKILLED JOBS:** maintaining and creating more and better middle-income jobs and other opportunities for Kansans.

E. **KANSAS CREATES OPPORTUNITIES FOR UPWARD MOBILITY:** creating more and better jobs likely to be held by poor people.

F. **KANSAS BENEFITS DIVERSE AREAS:** increasing real income in rural counties and in urban central cities in Kansas.

G. **KANSAS RELIES ON COMPETENT PUBLIC AND PRIVATE ORGANIZATIONS:** making physical investments in Kansas, improving communication among businesses and government.

H. **KANSAS HAS A HIGHLY SKILLED WORKFORCE:** enhancing the skill and education level of people in Kansas, providing training and retraining.

I. **EXISTING KANSAS BUSINESSES COMPETE SUCCESSFULLY:** increasing the number and quality of high value-added products, high work

performance organizations, and technological improvements and innovations.

J. **KANSAS HAS A SUPPORTIVE BUSINESS CLIMATE:** increasing the number and success rate of new businesses, supporting new markets, encouraging commercialization of R&D, seed and venture capital, and efficient taxation.

If all of these objectives were fully achieved, would any *additional* objectives still need to be achieved for economic development?

Please list: ----------

ROPI OBJECTIVES RANKING: PART II

Instructions: In this part, we request you to compare the various objectives that were outlined in part I. We will give you several pairs of objectives. In each case, we request that you compare one objective against the other.

For comparison, we request that you adopt the following two scales.

I. Consider two objectives A and F. Which objective is more important than the other? Check one alternative.

---- A is more important than F
---- F is more important than A

II. Please score on the following scale, your assessment of how much more important is one objective over the other

no difference absolutely different

---

1 2 3 4 5 6 7 8 9 10

That is, "1" represents no appreciable difference in importance.
"2" represents a barely perceptible difference.
...
"10" represents a maximal or absolute difference.

ILLUSTRATION:

Consider two objectives: A. Kansas creates and maintains jobs, and F. Kansas benefits diverse areas.

Suppose that you believe that benefitting diverse areas is more important that job creation.

Then for scale I, you will choose the option:
_x_ F is more important than A.

Next suppose that you believe that both are important, however, benefitting diverse areas is somewhat more important,

Then for scale II, you may choose 4, 5, 6, 7 depending on your assessment of the extent to which benefitting the diverse areas is **more** important than job creation.

SCORING FOR PART II

[Instructions for interviewer: fill in only the upper half diagonal of the matrix. Enter the integer measuring intensity AS IS if the LEFT option is preferred over the TOP option (i.e. if preferences obey alphabetic order). Enter the RECIPROCAL of the integer if the TOP option is preferred over the LEFT option (i.e if preferences are anti-alphabetic).]

	A	B	C	D	E	F	G	H	I	J
A	1	___	___	___	___	___	___	___	___	___
B		1	___	___	___	___	___	___	___	___
C			1	___	___	___	___	___	___	___
D				1	___	___	___	___	___	___
E					1	___	___	___	___	___
F						1	___	___	___	___
G							1	___	___	___
H								1	___	___
I									1	___
J										1

Survey 2.3
ROPI Panel Survey on Present-Future Tradeoffs

In this survey there are no right or wrong answers. Instead we are asking you to make some political value judgments.

Suppose that you are a member of a committee which has been formed to evaluate and approve public investment projects for the state of Kansas. In questions 1 to 5, you will be given descriptions of hypothetical projects under hypothetical conditions and asked to decide what would most benefit the citizens of Kansas.

1. Suppose that a public investment project will cost Kansas state government **$1 million** this year, but it will increase state tax revenues by a stated amount next year (and *only* next year, with no additional revenues in the future).

In general, assume that other things are not affected by the project. For example, any benefit for the citizens next year will come purely from the uses to be made of the additional tax revenues next year.

For each range of stated amounts to be returned next year, decide whether you would approve or reject the project.

approve	reject		
___	___	(a)	less than $1.00 million
___	___	(b)	$1.00 - 1.05 million
___	___	(c)	$1.06 - 1.10 million
___	___	(d)	$1.11 - 1.15 million
___	___	(e)	$1.16 - 1.20 million
___	___	(f)	$1.21 - 1.25 million
___	___	(g)	$1.26 - 1.35 million
___	___	(h)	$1.36 - 1.50 million
___	___	(i)	more than $1.50 million

2. Suppose Kansas state government has an opportunity to borrow $1 million this year (from an out-of-state lender), but will have to pay back a stated amount next year (and *only* next year, with no additional cost in the future).

In general, assume that other things are not affected by the loan. For example, any benefit for the citizens now comes purely from the uses that will be made from the $1 mil.

For each range of stated amounts to be paid back next year, decide whether you would approve or reject the loan.

approve	reject	
___	___	(a) less than $1.00 million
___	___	(b) $1.00 - 1.05 million
___	___	(c) $1.06 - 1.10 million
___	___	(d) $1.11 - 1.15 million
___	___	(e) $1.16 - 1.20 million
___	___	(f) $1.21 - 1.25 million
___	___	(g) $1.26 - 1.35 million
___	___	(h) $1.36 - 1.50 million
___	___	(i) more than $1.50 million

3. Given the current state economic development budget, suppose that Kansas state government can spend its budget either on a short run project which will create 1000 new full-time jobs for Kansans during this year, or on a longer-run project which will create a stated number of new full-time jobs for Kansans next year. In either case, each job lasts for exactly one year.

In general, assume that other things are not affected by the choice of projects. Any benefit to the citizens comes purely from the new jobs.

For each range of jobs created under the long-run project decide between approving the short-run project or the long-run project.

preferred project:		jobs to be created by long-run project:
short-run	long-run	
___	___	(a) less than 1000 jobs
___	___	(b) 1001 - 1050 jobs
___	___	(c) 1051 - 1100 jobs
___	___	(d) 1101 - 1150 jobs
___	___	(e) 1151 - 1200 jobs
___	___	(f) 1201 - 1250 jobs
___	___	(g) 1251 - 1350 jobs
___	___	(h) 1351 - 1500 jobs
___	___	(i) more than 1500 jobs.

Next, you will be asked to compare seven different public investment projects. The expenditure and revenue streams for the projects are given in the following table. A negative number indicates an expenditure amount (in $ millions), while a positive number indicates a revenue amount (in $ millions). Once again, assume that other things will not be affected by the choice.

Project	year 0	year 1	year 2	year 3
A	-1	1.1	0	0
B	-1	0	1.21	0
C	-1	0	0	1.33
D	-1	1.2	0	0
E	-1	1.3	0	0
F	-1	0	1.69	0
G	-1	0	0	2.2

We will ask you rank these projects from the least preferred to the most preferred project. Then we will ask you to score the *differences* between closely ranked projects on a scale of 1 to 10.

In particular, if two adjacent projects are not distinguishable, you should score a 1 for that pair; if the difference between adjacent projects is barely perceptible, score a 2; if the difference between adjacent projects is absolute or they are incomparably different, score a 10.

An example:

Mr. X ranks the projects in the following order

A = B = C, D, E, F, G

(Note that Mr. X happens to rank the projects in alphabetic order; you will probably select a different rank order.)

Next, Mr. X scores the *pairs* of adjacent projects on the scale as follows:

project pair:	score:
A,B	1
B,C	1
C,D	4
D,E	6
E,F	8
F,G	6

From the rank, we know that Mr. X is indifferent among projects A, B, and C, and that F is his most-preferred project. From the scoring, we know that Mr. X prefers project D over projects A, B and C by 4 units, a moderate amount. He also prefers project F over project E by 8 units, indicating a rather large (but not absolute) difference.

Now please rank the projects in order, starting with the *least*-preferred project. Please put the equal sign between any projects which in your view are equally preferred.

— — — — — — —

Now please score the difference between pairs of adjacent projects on the scale from 1 to 10:

project pair:	score:
___/___	___
___/___	___
___/___	___
___/___	___
___/___	___
___/___	___

5A. Suppose the numbers listed in the table (describing projects A through F) were net job changes (in units of 1000 jobs) instead of $Millions. Would your answers to question 4 still be the same?

___ yes, the same ___ no, different

5B. As well as you can, try to explain why you decided as you did in part 5A.

6. Now suppose that you are an ordinary Kansas citizen (that is, you are no longer a member of the public investment committee). Suppose that a public investment project is approved by the public investment committee and it will *increase* your tax payment by $100 *this* year. However, it will *reduce* your tax payment by a stated amount *next* year.

For each range of stated amounts to be deducted from taxes next year, decide whether you would personally benefit from the project, or not.

would benefit	wouldn't benefit		tax reduction next year
___	___	(a)	less than $100
___	___	(b)	$100 - $105
___	___	(c)	$106 - $110
___	___	(d)	$111 - $115
___	___	(e)	$116 - $120
___	___	(f)	$121 - $125
___	___	(g)	$126 - $130
___	___	(h)	$131 - $150
___	___	(i)	more than $150

7. Please give your comments on this survey. We are especially interested in any thoughts you may have had while grappling with these questions.

Survey 2.4
Conclusions on Goals and Indicators

Now that you have had a chance to discuss the goals and indicators, please indicate your final conclusions. You may return the results to us in the attached stamped envelope. Thank you for your response.

1. Are you completely satisfied with the results of the ranking of the goals of economic development for Kansas? **Yes_____No____**

If your answer is NO please explain why.

2. Do you consider the indicators that define each goal important and representative?
Yes_____ No____

If your answer is NO please explain why.

3. Do you want to add some additional important indicators that are relevant to goals 1 - 5?
Yes____ No____

If your answer is YES please take into account the statement that indicators should be measurable. Explain what indicators you would like to add and the goals to which they apply.

4. With regard to goal #1 (business climate) are there some indicators that you consider more important than others? **Yes____ No____**

Please explain.

Panel Member Name (optional) _____

Survey 2. 5
Pure Time Preference Rate versus Gross Time Preference Rate

In this survey you are asked one question used before in survey 3. You are requested to answer this question based on two situations: perfect certainty and some uncertainties. You are assumed to be a member of a committee which has been formed to evaluate and approve public investment projects for the state of Kansas.

Suppose that a public investment project will cost Kansas state government $1 million this year, but it will increase state tax revenues by a stated amount next year (and only next year, with no additional revenues in the future).

In general, assume that other things are not affected by the project. For example, any benefit for the citizens next year will come purely from the uses to be made of the additional tax revenues next year.

For each range of stated amounts to be returned next year, decide whether you would approve or reject the project.

(i) With Perfect Certainty:

approve	reject	
___	____	(a) less than $1.00 million
___	____	(b) $1.00 - 1.05 million
___	____	(c) $1.06 - 1.10 million
___	____	(d) $1.11 - 1.15 million
___	____	(e) $1.16 - 1.20 million
___	____	(f) $1.21 - 1.25 million
___	____	(g) $1.26 - 1.35 million
___	____	(h) $1.36 - 1.50 million
___	____	(i) more than $1.50 million

(ii) With Uncertainties:

approve	reject	
___	____	(a) less than $1.00 million
___	____	(b) $1.00 - 1.05 million
___	____	(c) $1.06 - 1.10 million
___	____	(d) $1.11 - 1.15 million
___	____	(e) $1.16 - 1.20 million
___	____	(f) $1.21 - 1.25 million
___	____	(g) $1.26 - 1.35 million
___	____	(h) $1.36 - 1.50 million
___	____	(i) more than $1.50 million

Institution (please circle one): PANEL KTEC IPPBR
Name (optional): _____

3. Macro Approaches to Evaluating Technology Programs

Chapter Summary

1. During the 1980s, states greatly expanded their spending on technology programs. In 1988, Kansas state technology spending lagged considerably behind the national average. It is likely that Kansas spending now exceeds the national average, due to the expansion of KTEC and the initiation of the MAMTC program.

2. We attempted a macro evaluation of KTEC programs, looking at the correlations between state technology spending and economic performance. This effort was largely thwarted by inadequate data.

3. However, information is available on more general questions about technology and economic growth. The academic literature indicates that research and development spending acts as an engine to growth at the national level. Our own data analysis suggests that a similar impact exists at the state level. This suggests a productive role for state technology programs.

4. An examination of current Kansas technology indicators shows that the rates of activity in Kansas are close to the national averages.

Introduction

This chapter takes a step back from KTEC programs in particular and looks more broadly at state-level research, development, and technology issues. The chapter begins with a discussion of the relationship between state technology programs and overall state economic performance. We note that there are serious limitations in our ability to evaluate state technology programs from macroeconomic data. The chapter then widens its focus to discuss more general issues of technology and growth. The chapter concludes with a discussion of technological capacity and an evaluation of the current Kansas situation.

State Technology Programs

The 1980s saw a strong nationwide push in state technology programs. By 1988, 43 states had instituted programs such as university-based research centers, research grant programs, and technology transfer programs to stimulate technological innovation and utilization. Funding totaled over $550M [Minnesota Dept. of Trade and Development, 1988]. At the time these data were compiled, KTEC was in its second year of funding. In Kansas, per capita spending on state technology programs averaged $1.41 compared

with a nationwide average of $2.32. Kansas ranked 29th among the states in per-capita spending [see Table 3.1].

Schmandt and Wilson [1988] identify three related reasons for the recent growth of state-level technology spending. They cite a reduction in the flow of federal funds to states, a growing desire of states to make their own decisions on important issues, and a perception by states that social and economic benefits can be achieved through partnerships with the private sector. The growth in spending on technology programs appears to follow from an increased emphasis on more general state economic development programs. Indeed, economic development goals are at the heart of state technology programs, including those sponsored by KTEC.

As economic development programs have expanded in the states, so has the call for accountability of these programs. Several states have started to design systems to systematically monitor the outcomes of their development efforts [see for example Hatry, 1990]. We believe that the ROPI project described in this report is among the most comprehensive of these efforts.

Broadly speaking, the goal of the ROPI project is to measure the impacts of a state technology program on variables of interest such as economic growth. There are two ways of measuring this impact: micro and macro. The micro approach measures performance based on the results reported by a program's direct beneficiaries. These results become inputs to an economic model that represents the structure of the economy. The outputs of the model then estimate the overall impact of the program. The alternative approach, the macro approach, estimates impacts of programs from published data about the overall performance of the state economy. For example, the macro approach might look for statistically significant correlations between state technology spending and external performance indicators such as total Kansas jobs, total Kansas patents, and total Kansas income.

Three major problems prevented us from actually implementing such a macro evaluation of KTEC. First, the magnitude of KTEC spending is small compared with the magnitude of other factors that affect the Kansas technological economy. In essence, it is easy for KTEC impacts to "get lost in the noise." In particular, KTEC and its affiliated programs such as MAMTC have an aggregate budget on the order of a few tens of million dollars per year, while high technology activities in Kansas (including aerospace) have budgets on the order of tens of billions of dollars. Second, KTEC programs have been in existence for fewer than 10 years. There is not a sufficiently long time series of data to control for other factors that affect Kansas technology. Finally, there are no consistently constructed time series of data on public technology spending in other states, preventing us from completing a cross sectional analysis.

Given these limitations of the macro approach, we decided to investigate more general issues of technology policy and growth. We began with a review of the literature. While there is much literature supporting the need for national intervention in technology creation, we found no studies that directly addressed the issue of whether research and development spending influences income at the state level. We attempted to fill in this gap with some new data analysis.

Research and Development: A Review of the Literature

Several recent studies have examined the economic benefits of technology. Griliches [1992] makes two important theoretical points. First, he emphasizes that technical change is the result of conscious decision making of various economic units (firms, individuals, and governments) who invest in research and development spending. Second, he stresses that research and development is likely to have positive spillover effects; for example, research done by one firm may improve productivity at a second firm. In fact, these positive spillover effects are probably necessary for sustained productivity growth to occur in an economy.

Griliches then goes on to look for empirical evidence on the extent of these spillover effects. After reviewing approximately 20 studies of R&D spillovers, he concludes that spillovers are in fact positive, that their magnitude may be large, and that the social rate of return on R&D very much outweighs the private return. Indeed, Griliches suggests that R&D returns may account for up to three-fourths of recent productivity growth in the U.S.

Mansfield [1991] pursues the same topic, the social returns to R&D. He examines and critiques several published studies of the impact of private industry research, and reports his original work on the spillovers resulting from academic research. He concludes that the social rate of return on research and development has been in the range of 40 percent per year.

These studies of research and development impacts have some clear implications for economic development. First, the studies indicate that R&D is a main engine of productivity growth at the national level. This means that R&D will be essential for U.S. products to remain competitive. Second, the studies report social returns far in excess of private returns. This suggests that the private sector R&D spending is likely to be less than optimal, and that there may be a role for government policy to increase aggregate R&D spending.

Research and Development Impacts at the State Level

An issue not fully addressed in the literature is whether the national relationship between R&D, productivity, and income holds true at the state level. The benefits of R&D are likely to diffuse geographically to some extent. It is even possible that the benefits of R&D taking place in Kansas could be larger in California or Washington than in Kansas itself.

The policy implications are clear: if there is no detectable relationship between R&D spending within a state and growth within that particular state, then technology programs are more appropriate at the federal level than at the state level. On the other hand, if there exist local benefits from R&D spending, then state-level programs are probably in order. Unfortunately, the degree of localization of R&D spillovers has not been studied.

To shed light on this question, we looked at data for five periods (measured at 2 year intervals) and 34 states with reported industrial research and development expenditures. We related state income (gross state product) to research and development expenditures, both in per-capita terms. We controlled for other factors that might influence state income by introducing state and year dummy variables [see Table 3.2].

Two models produced significant and interpretable results. The first model related state income per capita to cumulative R&D for the last two periods.[7] The model results suggest that $1.00 in R&D spending leads to $0.75 in state income in the current period.

Our second (and preferred) model is dynamic in the sense that it includes a lagged value of state income as an explanatory variable. The lagged value acts as an additional control. This model indicates that $1.00 in R&D spending leads to $0.57 in state income in the current period. Because the model is dynamic, we are also able to estimate a cumulative effect of R&D spending. We estimate that $1.00 in R&D leads to $2.50 in state income over time.

Both model variations indicate significant effects of in-state R&D upon state income. The measured size of the impact varies with the specification of the model, and is less important than the sign (positive) of the result. The analysis suggests that state-level technology policies can benefit the state that supports them.

---

[7] We also experimented with a version of the model with one period of R&D spending, but found better results with the cumulative variable.

How does Technology Affect Economic Performance?

Both the published literature and our original analysis tend to establish a quantitative link between R&D and economic performance. What is not addressed is *how* this linkage takes place. Studies of the *process* through which new ideas are transformed into products are generally based less on quantitative data than on case studies and historical observation.

As a partial explanation of this linkage, Malecki [1990] describes what he refers to as the "linear model of innovation," from research and development through technology transfer. Despite numerous shortcomings of the model, Malecki finds it useful as a tool to show paths to regional growth and development. He suggests ways in which state policies might augment the innovation process, and notes there are significant constraints on the effectiveness of state policy [see Figure 3.1].

In particular, Malecki emphasizes the stage of innovation that focusses on process development and improvement. He suggests that regional economic competitiveness depends on the extent to which firms adopt best practice processes and methods. Regional variations in adoption rates for new technologies depend on factors such as the size of firms in an area, the existing labor force, and the industrial mix. Most of these factors are outside the control of state government. Hence Malecki offers caution about the influence that state technology policy can have on economic development. He points out that technologies developed in one region may benefit other regions more than the region of origin, that corporate strategies rather than state policies may determine what areas benefit from technology, and that entrepreneurship, an essential element in the link, is difficult to foster by state policies.

We see Malecki's cautions as a challenging research agenda rather than as a pessimistic outlook on state policies. In fact, the relationships between technological advancement and state policies are still largely unknown. As Barke [1990 p. 455] puts it: "states will be experimenting with new policy approaches in a highly unstable arena."

State Level Indicators of Technological Capacity

We conclude this chapter by examining the current state of Kansas technology. The available research indicates that technological progress is a multidimensional phenomenon. Kamieniecki and Lacki [1992] provide an operational definition of high technology capacity as a combination of five types of activities–high technology employment, research and development activity, research innovation, state direct assistance to high tech businesses, and state assistance in the provision of labor and capital to high tech firms. The results of their study may not have much application to

Kansas, primarily because the indicators chosen to represent each dimension of technology are problematical. However their framework does provide a useful way to sort out how Kansas stands in terms of technological achievement.

High Technology Employment

High technology employment can be measured in two ways: by occupation or by industry. The 1990 Census data provide the most recent and accurate information on high technology employment by occupation. We define high technology occupations by looking at two Census categories: professional specialty occupations, which includes scientists and engineers (as well as teachers and lawyers) and precision production occupations, which includes high skilled industrial workers. The Kansas workforce appears about average for the nation in terms of its share of high-technology employment [see Table 3.3].

A breakdown by industry yields similar results. We used the U.S. Bureau of the Census publication *County Business Patterns* to extract employment and establishments for a number of high technology industries. The classification of high technology was based on an industry's standard industrial classification, or SIC code. In Kansas, employment is concentrated in high-technology industries to a slightly greater extent than for the nation as a whole. (see Table 3.4)

Research and Development Activity

We analyzed 1987 data on industrial research and development from the National Science Foundation. In per capita terms, Kansas R&D expenditures by industry averaged $482, in excess of the U.S. average of $397. Kansas R&D exceeded that of most of the midwestern states that we used for comparison [see Table 3.5]. The relatively high level of R&D is a good sign for future economic growth.

Research Innovation

We analyzed 1992 patents issued as an indicator of research innovation. A number of researchers have found patents to be a useful (but imperfect) indicator of technological advancement. As indicated in Table 3.6, Kansas patents per million population (129) fall far behind the comparable figures for the U.S. (230) or for the midwest comparison states. This may indicate that Kansas has less research innovation than average. However, it may only indicate that Kansas specializes in industries where patenting is less common than average. To support this, a discussion with the Director of the National Institute for Aviation Research at Wichita State indicated that patenting is fairly unusual in the aircraft industry.

State assistance to high tech firms

As indicated in Table 3.1, Kansas lagged the nation in state spending on technology initiatives in 1988. Since that time, KTEC funding has increased more than four-fold.

KTEC spending now averages about $3.34 per capita. When the federally funded MAMTC initiative is included, the figure rises to $4.55. While recent comparable data for other states are not available, we suspect that this is an area where Kansas now exceeds that national average.

Where does Kansas stand?

These technology indicators give a current snapshot of the Kansas technology base. They also suggest something about Kansas's prospects for future developments. High technology industries are unlikely to develop in areas with no pre-existing technology infrastructure.

The data presented give Kansas a generally average score among states of the U.S. in terms of its technology base. While this certainly leaves room for improvement, a lack of pre-existing technology should not hinder the development of technology intensive industries. However, the Kansas technology infrastructure is highly concentrated in urban areas of the state and near the state universities. The lack of pre-existing technology is probably a serious hinderance to technology transfer and development in more rural areas of the state.

Conclusion

Research and development appears to be an important factor in productivity and output growth, both at the state and national levels. But there are still many unknowns about the *processes* that link research and development with economic performance. One of these unknowns is the effectiveness of state government policies, which to date has not been carefully evaluated. Part of the problem of evaluating the impact of technology programs is that technology is a multi-dimensional entity. Several authors have tried to define technological capacity. When we evaluate Kansas along the lines of the factors indicated in the literature, the Kansas technological base appears to be about average among states of the U.S.

Chapter 3 Appendix Follows

Table 3.1
State Spending on Technology Programs, 1988
U.S., Kansas, and Selected Midwest States

	Spending ($1,000)	Population (1000)	Spending per Capita
U.S.	563,677	242,777	2.32
Kansas	3,550	2,476	1.43
Illinois	13,540	11,582	1.17
Indiana	10,637	5,531	1.92
Iowa	4,895	2,834	1.73
Minnesota	39,439	4,246	9.29
Missouri	28,566	5,103	5.60

Source: Minnesota Department of Trade and Development [1988]

Table 3.2
Regression Results for Impact of Research and Development

Variables:

GSPPC: Gross state product (total state income produced),per capita. 1977-1987. Bureau of Economic Analysis.

GSPPC-2 Gross state product per capita lagged 2 years.

R&DPC: Industrial research and development expenditures by state, per capita. 1977-1987. National Science Foundation. Data were available at two year intervals.

R&D2PC: Research and development per capita, two years cumulative data.

State and Year dummy variables.

MODEL 1:

$GSPPC = \beta\ R\&D2PC + \gamma\ YEAR\ DUMMIES + \delta\ STATE\ DUMMIES$

Adj R-sq 0.9955

Variable	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
R&D2PC	0.757212	0.20015312	3.783	0.0002

Year and state dummies were generally significant.

MODEL 2:

$GSPPC = \alpha\ GSPPC\text{-}2 + \beta\ R\&D2PC + \gamma\ YEAR\ DUMMIES + \delta\ STATE\ DUMMIES$

Adj R-sq 0.9975

Variable	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
GSPPC-2	0.591421	0.05769201	10.251	0.0001
R&DPC	0.577115	0.23504646	2.455	0.0154

Year and state dummies were generally significant.

Estimation of long-run effects in Model 2:

The cumulative effect of research and development on total gross state product is estimated by $(\beta)/(1-\alpha^2) = 2.498$.

Table 3.3
Employment in High Tech Occupations, 1990
Percent of Workforce

State	Professional	Precision Production	Combined Share
U.S.	14.1%	11.3%	25.4%
Kansas	14.1%	11.5%	25.5%
Illinois	13.8%	10.7%	24.5%
Indiana	12.0%	12.9%	24.9%
Iowa	12.7%	10.5%	23.2%
Minnesota	14.3%	10.1%	24.4%
Missouri	13.2%	11.1%	24.3%

Source: 1990 Census
Note: Professional includes scientists, engineers, teachers, lawyers. Precision production includes most skilled industrial occupations.

Table 3.4
Total Employment and
Employment in High Tech Industries, 1989

Industry Type	U.S.	Kansas
Total Employment: All Ind.	91,631,203	865,859
Employment: High Tech Ind.	6,462,512	80,749
Ratio: High Tech to Total	0.071	0.093

Source: Compiled from *County Business Patterns*, 1989. Suppressed data were estimated by IPPBR. Approximately 60 industries at the 4-digit SIC level were included in the definition of high tech.

Table 3.5
Industrial Research and Development Expenditures, 1987
U.S., Kansas, and Selected Midwest States

State	$ per capita
U.S.	397
Kansas	482
Illinois	376
Indiana	355
Iowa	124
Minnesota	529
Missouri	377

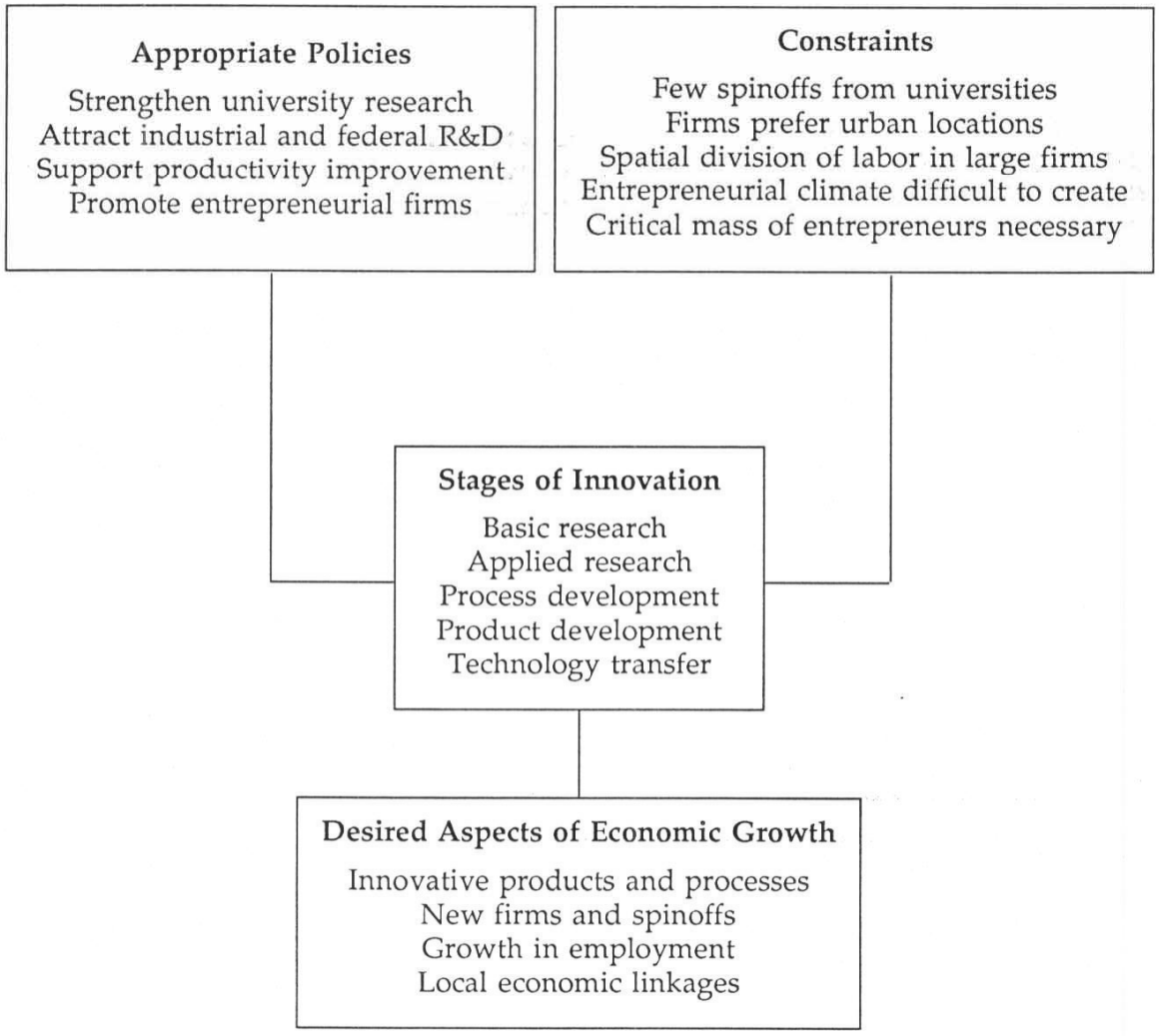
Source: National Science Foundation (R&D) and Bureau of Economic Analysis (population)

Table 3.6
Patents per 1,000,000 population, 1992
U.S., Kansas, and Selected Midwest States

State	Patents per million pop.
U.S.	230
Kansas	129
Illinois	283
Indiana	194
Iowa	145
Minnesota	357
Missouri	158

Source: U.S. Patent Office (patents) and Bureau of Economic Analysis (population).

Figure 3.1
Stages of Innovation and State Government Policies



Source: Malecki [1990, p.103]

4. Micro-ROPI: Programs, Budgets, and Client Surveys

Chapter Summary

1. The role of the Applied Research Matching Fund program is to assist Kansas businesses in overcoming technical and financial hurdles in new product development. The role of the Centers of Excellence program is to assist Kansas businesses with research and development and to move technology from the universities into the market place. The Centers each have their own area of expertise including aviation, manufacturing processes, pharmaceuticals, computer-assisted design, and woods, plastics, and printing.

2. The Applied Research Matching Fund, the Centers of Excellence, and KTEC internal operations account for approximately 75 percent of KTEC expenditures through 1993. The remaining programs are quite small.

3. To date, the value of legislated KTEC expenditures is approximately $43 million. This figure consists of legislative allocations, plus an allowance for a return at 11.5 percent per year on the public monies invested during 1987-1992. Since fiscal year 1989, KTEC's funding has come entirely from the Economic Development Inititatives Fund, which consists of revenues from the Lottery and Racing Commissions. KTEC currently receives no general fund monies.

4. Surveys of client firms were conducted for each of the five Centers of Excellence and for the ARMF program. About 90 of the surveys of Centers clients were returned, for a response rate of over 45 percent. An additional 37 valid surveys were returned for the ARMF program.

5. Projects for which clients received assistance from KTEC created approximately 900 new jobs and over $100 million per year in new sales in Kansas as of 1993. Of course not all of this job and revenue creation can be attributed directly to KTEC's intervention; KTEC was typically one of many factors facilitating growth.

6. Most client firms reported a reasonably high degree of satisfaction with the services they received.

7. Comparisons across programs and Centers of Excellence are of interest, but they may be misleading in some respects. Different programs have different time horizons; so the comparisons could look very different 10 years from now. Also, at the Center's level there is a great deal of sensitivity to factors beyond the control of the Centers. This

sensitivity is less of a problem at the broader KTEC level, because some of the random fluctuations may cancel out across Centers.

Introduction

This chapter describes the pattern of KTEC activities, as viewed though its mission statement, its budgets, and direct surveys of its clients. This pattern provides the basis for the ROPI calculation, because it measures the direct effect of KTEC on the Kansas economy.[8] We begin by describing the missions of the several KTEC programs. These missions are summarized in Table 4.1.

The Missions of the Centers of Excellence

KTEC has devoted the largest share of its resources to the five Centers of Excellence (approximately 40 percent of KTEC expenditures in present value terms). The Centers of Excellence program is a vehicle for meshing expertise, equipment, and facilities for basic and applied research efforts. The goal is to help companies expand their services, manufacture new products, improve their processes, and increase productivity. The Centers are funded by KTEC as well as by other sources. They are administered by the universities.

AMI, the Advanced Manufacturing Institute, is located at Kansas State University in Manhattan. This Center performs research and transfers technology in the area of automated design and manufacturing systems.

CECASE, the Center for Excellence in Computer-Aided Systems Engineering, is located at the University of Kansas in Lawrence. CECASE specializes in designing and tailoring software to meet a company's needs. It supports all facets of computer-aided analysis and design and fosters the development of spin-off companies. CECASE also assists in transfer of technology in fields of engineering and computer science for product development and marketing.

CTT, the Center for Technology Transfer,[9] is located at Pittsburg State University in Pittsburg. This Center assists businesses in solving technology related problems, developing prototypes, and expanding their technical capabilities, with an emphasis on

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[8] The set of survey procedures for collecting this information is referred to as the "Scoring Module" in Burress *et al.* (1992).

[9] Very recently renamed the Center for Design, Development and Production, the Center is referred to by its older name of CTT throughout this report.

wood, plastics, and printing. CTT provides consulting services including needs analysis, training and education services, and referrals.

HBC, the Higuchi Biosciences Center, is located at the University of Kansas in Lawrence. HBC is a pharmaceutical research hub that includes three research centers. Its Center for Bio-analytical Research develops methods to detect, identify, and analyze trace amounts of biologically active compounds in living systems and environmental contaminants. Its Center for Drug Delivery Research develops chemically driven drug delivery systems such as prodrugs, and focuses on the efficient delivery of pharmaceuticals throughout the body. Its Center for Neurobiology and Immunology focuses on exploratory research in neurological and immunological diseases.

NIAR, the National Institute for Aviation Research, is located at Wichita State University. NIAR serves the advanced technology requirements of the aviation industry by providing cutting edge research, training, product development and testing. Its facilities are available for use by industry. Programs of sustained focus include: advanced materials used in aircraft structures; new metal alloys and new materials with high temperature superconductivity; crashworthy structures; aging aircraft; human factors; computer integrated manufacturing; and quality and economic and management issues in aircraft manufacture and operation.

The Missions of KTEC's Directly Administered Programs

ARMF, the Applied Research Matching Fund program, is the second largest KTEC program (after the Centers). This program helps Kansas businesses develop market-driven new products by linking them with universities and financing up to 40 percent of research that leads to new and improved products. The program also provides careful reviews of each client's technical proposals and business plans. A project must apply current scientific and technological knowledge and lead to new developments that can have a positive impact on the Kansas economy.

The Research Equipment Grant Program provides state of the art equipment to universities. This program has not been funded since FY 1990.

The Technology Referral Service is a personal computer-based data retrieval system for information about research and development resources in Kansas. It catalogs research at the major universities in Kansas.

The Training Equipment Grants program supports training to meet the needs of Kansas industry. It provides grants to community colleges and vocational schools for training students and manufacturing employees in advanced technology fields with significant economic development potential.

The Industrial Liaison Program delivers technical, on the factory floor assistance to Kansas companies. Retention and expansion of current Kansas business is the goal. It helps firms identify and solve production or other technical problems, improve production processes, and capitalize on advanced production techniques and technologies.

Finally, the Small Business Innovation Research Matching Awards assist in the preparation of proposals for Federal SBIR grants.

The Missions of KTEC Cooperative Programs

The following programs have independent boards of directors. They are not included in the ROPI results calculated for this report due to lack of sufficient data, and, for the case of MAMTC, the relative newness of the program.

The Ad Astra Fund is a seed capital fund for start-up and early stage advanced technology companies. It is a private, limited partnership developed and funded in part by the state of Kansas. It seeks quality, high return investments in companies which have a highly motivated management team and whose technology has broad market appeal.

MAMTC, the Mid-America Manufacturing Technology Center, provides technical consultation and assistance to small and medium size manufacturers throughout Kansas, greater Kansas City, western Missouri and Colorado. MAMTC strives to help firms turn out better quality products and operate more efficiently. MAMTC offers informed, objective consultation, training, advice and demonstrations. The major funding for MAMTC comes from a grant from the National Institute of Standards and Technology–a grant that KTEC successfully competed for in 1992.

ITEC, the Innovative Technology Enterprise Corporation, provides assistance to inventors and entrepreneurs in the commercialization, marketing, and development of new ideas.

KVAC, the Kansas Value-Added Center, is associated with Kansas State University. This center strives to enhance agricultural, economic, and rural revitalization by promoting the growth of value-added processing facilities.

The Direct Costs of KTEC Programs

The direct costs of KTEC programs are shown in Table 4.2. The table provides figures for FY 1993, and cummulative present value figures. Present value calculations are used

to make dollar flows that occurred in an earlier year comparable with those of a later year. Present values are calculated using the 11.5 percent social discount rate that was explained in Chapter 2.

Since fiscal year 1989, KTEC's funding has come entirely from the Economic Development Inititatives Fund, which consists of revenues from the Lottery and Racing Commissions. KTEC currently receives no general fund monies.

Survey Procedures

During the Summer and Fall of 1993, clients were surveyed for the ARMF program and for each of the five Centers of Excellence. KTEC administered the ARMF survey, CTT administered its own survey, and IPPBR administered surveys for the other four Centers. In general, the survey protocol was as follows. Each recent client was sent a two page survey, with a cover letter from KTEC and sometimes another letter from the Center director. The survey packet included a stamped return envelope, along with a promise of confidentiality. A follow up letter was sent if no response had been received after three weeks. In most cases, IPPBR entered the data and performed consistency checks.

The survey instruments and protocols differed somewhat for each program; therefore the results are not entirely comparable across programs. Differences arose because of differences in the programs, and because each survey instrument and cover letter was determined through a process of negotiation with a (different) Center director. Center directors often helped us to focus and customize the survey instruments so that they more accurately reflected Center programs. The Center directors also raised concerns about confidentiality of client data and about client resistance to being surveyed.

KTEC staff were quite helpful in the negotiations with Centers directors. However, it is important to understand that the Centers are organizationally part of the Kansas Regents Universities, and not part of KTEC. KTEC is a major funding source for each Center, but KTEC is not the only funding source.

In addition to survey instruments, differences in the surveys included the following:

1. The surveys were executed at different points in time.
2. The sampling frames for the mailing lists were selected by the individual Center directors, not by IPPBR.
3. In the case of NIAR in Wichita, co-clients of NIAR and MAMTC were specifically omitted. This may lead to an under-estimation of NIAR's ROPI.

4. In the case of CTT in Pittsburg, IPPBR piggy-backed on a client survey being conducted by CTT; therefore CTT had final control of the protocol.

5. In the case of ARMF, IPPBR used data from a routine survey of clients performed by KTEC; therefore KTEC had final control of the protocol. In cases of missing or inconsistent data, IPPBR relied on KTEC's interpretations of the data.

These differences should not pose a serious problem in most cases, however, because the point of the survey was to uncover *successful* development efforts. Failed development efforts do not have much effect in the ROPI model used in this study. At best, the ROPI values derived in Chapter 6 may not be much affected by these survey differences; at worse, they may be understated in some cases.

Because of time limitations and other considerations, ITEC, MAMTC, Ad Astra, and KVAC clients were not surveyed (except in some cases where a firm was a client of multiple programs). Most of these programs are relatively recent, and as yet account for a relatively small percentage of cumulative state of Kansas funds expended through KTEC (see Table 4.2).

Response Rates

Response rates have different interpretations depending on the programs surveyed. For ARMF, KTEC requires that firms complete economic impact reports on a semi-annual basis. Hence, we are reasonably confident that all firms with positive outcomes are included in the survey results. KTEC provided us with information on 75 ARMF projects, taking the data off of their own internal database.

Clients of the Centers were under no obligation to respond to our survey, but were nevertheless quite cooperative. The overall response rate for Centers was about 45 percent. Time constraints prevented us from making a second mailing for AMI, helping to explain the relatively low response rate for that Center. Response rates by program are given in Table 4.3.

Client Firm Satisfaction

Our survey asked firms to rate their satisfaction with the various services provided by the Centers of Excellence. Most client firms reported a reasonably high degree of satisfaction with services received. Several survey respondents wrote additional comments elaborating on the usefulness of Centers' services. Complete responses are found in the appendix to this chapter.

More important for calculating ROPI, our survey also asked clients to rate how important the Centers were in the success of the firm projects. We refer to this rating as the attribution ratio. The mean response is reported in Table 4.3 and is generally more than 50 percent.

The Direct Benefits of KTEC Programs

Benefits of KTEC programs in terms of jobs and sales of client firms are reported in Table 4.3. Projects for which clients received assistance from KTEC created approximately 900 new jobs and over $100 million per year in new sales in Kansas as of 1993. Of course not all of this job and revenue creation can be attributed directly to KTEC's intervention; KTEC was typically one of many factors facilitating growth. It should be pointed out that the relatively high numbers for CTT and NIAR are due to interactions with a few large clients.

Conclusion

Comparisons across programs and Centers of Excellence are of interest, but they may be misleading in some respects. Different programs have different time horizons; so the comparisons could look very different 10 years from now. Also, at the program level there is a great sensitivity to unusual events; one successful project with a large client can dramatically change the overall performance of a Center.

The main implication of the survey data is that KTEC does appear to have some significant success in causing economic development. In a subsequent chapter, we will try to evaluate the importance of that success. However, first we will need to develop some machinery for filling in the holes in this data.

Chapter 4 Appendix Follows

Table 4.1
Summary of Program Missions

Program	Mission
Centers of Excellence	
AMI	To perform research and technology transfer in the area of automated design and manufacturing systems
CECASE	To design software for companies, use computer aided analysis and help spin off companies develop
CTT	To assist businesses in technology development, problem solving and expansion
HBC	To perform pharmaceutical research
NIAR	To conduct technology research for the aviation industry
ARMF	To develop market- driven new products through partial financing of research and by linking firms with universities.
Research Equipment Grants	To provide state-of-the-art equipment to universities
Technology Referral Service	To perform computer-based data retrieval about research and development in Kansas
Training Equipment Grants	To assist community colleges and vocational schools for training in technology fields
Industrial Liaison Program	To assist businesses with on-the-factory-floor technical consultation
Small Business Innovation Research Matching Awards	To assist in proposal preparation for Federal SBIR grants
Ad Astra Fund	To provide seed capital for start-up and early stage advanced technology companies
ITEC	To assist businesses with commercialization and the development and protection of marketable ideas
MAMTC	To assist manufacturing companies in product quality and operational efficiency
KVAC	To enhance agricultural, economic and rural revitalization

Source: Kansas Technology Enterprise Corporation

Table 4.2
KTEC Budget: FY 93 and Present Value, FY 87-93

Program	FY 93	PV 87-93	Present Value Share
KTEC Programs			
Centers of Excellence	$3,715,000	$17,134,935	0.400
Center for Technology Transfer	360,000		
National Institute for Aviation Research	780,000		
Higuchi Biosciences Center	1,325,000		
Center for Excellence in Computer Aided Systems Engineering	450,000		
Advanced Manufacturing Institute	800,000		
Applied Research Matching Grants	1,130,146	9,969,582	0.232
Operations	687,562	5,164,826	0.120
Seed Capital	0	3,021,075	0.070
Research Equipment Grants	0	2,381,423	0.056
Special Projects	286,250	1,666,179	0.039
Industrial Liaison	300,000	1,423,326	0.033
Training Equipment Grants	150,000	861,519	0.020
SBIR	25,000	375,749	0.009
Commercialization	250,000	250,000	0.006
KTR Database	35,000	288,224	0.007
Industrial Agriculture	200,000	200,000	0.005
Centers Peer Review	40,000	109,926	0.003
Telecommunications	35,000	35,000	0.001
Total KTEC	$6,853,958	$42,881,765	1.000
Cooperative Programs			
KVAC	$622,705	$2,804,499	–
MAMTC	1,000,000	2,114,954	–
MAMTC Fed Funds	3,000,000	3,546,773	–
Total KTEC, MAMTC, & KVAC	$11,476,663	$48,614,268	–

Source: Data provided by KTEC.
Present value calculated with a discount rate of 11.5%.

Table 4.3
Survey Results

Center	Number of Surveys Sent	Number of Surveys Returned	Total Employment 1993	Total Sales ($) 1993	Mean Attribution Ratio	Sampling Weight
AMI	30	11	12	2,700,000	0.26	2.73
CECASE	16	12	3	400,000	0.50	1.33
CTT	99	35	717	NA	0.62	2.83
HBC	9	8	12	500,000	0.66	1.13
NIAR	37	21	74	>100,000,000	0.72	1.76
Total Centers	**191**	**87**	**818**	**>100,000,000**	**NA**	**2.20**
ARMF	NA	37	85	7,759,344	NA	NA
Total	**NA**	**124**	**903**	**>100,000,000**	**NA**	**NA**

Source: ROPI2 Model
NA: not available

Survey 4.1
Advanced Manufacturing Institute Clients

Firm Characteristics

1. Number of years that this firm has been in business (please check one).
___ less than 1___ 1 to 2 1 3 to 5 12 6 or more

2. Current number of employees in Kansas (please check one).
___ 1-4 1 5-9 1 10-19 3 20-49 2 50-99
3 100-249 3 250-499___ 500-999___ 1000 or more

3. Percent of firm's employment in Kansas. 82.5 %

Firm's Use of Services and Facilities of Advanced Manufacturing Institute

4. Please give a brief non-technical description of the product(s), services, or processes that you have developed or improved making use of Advanced Manufacturing Institute (AMI) services or facilities. (provide firm's SIC code if known)

5. What are the approximate dates during which you used AMI services or facilities?
approximate months and years of use _____

6. To what extent have you used AMI services or facilities? (please check one)
2 less that 8 hours 3 9-16 hours 3 17 - 40 hours 2 41-100 hours
2 101-250 hours___ 251-500 hours___ 501-1000 hours 1 more than 1000 hours

7. Below is a list of specific services and facilities offered by AMI. For each please answer:
a) Did your firm use that service or facility provided by AMI? Please respond yes or no.
b) How important was that service or facility to the overall development of your firm's products or services? Please use a scale of 1 (not important) through 10 (essential)

Service or Facility	Used? (yes or no)	Importance 1=not important thru 10=essential
On-site training	Yes=1	Mean=7.0
Seminars and workshops	Yes=5	Mean=5.2
Consulting by AMI associates	Yes=9	Mean=5.4
Process development	Yes=1	Mean=7.0
Industry-sponsored graduate and faculty research	Yes=3	Mean=5.5
Adoption of AMI-developed technologies	Yes=0	Mean=0.0
Contract for applied product research	Yes=3	Mean=5.0
Integrated Design, Manufacture, and Assembly laboratory	Yes=1	Mean=9.0
Other AMI-supported laboratories	Yes=2	Mean=5.0
AMI/MAMTC field office activities	Yes=3	Mean=4.3
Other (please specify)	Yes=1	Mean=.....

8. Did you pay a charge for the use of AMI services or facilities?
5 yes 6 no If yes, approximate total charge **Mean= 10750** .

9. If the services or facilities of AMI had not been available to your firm, what would you have done as your next best alternative? (please check the one best alternative)

1 would not have been aware of options for technology enhancement
4 would have foregone consulting, testing, or development services
3 would have performed the services "in-house"
2 would have contracted for consulting, testing, or development with a private firm in Ks.
1 would have contracted for consulting, testing, or development with a public or private agency in another state
1 other (please specify) _____

Economic Impact on Firm

10. What impact have the services and facilities of AMI had on your firm? (check all that apply)

2 cost saving for existing product or service
6 quality improvement for existing product or service
2 process improvement
3 development of new product
0 helping with new firm start-up
3 helping to provide training and information for firm's personnel
5 increasing awareness of available advanced technology
1 helping firm to increase scale of operations
2 other (please specify) _____

11. Have any patents or licenses resulted from the use of AMI services or facilities?
1 yes 12 no. If yes, number of patents: **mean = 1** number of licenses: **mean= 0**

12. Please estimate the amount of employment that has been ***created in Kansas*** or ***retained in Kansas*** as a result of the specific project(s) for which you used AMI services or facilities.
mean=1.5 # of employees to date **mean=1.8** # additional employees projected in 2 yrs.

13. To what extent can you attribute this employment to AMI services or facilities? Please use a scale of 1 through 10 with 1 indicating that AMI had almost no role, and 10 indicating that the employment could not have been created or retained without AMI. **Mean= 2.6** (1 through 10)

14. Please estimate the amount of current and projected sales ***at your Kansas facilities*** resulting from the specific project(s) for which your firm used AMI services or facilities.
Mean= 675000.00 current annual sales **Mean= 1,233,333** annual sales projected in 2 years

15. Please estimate the amount of current and projected cost savings and/or increased profits ***at your Kansas facilities*** resulting from the specific project(s) for which your firm used AMI services or facilities. **All numbers are mean**

1666.66 current annual cost savings
0.0 annual cost saving projected in 2 years
0.0 profits due to project(s) this year
0.0 profits due to project(s) projected in 2 yrs.

16. Do you have any other comments about AMI or about this survey?
Thank you for your assistance. Your responses will be held in strict confidence.

Survey 4.2
Applied Research Matching Fund Clients

1. Name of firm (needed to cross-match against data from Centers of Excellence)

2. ARMF #

3. Date that ARMF granted.

4. ARMF Amounts
   a) $ from KTEC Mean = 32655.61
   b) $ from firm Mean = 60033.00

5. Brief description of product or process. Include firm's SIC code if known.

6. Sales and Employment.

Employment and sales numbers are critical. We need the annual totals for employment and sales due to the project for which the firm got the ARMF.

Please fill in 0 if there was no employment or sales, and -- if the firm failed to answer the question. Note that there will be many zeros in the early years.

Numbers are Means

	Annual Sales	Annual Employment
1988	0	--
1989	0	--
1990	0	14
1991	0	12
1992	7525.83	2
1993, first half	229602.88	3
1993, second half	224363.63	--
1994	858655.17	1
1995	228571.42	0
1996	33333.33	0

Survey 4.3
Center for Excellence in Computer Aided Systems Engineering Clients

Firm Characteristics

1. Number of years that this firm has been in business (please check one).

2 less than 1___ 1 to 2 1 3 to 5 8 6 or more

2. Current number of employees in Kansas (please check one).

4 1-4 1 5-9 2 10-19 3 20-49___50-99
___ 100-249___ 250-499___ 500-999 1 1000 or more

3. Percent of firm's employment in Kansas. **Mean = 84.1%**

Firm's Use of Services and Facilities of the Center for Excellence in Computer Aided Systems Engineering (CECASE)

4. Please give a brief non-technical description of the product(s), services, or processes that you have developed or improved making use of CECASE services or facilities. (provide firm's SIC code if known)

5. What are the approximate dates during which you used CECASE services or facilities?
approximate months and years of use _____

6. To what extent have you used CECASE services or facilities? (please check one)
2 less that 8 hours 1 9-16 hours 5 17 - 40 hours 1 41-100 hours
1 101-250 hours___ 251-500 hours___ 501 - 1000 hours___ more than 1000 hours

7. Below is a list of specific services and facilities offered by CECASE. For each please answer:

a) Did your firm use that service or facility provided by CECASE? Please respond yes or no.

b) How important was that service or facility to the overall development of your firm's products or services? Please use a scale of 1 (not important) through 10 (essential)

c) How satisfied was your firm with that service or facility? Please use a scale of 1 (very dissatisfied) through 10 (very satisfied).

Service or Facility	Used? (yes or no)	Importance 1=not important thru 10=essential	Satisfaction 1=very dissatisfied thru 10=very satisfied
short term consulting	Yes=7	Mean=7.7	Mean=8.7
research on contract	Yes=2	Mean=8.0	Mean=9.0
licensing of CECASE products	Yes=0	Mean=....	Mean=....
rapid prototyping of computer tools	Yes=3	Mean=8.0	Mean=9.3
conferences, workshops, seminars	Yes=2	Mean=6.5	Mean=7.5
other (please specify)	Yes=2	Mean=6.5	Mean=7.5

8. Did you pay a charge for the use of CECASE services or facilities?
4 yes 6 no If yes, approximate total charge Mean= 2677.50

9. If the services or facilities of CECASE had not been available to your firm, what would you have done as your next best alternative? (please check the one best alternative)

2 would have foregone consulting, licensing, or development services
2 would have performed the services "in-house"
4 would have contracted for consulting, licensing, or development with a private firm in Kansas
1 would have contracted for consulting, licensing, or development with a public or private agency in another state
1 other (please specify) _____

Economic Impact on Firm

10. What impact have the services and facilities of CECASE had on your firm? (check all that apply)

2 cost saving for existing product or service
4 quality improvement for existing product or service
3 process improvement
8 development of new product
2 helping with new firm start-up
1 helping firm to seek additional financing
2 other (please specify) _____

11. Have any patents or copyrights resulted from the use of CECASE services or facilities?
2 yes 9 no. If yes, mean=1 number of patents mean=1.5 number of copyrights

12. Please estimate the amount of employment that has been *created in Kansas* or *retained in Kansas* as a result of the specific project(s) for which you used CECASE services or facilities.
mean=0.4 # of employees to date mean=3.5 # additional employees projected in 2 years

13. To what extent can you attribute this employment to CECASE services or facilities? Please use a scale of 1 through 10 with 1 indicating that CECASE had almost no role, and 10 indicating that the employment could not have been created or retained without CECASE.
mean=5.0 (1 through 10)

14. Please estimate the amount of current and projected sales resulting from the specific project(s) for which your firm used CECASE services or facilities.
Mean=44444.44 current annual sales Mean=647500.00 annual sales projected in 2 years

15. Do you have any other comments about CECASE or about this survey?

Thank you for your assistance.
Your responses will be held in strict confidence.

Survey 4.4
Center for Technology Transfer Clients

1. How many people are employed in your firm at this location? Mean = 171.75
2. In what year did your firm begin business at this location? Mean = 1967
3. What percentage of your employees at this location live in Kansas? Mean = 65.5%

4. In what ways has Pittsburg State University's Center for Technology Transfer (CTT) or MAMTC assisted you or your company? Please respond to each item.

Yes	No/NA	
4	25	A KTEC Applied Research Matching Grant Proposal
15	13	Analysis of/or assistance with a particular product, service, or process
11	10	Assistance to determine the feasibility of a product, service, or process
9	21	Product Development
3	24	Assisted in my company start-up
11	18	Arrangement or provision of industrial training support
7	22	Referrals to other economic development services
5	22	Other: _____

5. What was the extent (approximate hours) of services rendered by the CTT or MAMTC?
   9 8 hrs. or less 1 9 to 16 hrs. 9 17 to 40 hrs. 11 more than 40 hrs.

6. Did you pay a charge for any of the services of the CTT or MAMTC?
   If yes, approximate charge $ Mean = 4655.94 .

7. If the services of the CTT had not been available, what would you have done as your next best alternative? (please check one)
   - 8 would have foregone the services
   - 6 would have performed the services "in-house"
   - 4 would have contracted with a private firm in Kansas
   - 8 would have contracted with a private firm in another state
   - 3 other

8. Please estimate the economic impacts that have been created by the project(s) for which you used the CTT/MAMTC's services.

	Yes	No/N/A	Amount in Kansas
Total cost savings to date	8	19	Mean = 31050.00
Total enhanced profits to date	8	20	Mean = 0.0
New jobs created to date	8	21	Mean = 55
Additional jobs projected in two years	11	17	Mean = 3
New venture or equity capital attracted	3	24	Mean = 6750.00
Were per capita employee wages increased?	3	24	Mean = 3.1%
Did the assistance result in any patents being filed?	2	25	Mean = 0

9. How important were the CTT/MAMTC's services to the overall development or improvement of your product, service, or process? Please use a scale of 1 (not important) to 10 (essential).

Mean = 6.16 (1 to 10)

Survey 4.5
National Institute for Aviation Research Clients

Firm Characteristics

1. Number of years that this firm has been in business (please check one).

2 less than 1___ 1 to 2 3 3 to 5 15 6 or more

2. Current number of employees in Kansas (please check one alternative)

9 zero 3 1-4 1 5-9___ 10-19___ 20-49___50-99
___ 100-249 1 250-499___ 500-999 1 1000-4999 5 5000 or more

3. Percent of firm's employment in Kansas. **Mean= 49.5 %**

Firm's Use of Services and Facilities of National Institute for Aviation Research

4. Please give a brief non-technical description of the product(s), services, or processes that you have developed or improved making use of National Institute for Aviation Research (NIAR) services or facilities. (provide firm's SIC code if known)

5. What are the approximate dates during which you used NIAR services or facilities?
approximate months and years of use _____

6. To what extent have you used NIAR services or facilities? (please check one)

1 less that 8 hours 3 9-16 hours 1 17 - 40 hours 5 41-100 hours
5 101-250 hours 1 251-500 hours 1 501-1000 hours 2 more than 1000 hrs.

7. Below is a list of specific services and facilities offered by NIAR. For each please answer:

a) Did your firm use that service or facility provided by NIAR? Please respond yes or no.

b) How important was that service or facility to the overall development of your firm's products or services? Please use a scale of 1 (not important) through 10 (essential)

c) How satisfied was your firm with that service or facility? Please use a scale of 1 (very dissatisfied) through 10 (very satisfied).

Service or Facility	Used? (yes or no)	Importance 1=not important thru 10=essential	Satisfaction 1=very dissatisfied thru 10=very satisfied
Engineering consulting-MAMTC	Yes= 5	Mean= 7.0	Mean= 8.0
CAD/CAM consulting	Yes= 2	Mean= 6.7	Mean= 7.5
Crash test laboratory	Yes= 8	Mean= 9.3	Mean= 8.0
Composites laboratory	Yes= 9	Mean= 7.3	Mean= 8.1
Materials laboratory	Yes= 3	Mean= 5.8	Mean= 8.3
Wind tunnel	Yes= 5	Mean= 7.6	Mean= 7.8
Other laboratories	Yes= 0	Mean= 8.0	Mean= ....
Other consulting	Yes= 2	Mean= 7.5	Mean= 8.5
Conferences, workshops, seminars	Yes= 4	Mean= 7.8	Mean= 9.3
Other (please specify)	Yes= 2	Mean= 8.5	Mean= 10

8. Did you pay a charge for the use of NIAR services or facilities?
13 yes 6 no If yes, approximate total charge Mean= 66516.67.

9. If the services or facilities of NIAR had not been available to your firm, what would you have done as your next best alternative? (please check the one best alternative)

1 would have foregone consulting, testing, or development services
4 would have performed the services "in-house"
1 would have contracted for consulting, testing, or development with a private firm in Kansas
12 would have contracted for consulting, testing, or development with a public or private agency outside of Kansas
1 other (please specify) _____

Economic Impact on Firm

10. What impact have the services and facilities of NIAR had on your firm? (check all that apply)

8 cost saving for existing product or service
8 quality improvement for existing product or service
6 process improvement
11 development of new product
2 helping with new firm start-up
2 helping firm to seek additional financing
1 other (please specify) _____

11. Have any patents or licenses resulted from the use of NIAR services or facilities?
2 yes 17 no. If yes, number of patents: Mean= 1 number of licenses: Mean= 0

12. Please estimate the amount of employment that has been *created in Kansas* or *retained in Kansas* as a result of the specific project(s) for which you used NIAR services or facilities.
Mean= 4.6 # of employees to date Mean= 4.1 # additional employees projected in 2 yrs.

13. To what extent can you attribute this employment to NIAR services or facilities? Please use a scale of 1 through 10 with 1 indicating that NIAR had almost no role, and 10 indicating that the employment could not have been created or retained without NIAR.
Mean= 7.2 (1 through 10)

14. Please estimate the amount of current and projected sales *from your Kansas facilities* resulting from the specific project(s) for which your firm used NIAR services or facilities.
Mean= >100000000 current annual sales Mean=>300000000 annual sales projected in 2 yrs.

15. Please estimate the amount of current and projected cost savings and/or increased profits *at your Kansas facilities* resulting from the specific project(s) for which your firm used NIAR services or facilities.
Mean= 9387.50 current annual cost savings Mean= 27000.00 annual cost saving projected in 2 years
Mean= 3002000.00 profits due to project(s) this year Mean= 6054166.67 profits due to project(s) projected in 2 yrs.

Survey 4.6
Higuchi Biosciences Center Clients

Firm Characteristics

1. Number of years that this firm has been in business (please check one).

1 less than 1___ 1 to 2___ 3 to 5 7 6 or more

2. Current number of employees in Kansas (please check one).

3 1-4 1 5-9___ 10-19___ 20-49___50-99
2 100-249___ 250-499___ 500-999___ 1000 or more

3. Percent of firm's employment in Kansas. Mean= 43.2%

Firm's Use of Services and Facilities of Higuchi Biosciences Center

4. Please give a brief non-technical description of the product(s), services, or processes that you have developed or improved making use of Higuchi Biosciences Center services or facilities. (provide firm's SIC code if known)

5. What are the approximate dates during which you used Higuchi Biosciences Center services or facilities?_____ approximate months and years of use

6. To what extent have you used Higuchi Biosciences Center services or facilities? (please check one)

6 less that 8 hours___ 9-16 hours 2 17 - 40 hours 2 41-100 hours
1 101-250 hours___ 251-500 hours___ 501 - 1000 hours 1 more than 1000 hrs.

7. Below is a list of specific services and facilities offered by Higuchi Biosciences Center. For each please answer:

a) Did your firm use that service or facility provided by Higuchi Biosciences Center? Please respond yes or no.

b) How important was that service or facility to the overall development of your firm's products or services? Please use a scale of 1 (not important) through 10 (essential)

c) How satisfied was your firm with that service or facility? Please use a scale of 1 (very dissatisfied) through 10 (very satisfied).

	Service or Facility Used? (yes or no)	Importance 1=not important thru 10=essential	Satisfaction 1=very dissatisfied thru 10=very satisfied
contract for research	Yes=5	Mean=8.5	Mean=8.6
contract for testing	Yes=0	Mean=---	Mean=---
consulting	Yes=3	Mean=6.0	Mean=6.5
license of Higuchi product or process	Yes=3	Mean=3.7	Mean=6.0
visiting scientists program	Yes=1	Mean=3.0	Mean=4.5
conferences, workshops, seminars	Yes=5	Mean=4.8	Mean=7.3
other (please specify)	Yes=1	Mean=8.0	Mean=10.0

8. Did you pay a charge for the use of Higuchi Biosciences Center services or facilities?
6 yes 2 no If yes, approximate total charge Mean= 57500.

9. If the services or facilities of Higuchi Biosciences Center had not been available to your firm, what would you have done as your next best alternative? (please check the one best alternative)

0 would have foregone research, testing, or licensing services
3 would have performed research, testing, or development "in-house"
1 would have contracted for research, testing, or licensing with a private firm in Kansas
2 would have contracted for research, testing, or licensing with a public or private agency in another state
1 other (please specify) _____

Economic Impact on Firm

10. What impact have the services and facilities of Higuchi Biosciences Center had on your firm? (check all that apply)

1 cost saving for existing product or service
3 quality improvement for existing product or service
2 process improvement
5 development of new product
2 helping with new firm start-up
1 helping firm to seek additional financing
0 other (please specify) _____

11. Have any patents or licenses resulted from the use of Higuchi Biosciences Center services or facilities? 3 yes 5 no. If yes, Mean=3.7 number of patents Mean=1.0 number of licenses

12. Please estimate the amount of employment that has been ***created in Kansas*** or ***retained in Kansas*** as a result of the specific project(s) for which you used Higuchi Biosciences Center services or facilities.

Mean=3.0 # of employees to date Mean=2.0 # additional employees projected in 2 years

13. To what extent can you attribute this employment to Higuchi Biosciences Center services or facilities? Please use a scale of 1 through 10 with 1 indicating that Higuchi Biosciences Center had almost no role, and 10 indicating that the employment could not have been created or retained without Higuchi Biosciences Center.

Mean=6.6 (1 through 10)

14. Please estimate the amount of current and projected sales resulting from the specific project(s) for which your firm used Higuchi Biosciences Center services or facilities.

Mean=83333.33 current annual sales Mean=250000.00 annual sales projected in 2 years

15. Do you have any other comments about Higuchi Biosciences Center or about this survey?

Thank you for your assistance. Your responses will be held in strict confidence.

5. Micro-ROPI: Economic Modeling

Chapter Summary

1. Micro-ROPI is an interrelated set of computer programs that:
   - process primary data from surveys and budgets to estimate direct KTEC effects;
   - infer total KTEC effects from direct effects;
   - relate total effects to the goals of economic development;
   - calculate comparisons of benefits and costs.

2. In order to calculate KTEC direct benefits, survey data from client firms and budget data for KTEC programs are expanded using a number of models of firm costs, firm investment behavior, and government spending patterns.

3. KTEC direct costs include all Kansas tax dollars spent in support of KTEC programs.

4. Indirect benefits and costs are estimated through a detailed model of Kansas economic linkages (KSSAM2).

5. The ROPI model estimates the "opportunity cost" of the budget dollars spent for KTEC programs. In other words, it infers the positive effects on the Kansas economy that would have resulted if the dollars spent on KTEC had instead been used to lower taxes.

6. ROPI calculations are performed for two scenarios, a lower and an upper bound. The scenarios differ in their treatment of firms that did not respond to our surveys and in their treatment of future benefits. For the lower bound, only benefits actually reported on surveys are included, and future benefits are ignored. For the upper bound, sampling weights are applied to survey responses and future projections are assumed to persist until the year 2000.

Introduction

The micro-ROPI model estimates the impact of KTEC through two main channels. The first channel is *direct effects*. In theory, these direct effects would be measured completely through KTEC client surveys, KTEC budget data, and other direct performance reports. But as we will discuss later, some direct effects were in practice estimated by economic models. The second channel is *indirect effects*. Indirect effects are by definition diffuse, affecting individuals, firms, and institutions who may not even know that KTEC exists. Since indirect effects often occur far from the initial impact of KTEC activities, they are difficult if not impossible to survey, and must, in principle, be inferred from models.

The Micro-ROPI Model Design

When we refer to the micro-ROPI model, we are actually talking about a set of interrelated submodels that:

1. process the budgetary and survey information, fill in the holes, and complete the measure of direct effects in terms of benefits and costs;
2. infer indirect effects of KTEC programs on Kansas output and income;
3. calculate total effects of KTEC programs and output and income;
4. relate the total effects to the fifteen indicators and five goals of economic development; and
5. calculate ROPI, the Return On Public Investment, from the ratio of total benefits to total costs.

The submodels are implemented as computer programs. The more elaborate programs are written in SAS®, a well-known data processing and data analysis package. Simpler programs use LOTUS®. In general, the submodels pull in data from primary or secondary sources, analyze and transform the data, and provide outputs for another stage of the project.

A general schematic of the ROPI model is shown in Figure 5.1. To provide a better understanding of the model, we will discuss the data and modeling tasks related to each of the main ROPI submodels.

Calculating the Direct Effects of KTEC Programs

The calculation of KTEC direct effects can be broken down into the measurement of benefits and the measurement of costs. We identified three channels through which direct benefits could occur–through the actions of KTEC and Centers client firms, through internal Centers of Excellence activities, and through internal KTEC activities. Our sources of data on benefits were the client surveys described in Chapter 4, the KTEC and Centers budgets, and other performance information supplied by KTEC.

As mentioned earlier, a survey of clients could in theory provide every piece of information required for economic impact modeling. On the other hand, such a survey would be extremely lengthy, and would require a great deal of the firm managers' time. Furthermore, requests for extremely detailed information might raise questions in the respondent's mind about confidentiality. We chose instead to limit the length of the survey. The surveys emphasized jobs and sales. We supplemented the set of survey variables through the use of several *imputation models*. Imputations were also used in the case that a respondent provided some but not all of the requested information, for example, jobs but

not sales. The imputation models were based on economic relationships estimated from published data–Kansas specific where available. The imputation models included:

1. a model of firm costs. What kinds and amounts of inputs does the firm buy?
2. a model of worker skills. What are the occupations and educational requirements of the workers that a firm hires?
3. a model of wages. What wages are expected for the workers that a firm hires?
4. a model of migration. What percent of the firm's employees are in-migrants to Kansas?
5. a model of investment. How are changes in jobs and income related to purchases of plant and equipment?

A final type of adjustment to the survey data should also be noted. It is one thing to observe that interactions with KTEC were followed by the success of a client firm. It is quite another thing to conclude that KTEC *caused* that success. The attribution of responsibility for a firm's success to KTEC's intervention is a difficult question. However, the survey instruments did attempt to gather information related to this issue. For purposes of this report, we used percentages of responsibility that were based on client firms' responses to the question: "How important was this assistance to the overall development of your product or process?" The responses were on a scale of 1 to 10. They were recoded linearly into percentage responses of 0 to 100 percent.

The budgetary data for KTEC programs were also supplemented through imputation models. We used published information about patterns of government spending to break the budgets into more detail than was originally provided. In addition, we sometimes had difficulty interpreting the Centers' budgets, and often had to make assumptions about what part of research funds were spent on wages.

On the cost side of the direct effects equation, we defined costs as any funds provided by the state of Kansas, whether or not from KTEC sources. For the Centers, costs should, in principle, include any money or in-kind resources provided by the state university. In practice, university in-kind support was rarely included in the Centers budget documents.

Inference of Indirect Effects

Indirect effects of KTEC programs are measured through the use of the Kansas Social Accounting Matrix Model (KSSAM2). This model describes the Kansas economy as a set of *linkages*. Examples of linkages are those between producers and suppliers (interindustry supply and demand), those between firms and employees (labor supply and demand), those between households and firms (consumer goods supply and demand), those between firms

and government, and those between households and government. Each linkage in the Kansas economy is represented by a parameter that indicates the intensity of the linkage.

Needless to say, the number of parameters in a model like KSSAM2 is very large. The model currently includes 55 Kansas sectors: 48 types of industries, 4 types of households (based on income), and three types of government (state, local, and education). In addition, an export sector represents interactions between Kansas and the rest of world. The model has 56 x 56 potential linkages, and hence over 3000 parameters. Each parameter is estimated using two or more data items.

The KSSAM2 model is invertible. This simply means that it provides a mathematically simple method of estimating the relationship between direct and total effects. These relationships are known as *multipliers*. Multiplier models are often employed in evaluations of economic development efforts. One thing that makes the KSSAM2 model different is that it's multipliers include household and government linkages that are often omitted in other models.

The KSSAM2 model is used to estimate total effects of both the benefits and costs of KTEC. The benefit side is perhaps easier to understand than the cost side. Take the example of a firm that adds jobs and increases its sales due to KTEC intervention. The KSSAM2 model estimates the additional benefits that accrue as the new workers spend their wages and as the new sales increase the demand for raw materials from the firm's suppliers.

On the cost side, the KSSAM2 model is used to infer the "opportunity cost" of the budget dollars spent for KTEC programs. In other words, it infers the positive effects on the Kansas economy that would have resulted if the dollars had been spent on lowering taxes instead of on KTEC.

Bridge Multipliers, Indicators, and Goals

Social accounting models such as KSSAM2 are typically designed to estimate output and income only. The output and income results still need to be related to the fourteen indicators and five goals of the ROPI model in order to completely account for KTEC effects. The parameters that relate output and income to indicators and goals are known as bridge multipliers. All of the bridge multipliers required additional data for estimation, and some of the bridge multipliers required the construction of additional regression models. We give examples of some of the bridge multiplier models below.

Bridge multipliers for the goal "middle income and high skilled jobs"

The goal of creating middle income and high skilled jobs has three indicators: the number of jobs providing wage income above the 40th percentile, the number of jobs belonging to

technical, professional, or managerial categories, and the number of jobs requiring post-secondary education.

We used the *Public Use Microdata Samples* (PUMS) from the 1990 Census to estimate each indicator. The PUMS file contains information on total income, wages, occupation, industry, employment status, educational attainment, and other variables. From this file we compiled the following ratios for each of the 55 KSSAM2 sectors: a) jobs with income above the 40th percentile to total jobs; b) jobs in technical, professional, or managerial categories to total jobs; and c) jobs with employees who have post-secondary education to total jobs. We then multiplied total jobs in each industry (itself the output of another bridge multiplier) by the three ratios. The three results were each given a weight of 1/3 in the construction of the goal. Figure 5.2 shows the flow of information for this goal.

Bridge multiplier for the indicator "patents"

The relationship between patents and Kansas output was estimated using a time series analysis. We obtained approximately 20 years of data on patents issued, categorized by state. A statistical technique known as regression analysis was used to relate patents to income and a number of other variables. The estimated coefficient for income was then used as the bridge multiplier.

Aggregation and Normalization in Calculating ROPI

As defined earlier in this report, ROPI is simply the ratio of benefits to costs minus one. This ratio is clearly defined if we are talking about single indicators such as total jobs. Both the numerator and the denominator of the ratio are in the same units, number of jobs, so that the arithmetic poses no problem. A complication occurs when we try to find an overall ROPI, or, for that matter, a ROPI for a goal comprised of several different indicators (for example, the business climate goal). To sum together indicators measured in different types of units (for example, jobs, and dollars), we first normalized all results by dividing by a base year (1987) value of that indicator. In essence, we summed together percentage changes in benefits and costs rather than absolute amounts.

Alternative ROPI Scenarios

We ran the ROPI model under two alternative scenarios based on assumptions about a) the performance of firms that did not respond to our survey and b) the relationship between a firm's current performance and its future performance. We constructed scenarios to represent lower and upper bounds to KTEC performance.

Survey Response

The clients of the Centers of Excellence were under no obligation to respond to our survey. Nevertheless, close to half of the surveyed firms did cooperate. Survey response rates are reported in Table 4.3. We have no information about the behavior of the non-respondents. In view of this, we constructed two extreme cases. In one case, we assumed that the non-respondents created no jobs, sales, investment, or income for the Kansas economy. In the other case, we assumed that non-respondents have economic impacts exactly like those of the respondents. We scaled the survey responses by a set of sampling weights indicating the ratio of total surveys sent to surveys returned. The lower bound scenario used no sampling weights, while the upper bound scenario used the weights reported in Table 4.3.

Future Direct Impacts

KTEC and the Centers of Excellence are best thought of as investment programs. It is likely that an investment made now will continue to have payoffs in future years. The client firms indicated potential future payoffs by making projections of jobs and sales. But projected benefits are uncertain; they are not the equivalent of jobs and investment already in place.

To deal with this kind of uncertainty, we again constructed two extreme cases. In one case, only actual impacts achieved to date were counted as benefits of KTEC programs. In the alternative case, projected benefits were assumed to extend until the year 2000. Only actual benefits were included in the lower bound scenario, while both projected and actual benefits were included in the upper bound.

Large Client Effects

When we looked at the survey data from the Centers of Excellence, we realized that, in some cases, the performance of that Center depended strongly on the performance of a single client. We felt that it would be unlikely that some of these single large successes would be repeated in the future. Therefore, we also ran simulations that removed the single large client effect. The results form the basis of a sensitivity analysis of the riskiness of these programs.

Relative ROPI: The Aggregate State Growth Benchmark

The ROPI model produces comparisons of benefits and costs for KTEC programs. These comparisons become more meaningful if they can be compared to some standard. The final step in the construction of the ROPI model was to construct a benchmark.

Our choice of a benchmark may be somewhat controversial. We looked at aggregate Kansas job and income growth since 1989 as a benefit, and aggregate state spending since 1989 as a cost. We estimated effects on the goals and indicators using the bridge multipliers previously described.

The benchmark can be interpreted as follows: Suppose that all growth in the Kansas economy were dependent on the public goods provided by government. How much growth would have been achieved per dollar of taxes spent? How does that compare with the growth actually attributed to KTEC? Comparisons of KTEC against the benchmark follow in Chapter 6.

Conclusion

The micro-ROPI model consists of a set of interrelated economic models. By economic models we mean computer programs that use economic theory and available data to infer additional information. The major economic models that comprise micro-ROPI include the imputation models for the original survey data, the KSSAM2 model that translates direct effects into total effects, and the bridge multiplier models that relate total income and output to the set of economic development indicators and goals.

The micro-Ropi model calculates benefits and costs for various KTEC programs, computes a ROPI measure, and compares that measure against recent aggregate state economic growth.

Chapter 5 Appendix Follows

Figure 5.1
ROPI Estimation

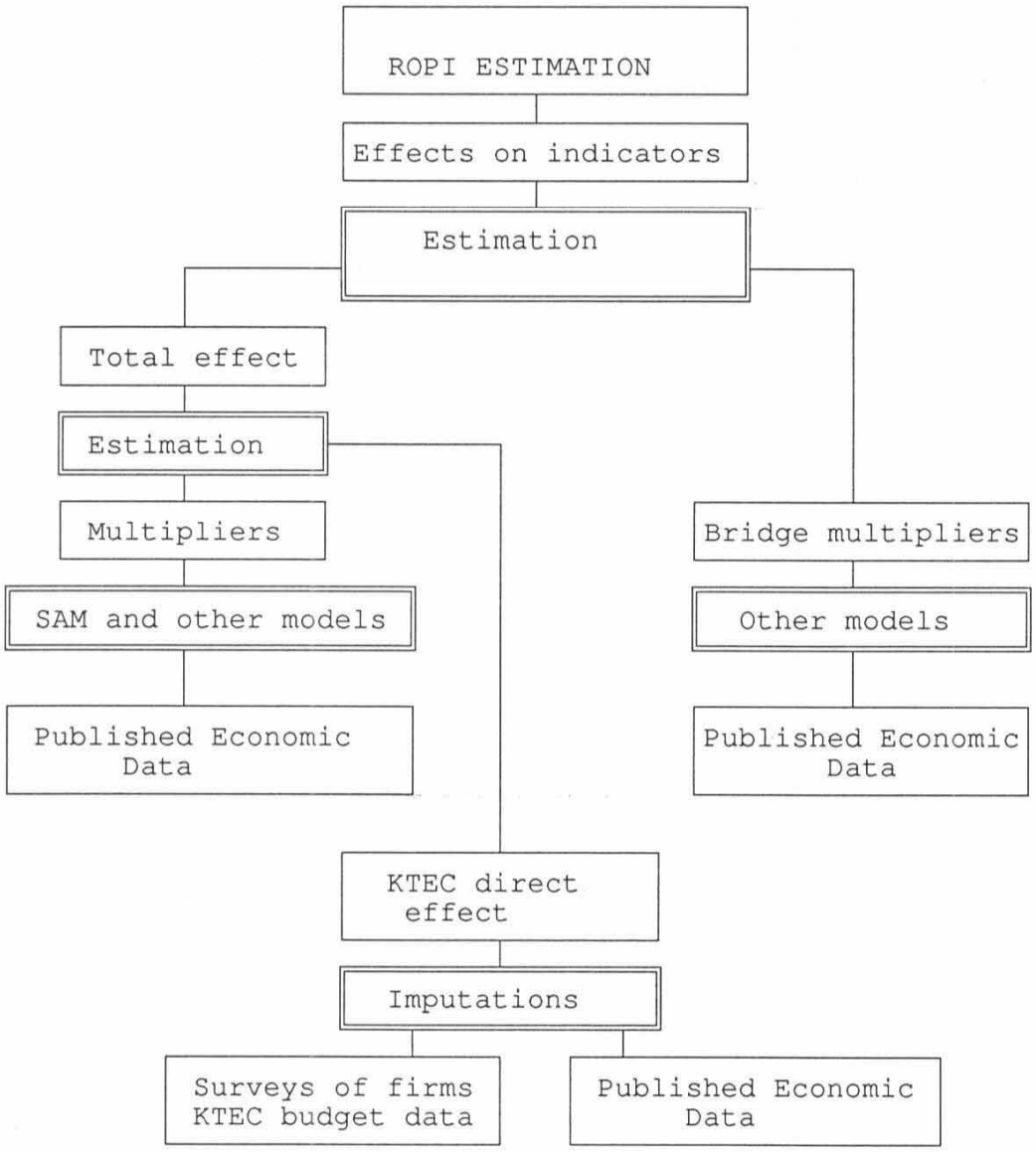
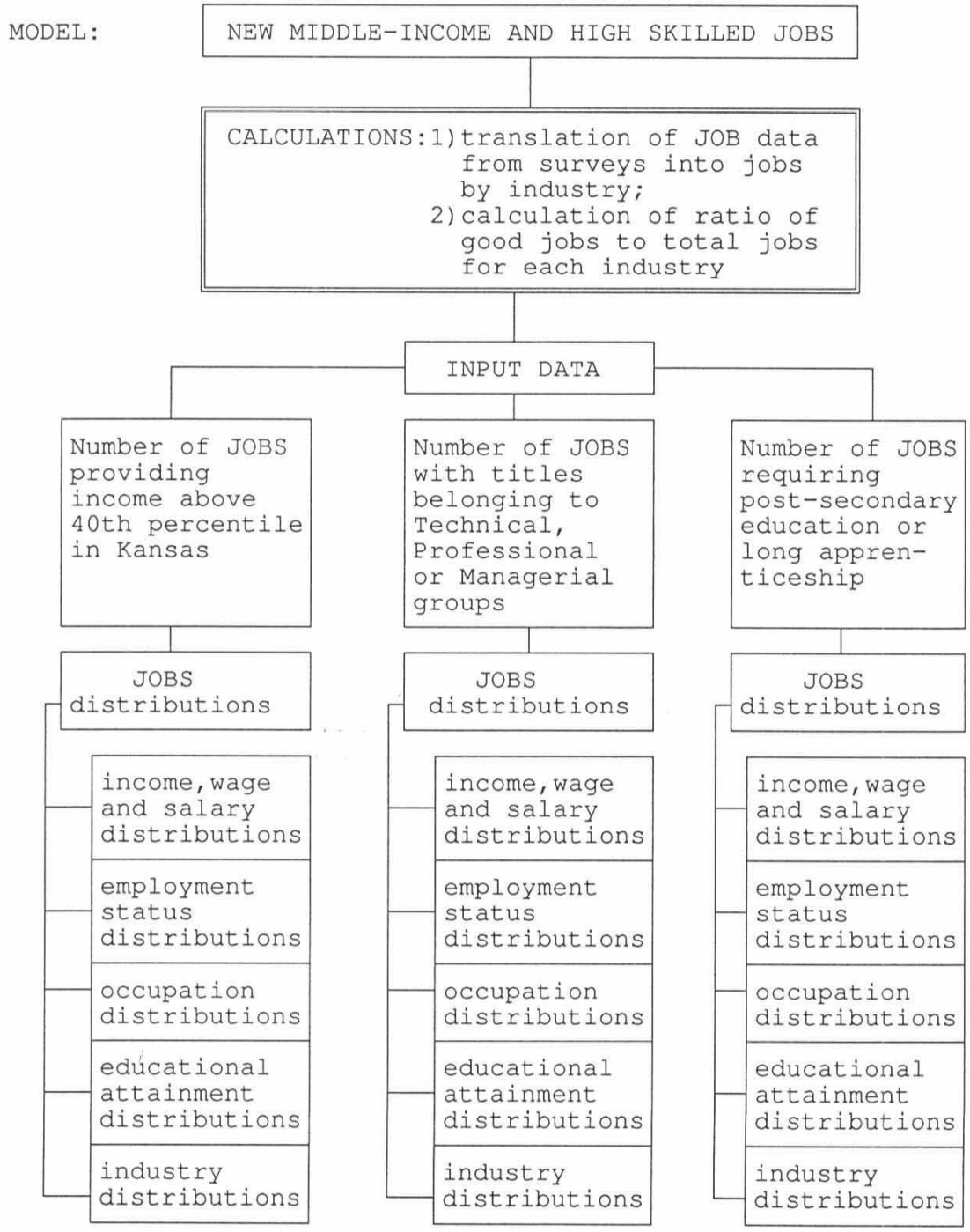


Figure 5.2
Example of ROPI Estimation for Individual Goals:
Kansas Creates and Maintains Middle Income and High Skilled Jobs



6. Micro-ROPI: Results

Chapter Summary

1. ROPI results can vary over a wide range, depending on the alternative assumptions that we make about a) the behavior of firms that did not respond to our surveys, and b) the amount of benefits expected in the future. Nevertheless, under any reasonable assumptions the results for KTEC appear to be quite positive.

2. Upper and lower bound estimates were calculated for the impacts of KTEC activities. The upper bound estimates include estimates of the benefits received by survey non-respondents and estimates of future benefits through the year 2000. The lower bound estimates exclude any estimates of benefits of survey non-respondents, and exclude projections of future benefits.

3. As a lower bound, KTEC activities are responsible for at least 12,000 job-years (a job-year is a job filled for a year) since 1987. As an upper bound, KTEC activities are responsible for over 100,000 job-years. Similarly, KTEC is responsible for between $500 million and $4 billion in personal income earned in Kansas.

4. KTEC's overall ROPI is between 36 and 141. In other words, the weighted benefits of KTEC activities (measured in terms of jobs, income, and so on) are between 37 and 142 times as large as the weighted costs.[10]

5. KTEC's lowest ROPI for an individual goal is between 10 and 82 for "highly skilled workforce." KTEC's highest ROPI for a goal is between 67 and 184 for "supportive business climate." KTEC's ROPI by individual indicator ranges from a low of between 11 and 72 for "infrastructure" to a high of between 238 and 374 for start-ups.

6. In terms of cost-effectiveness, $1 million of state expenditures on KTEC programs generates the equivalent of between $12 million and $98 million in personal income; between 300 and 2500 jobs-years; between $0.5 million and $5 million in additional tax revenues from businesses; and between 2 and 3 manufacturing start-ups.

7. In absolute terms, KTEC's high ROPI values imply that the program is very effective in producing economic development.

8. Since this is the first full ROPI study, we do not have any other ROPI values from other economic development programs for comparison purposes.

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[10] The ROPI formula subtracts one from the ratio of benefits to costs.

9. Results for a given KTEC program may vary a great deal year to year due to risk and chance as well as inherent measurement error in the model. Therefore the initial results do not necessarily provide a fair comparison of performance across programs.

Introduction

This chapter gets to the heart of the question: How well has KTEC been performing? The chapter provides three kinds of measurements:

- estimates on KTEC total impacts on the various indicators;
- estimated ROPI values; and
- an effectiveness measure that relates the quantity of economic development produced by KTEC to the tax dollars expended.

This chapter also discusses the meaning and reliability of these measurements.

Error Bounds and Simulations

All of the results in this chapter are presented twice, using two different variants of simulations. As described in the previous chapter, the first simulation provides a kind of lower bound on ROPI. It omits all benefits provided by firms that did not respond to the survey (by omitting sampling weights), and it also omits benefits expected to occur in the future. Both features lead to understating benefits, without understating costs.

The second simulation includes sampling weights and also includes an estimate of future benefits. This is likely to lead to an upper bound on ROPI because the benefits expected in the future will not always materialize. Perhaps more importantly, the sampling weights are probably too large. The weights assume that non-respondents are similar to respondents; but in reality, firms that do poorly are less likely to respond than firms that do well. At the extreme, we received no responses from firms that went out of business, and probably a number of the non-respondents did go out of business.

There is an additional feature in both simulations that leads to a downward bias in the measurements for KTEC as a whole (but not in measurements for the individual programs). In particular, total benefits of KTEC are understated by something like one-fourth because the smaller KTEC programs were not surveyed.

Moreover, other parts of the model may lead to errors in unknown directions. The estimates of investments by client firms are especially prone to error, because investment expenditures were not surveyed directly. Also, most of the sub-models of the ROPI model were developed from scratch especially for this study. If the ROPI model is used in the future, these models will undoubtedly undergo a process of revision and

improvement. Nevertheless, the authors believe that the true value of KTEC's overall ROPI is reasonably likely to fall within the broad range measured by the two simulations.

Estimates other than ROPI contained in this chapter (i.e. estimates of KTEC impacts on the fourteen indicators, and estimates of KTEC's cost-effectiveness) are subject to one additional source of error. In particular, the bridge multipliers for each indicator contain a scaling factor which measures the strength of the relationship between that indicator and the underlying KSSAM2 model. A given scaling factor does affect the given indicator. However the scaling factor may not affect the corresponding ROPI very much, because the scaling factor causes a proportional change in both the benefit and in the cost. (Recall that ROPI is an adjusted ratio of benefits to costs). Since these scaling factors do not affect ROPI very much, we put only a small effort into calibrating them.

Economic Impacts

The first set of tables shows estimates of direct and total KTEC effects on the fourteen indicators, broken out by KTEC program. Wherever possible, the "direct" measure comes from survey data, while the "total" measure includes indirect effects estimated using multipliers. However, in the case of the Kansas state growth model, total effects were estimated purely by applying bridge multipliers to Kansas employment growth by sector.

Each estimate includes annual results added together across time so as to get the equivalent contemporaneous impact. That is, the numbers are reported as if all impacts had taken place in 1993. For example, "total jobs" may refer either to jobs that last for one year in 1993; or to equivalent numbers of year-long jobs in other years, after correcting for the social discount rate. (See Table 6.1.)

These results show that KTEC activities are responsible for an effect equivalent to between 12,000 and 100,000 jobs-years. They are responsible for the equivalent of between $500 million and $4 billion in personal income earned in Kansas (in 1993 dollars). They are responsible for between 4,500 and 35,000 high-skilled jobs. And they are responsible for between $22 million and $200 million in additional business tax revenues.

Note that the reported results for the "other KTEC" program are small because they refer to the one-fourth of KTEC activity that was not surveyed. The only benefits captured in this category are those stemming from the salaries paid to KTEC's own staff and from the expenditures made by KTEC on supplies, equipment, and services.

Absolute ROPI Measures

The second set of tables shows the estimated ROPI values. Again, these are broken out by program. (See Table 6.2.) The most important conclusion from these tables is that KTEC's overall ROPI is between 36 and 141. In other words, the weighted benefits of KTEC activities (in terms of jobs, income, and so on) are between 37 and 142 times as large as their weighted costs.

KTEC's lowest ROPI for an individual goal is between 10 and 27 for "highly skilled workforce." KTEC's highest ROPI for an individual goal is between 67 and 184 for "Supportive Business Climate." Its ROPI by indicator ranges from a low between 11 and 72 for infrastructure, to a high between 238 and 374 for manufacturing start-ups.

Compared to What?

The above discussion provided quantitative values for KTEC's ROPI. We still need to interpret those results. Is the ROPI for KTEC "high enough"? What would we mean by a "really high" value of ROPI? These questions suggest that we need a standard of comparison.

One simple kind of comparison is built into the definition of ROPI. If ROPI were negative, that would indicate that KTEC was doing more harm than good in terms of economic development goals. Conversely, a positive ROPI means that KTEC is doing more good than harm. For example, a negative ROPI with respect to jobs would have meant that the number of jobs in Kansas could be increased if we simply abolished KTEC and used any dollars saved so as to lower taxes. However the ROPI for jobs was actually positive, which means that eliminating KTEC would decrease the number of jobs in the state.

As we have seen, most of our estimated ROPI results are highly positive; and even the lowest values appear likely to be strongly positive when future benefits are counted. Therefore KTEC easily passes the "sign" test.

But the requirement for a positive ROPI isn't very stringent. Asking KTEC to produce a positive ROPI is like asking a private firm to produce a positive ROI: this is reasonable as a minimum, but we probably ought to ask for more.

That seems to suggest another kind of comparison: we might try to compare KTEC's ROPIs to the ROIs (return on investment) that are available in private investment markets. Unfortunately, this kind of comparison is like comparing apples and oranges. The units of measurement are simply different. If you want to compare KTEC with private markets, then you have to use KTEC's ROI (and not its ROPI); or else you have

to use the private market's ROPI (and not its ROI). Creating jobs is simply a different activity from creating profits. As measured by the appropriate own-rate of return, creating jobs might turn out to be typically either a harder or an easier activity than creating profits.[11]

Similarly, KTEC's ROPIs cannot be compared between different goals or indicators. For example, it is not meaningful to note that KTEC's income-ROPI is higher than its jobs-ROPI. Creating income is simply a different activity from creating jobs (and, apparently, an easier activity as measured in terms of own-rates of return).

Another useful comparison would be to compare KTEC's ROPI with the ROPI measured for other economic development activities in Kansas or in other states. It would also be helpful to compare KTEC's performance this year with its performance in previous years. But unfortunately, the present study is the first ROPI study; these kinds of comparisons can't be done until we have the results of future ROPI studies.

Two kinds of additional comparisons are available now, however. One compares KTEC with the Kansas state growth model (described in the previous chapter). The other provides a non-ROPI standard of cost-effectiveness that may cast some light on the ROPI standard.

Relative ROPI Measures

First, we will compare KTEC's ROPI with an estimated ROPI for Kansas state government taken as a whole. Resources for this study did not permit a detailed ROPI survey for all of state government. As a next best approach, we tried to estimate an approximate upper bound on what such a survey might find. We refer to this approach as the Kansas state growth model. By construction, this model estimates the ROPI of Kansas government by assuming that all the growth in the Kansas economy since 1989 was caused by state government activities. We have provided ROPI values for the aggregate Kansas growth model in the last columns of Tables 6.1 and 6.2.

It seems reasonable to expect KTEC to have a substantially higher ROPI than the state growth model ROPI. Therefore we define a relative ROPI as KTEC's ROPI, less the ROPI of the state growth model. We expect this measure to be positive. And it is, as shown in Table 6.3.

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[11] Technically, there is another reason why ROI is not comparable to ROPI. ROPI is constructed as a benefit-cost ratio; while ROI is constructed as an internal rate of return.

However, once again this test is not terribly stringent; Kansas government in general has many goals and not just economic development goals. Most agencies of Kansas government are probably rather ineffective at creating jobs, simply because creating jobs is not their main purpose.

Cost-effectiveness Measures

A final kind of comparison can be established by stepping partly outside of the ROPI approach. In addition to ROPI measures, we have calculated measures of the taxpayer's cost of achieving each indicator. That is, using the ROPI model we can provide direct information on the number of jobs created per KTEC or Centers tax dollar; the amount of new income created per KTEC or Centers tax dollar; and so on. This kind of information may be useful to policy-makers deciding how to allocate tax dollars because it gives them a clear idea of what they are getting when they spend the money.

This information is provided in Table 6.4. The table shows, in particular, that one million dollars in legislated expenditures for KTEC or the Centers generates the equivalent of between $12 million and $98 million in income; between 300 and 2500 jobs-years; between $0.5 million and $5 million in additional tax revenues from businesses; and between 2 and 3 manufacturing start-ups.

Note that these figures are weighted using the assumed Kansas social discount rate of 11.5 percent per year. For example, if a certain number of jobs were created following on a lag of one year from the time of the corresponding KTEC expenditure, then that number of jobs would be counted only after reducing it by a factor of 1.115.

Comparisons Across KTEC Programs

Absolute ROPI results for the individual programs vary from a low of between 9 and 19 for the Advanced Manufacturing Institute at Manhattan, to a high of between 176 and 827 for the Center for Technology Transfer in Pittsburg. The "other KTEC" results are much lower; but as noted earlier, these results are highly understated because the corresponding programs were not surveyed.

These data imply that there may be real differences across KTEC programs in the measurable economic development benefits delivered to date. The Center for Technology Transfer in Pittsburg, the National Institute for Aviation Research, and the Applied Matching Fund grants program all have very high measured returns. Moreover, the Centers program as a whole does appear to have a value of ROPI that is likely to be persistently high in the future.

Two factors are important in understanding differences in measured ROPIs across KTEC programs. One factor is measurement errors in the ROPI model due to problems such as to incomplete survey data, problems with attribution in benefits, and inaccurate modeling of investment. But a more important factor is the inherent riskiness of economic development activities. "Risk" refers to the degree to which results vary wildly from year to year even when the agency's skill and effort do not change. Economic development is by its nature much riskier than most other government activities. For example, economic development leads to new private investments in Kansas that can fluctuate unpredictably by as much as 400 percent from year to year. As a standard of comparison, consider that Kansas state tax collections generally fall well within 4 percent of the estimate made a year earlier.

This riskiness occurs because economic development outcomes tend to depend on a few large successes. Economic developers generally take on a large number of cases, of which many fail and only a few pan out. This kind of prospecting works out on average provided that the occasional successes are big enough and often enough.

Therefore these initial results do not necessarily provide a fair comparison of effectiveness across individual KTEC programs. This point will be reinforced when we look at a sensitivity analysis.

A Sensitivity Analysis of Riskiness

It turns out that the ROPI values for the individual Centers of Excellence are extremely sensitive to "outliers"–i.e. to the performance of one or two exceptional firms. One way to analyze this sensitivity is to look at what would have happened to the ROPI of a program if its single most successful firm had failed instead of succeeding. This analysis is performed in Table 6.5.

That is, Table 6.5 shows ROPI for the ARMF program and for each Center of Excellence, both before and after the single largest success is resimulated as a failure. As we can see, there is a drastic reduction in ROPI in each Center of Excellence, implying a great sensitivity to outliers. It is also apparent from the table that the two Centers with the highest ROPIs (CTT and NIAR) are also the most reliant on a single successful firm. That is, after each Center loses its top firm, CTT and NIAR drop from a position of clear leadership to a position in the middle of the pack. For the lower bound simulations, Higuchi Biosciences Center maintains the highest ROPI after the removal of outliers.

We emphasize the fact that this analysis is purely hypothetical; it is the higher values of ROPI shown in Table 6.3 that are real for each program, and not the lower values

simulated in Table 6.5 without outliers. What we are showing is a degree of riskiness in KTEC programs, and not a degree of measurement error in ROPI.[12]

The results for "other KTEC" are shown as unchanged in this table; that occurs because no firms were surveyed in this residual category. Note also that the results for KTEC as a whole assume that six top firms are eliminated (not just one, but one in each program). It is much less likely that all six top firms would fail than that any one of them would fail. Therefore the problem of riskiness is much less important at the level of KTEC as a whole, than at the level of individual Centers.

This riskiness has several policy implications. First, KTEC does need to have a wide portfolio of economic development programs so that it doesn't "put all its eggs into one basket." Second, there is likely be a lot of variation in ROPI across time for any given program. Therefore we should not be hasty to draw either negative or positive conclusions about a single Center's performance based on a single year's ROPI results.

Conclusion

Since this is the first full ROPI study, we do not know of any other ROPI results to compare with ours. Therefore we can not say, in relative terms, whether KTEC's performance is better or worse than what other typical economic development programs might achieve. But in absolute terms, KTEC's high ROPI values do imply that the program is very effective in producing economic development.

We have discussed some of the potential sources of error in this ROPI measurement. These sources include errors in the survey data, errors in the specification of the economic models, and errors in the measured parameters of the economic models. There is much room for improvement in this initial ROPI model; the attribution of causality, in particular, needs to be closely examined in future work. The authors freely admit that any attempted replication of this ROPI measurement would lead to noticeably different results, at least in detail.

At the same time, the authors do want to express a reasonable degree of confidence in their models. These models have been constructed according to methods generally accepted by regional economists. The nature of the model design is such that a very

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[12] At the same time, this sensitivity analysis does cast some light on the question of measurement error. As a worst case analysis, suppose that the "attribution model" of each outlier were measured with extreme error; i.e. suppose that KTEC "really" bore zero responsibility for the success of the outlier firm. Then the sensitivity analysis would show the measurement error that would result in ROPI. However, the authors believe that the attribution model actually is substantially more reliable than this comparison would assume.

large number of parameters work together, constrained by accounting identities so that no single parameter is very important in and of itself. Moreover, the model gains in reliability by averaging over a number of indicators of economic development; no single indicator is very important in the overall weighted ROPI. Therefore the authors believe that these results are at least qualitatively replicable; that is, that any independent study would have reached similar conclusions about the general magnitude of ROPI, and about the approximate ranking in effectiveness of the six programs based on actual results to date.

Chapter 6 Appendix Follows

Table 6.1a
Economic Impacts
KTEC and Kansas State Growth
Upper Bound Simulation: Future Data Included, Samples Weighted

Indicators	Effect	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Manufacturing Start-ups	Direct	4	1	2	2	1	0	0	10	
	Total	11	38	3	2	2	72	0	127	174
Five Year Survivals	Direct	0	0	0	0	0	0	0	0	
	Total	9	36	0	0	1	1	0	46	70
Fed. Funds for (R&D)	Direct	0.4	7.8	8.0	1.1	2.0	0.0	0.0	19.3	
(Millions $)	Total	10.8	43.1	8.6	1.4	2.4	1.0	0.1	67.4	483.0
Non-fed. Funds (R&D)	Direct	2.7	0.1	0.1	0.0	0.0	0.1	0.0	3.0	
(Millions $)	Total	2.8	0.7	0.1	0.0	0.0	0.3	0.0	3.9	3.7
Taxes for Estab. Firms	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
(Millions $)	Total	27.7	162.5	2.0	0.8	1.2	3.1	0.3	197.6	894.7
Patents Issued	Direct	0	1	3	3	1	0	0	8	
	Total	9	31	4	4	1	49	0	97	414
Infrastructure	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
(Millions $)	Total	28.3	93.8	1.6	0.7	1.1	3.0	5.3	133.8	4,856.8
Workforce Training	Direct	0	0	0	0	0	0	0	0	
(number of students)	Total	1,779	7,356	94	21	89	201	9	9,547	16,172
Human Capital Stock	Direct	4,575	503	499	142	208	217	0	6,143	
(years of experience)	Total	23,786	64,680	1,575	581	964	2,020	431	94,037	1,181,685
Good Jobs - Income	Direct	2,211	434	364	112	154	219	0	3,494	
	Total	10,748	30,167	845	305	496	1,027	147	43,735	617,371
Good Jobs - Titles	Direct	4,869	610	424	123	190	335	0	6,550	
	Total	10,888	21,508	767	263	426	900	162	34,913	661,826
Good Jobs - Education	Direct	1,538	299	362	105	130	149	0	2,583	
	Total	7,826	21,435	722	252	373	742	243	31,593	650,973
Total Jobs	Direct	9,544	810	575	192	275	516	165	12,077	
	Total	28,756	64,987	1,651	631	1,031	2,308	431	99,794	1,493,071
Personal Income	Direct	342	24	19	6	9	20	5	425	
(Millions $)	Total	1,014	2,752	57	24	40	92	17	3,996	26,197

* Other KTEC results are understated because clients were not surveyed. See text.

Table 6.1b
Economic Impacts
KTEC and Kansas State Growth
Lower Bound Simulation: Future Data Not Included, Samples Not Weighted

Indicators	Effect	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Manufacturing Start-ups	Direct	1	1	1	1	1	0	0	4	
	Total	3	4	2	1	1	72	0	81	89
Five Year Survivals	Direct	0	0	0	0	0	0	0	0	
	Total	2	3	0	0	0	1	0	6	36
Fed. Funds for (R&D)	Direct	0.4	7.8	8.0	1.1	2.0	0.0	0.0	19.3	
(Millions $)	Total	2.0	11.1	8.3	1.2	2.0	0.4	0.1	25.1	239.2
Non-fed. Funds (R&D)	Direct	0.9	0.0	0.0	0.0	0.0	0.1	0.0	1.0	
(Millions $)	Total	1.0	0.1	0.1	0.0	0.0	0.3	0.0	1.5	3.3
Taxes for Estab. Firms	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
(Millions $)	Total	4.7	14.9	0.8	0.1	0.2	1.4	0.3	22.4	364.2
Patents Issued	Direct	0	0	1	2	0	0	0	4	
	Total	1	3	1	2	1	49	0	57	205
Infrastructure	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
(Millions $)	Total	7.9	17.1	1.6	0.2	0.3	2.8	10.6	40.5	9,178.9
Workforce Training	Direct	0	0	0	0	0	0	0	0	
(number of students)	Total	459	672	32	2	9	90	9	1,273	7,249
Human Capital Stock	Direct	764	263	467	77	161	155	0	1,887	
(years of experience)	Total	3,597	6,181	980	129	276	905	431	12,499	793,110
Good Jobs - Income	Direct	162	180	322	52	109	67	0	891	
	Total	1,449	2,921	549	74	160	405	147	5,704	286,147
Good Jobs - Titles	Direct	329	203	348	55	118	98	0	1,149	
	Total	1,210	2,129	510	71	154	334	162	4,570	338,348
Good Jobs - Education	Direct	123	171	325	52	109	46	0	826	
	Total	1,033	2,120	497	70	146	294	243	4,403	402,434
Total Jobs	Direct	625	274	479	76	164	166	165	1,950	
	Total	3,459	6,192	992	128	279	904	431	12,385	798,748
Personal Income	Direct	22	8	14	2	5	6	5	62	
(Millions $)	Total	138	260	31	4	9	38	17	496	9,534

* Other KTEC results are understated because clients were not surveyed. See text.

Table 6.2a
Absolute ROPI Measures
KTEC and Kansas State Growth
Upper Bound Simulation: Future Data Included, Samples Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Business Start-ups	768.9	591.6	53.8	166.3	46.8	1,567.5	0.9	373.6	2.1
Five Year Survivals	1,544.8	1,390.5	11.7	33.1	32.6	60.2	0.9	340.2	2.1
Federal Funds for (R&D)	414.2	357.9	88.0	61.9	35.7	11.3	0.7	105.5	3.1
Non-federal Funds for (R&D)	10,869.0	614.8	85.7	61.9	35.8	293.2	0.8	617.4	2.4
Taxes for Established Firms	464.4	587.6	9.1	15.4	8.0	15.6	0.6	134.9	2.5
Patents Issued	399.1	297.4	42.3	184.7	23.1	666.2	0.7	177.8	3.1
Infrastructure	375.4	267.9	5.7	10.7	5.6	11.8	8.4	72.2	10.8
Workforce Training	1,255.3	1,119.0	17.6	17.3	24.6	42.7	0.7	274.3	1.9
Human Capital Stock	485.1	284.4	8.5	14.0	7.7	12.4	1.0	78.1	4.0
Good Jobs - Income	503.6	304.7	10.5	16.9	9.1	14.5	0.8	83.4	4.9
Good Jobs - Titles	702.9	299.3	13.1	20.0	10.8	17.5	1.2	91.8	7.2
Good Jobs - Education	478.7	282.7	11.7	18.2	9.0	13.7	1.8	78.7	6.7
Total Jobs	586.5	285.7	8.9	15.2	8.3	14.2	1.0	82.9	5.1
Personal Income	695.7	406.9	10.4	19.5	10.9	19.0	1.3	111.6	1.4
Goals									
Supportive Business Climate	1,057.9	484.3	59.9	80.2	29.9	256.8	0.8	184.5	2.9
Create and Maintain Good Jobs	1,065.5	913.3	15.4	16.5	20.4	35.3	0.8	225.9	2.4
Create and Maintain Jobs	558.8	298.5	11.5	18.1	9.6	15.3	1.1	85.0	5.9
Highly Skilled Workforce	586.5	285.7	8.9	15.2	8.3	14.2	1.0	82.9	5.1
High Income and Wealth	695.7	406.9	10.4	19.5	10.9	19.0	1.3	111.6	1.4
Overall Absolute ROPI	827.2	443.5	30.4	42.2	18.6	112.6	1.0	141.0	3.3

* Other KTEC results are understated because clients were not surveyed. See text.

Table 6.2b
Absolute ROPI Measures
KTEC and Kansas State Growth
Lower Bound Simulation: Future Data Not Included, Samples Not Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Business Start-ups	183.4	61.6	29.4	48.7	17.2	1,557.9	0.9	237.5	1.1
Five Year Survivals	405.0	127.2	5.5	2.7	4.0	25.6	0.9	45.6	1.1
Federal Funds for (R&D)	75.3	92.1	84.8	52.5	30.5	4.7	0.7	39.3	1.5
Non-federal Funds for (R&D)	1,926.9	59.9	26.7	3.2	4.5	147.4	0.8	114.6	1.1
Taxes for Established Firms	79.2	53.9	3.5	1.4	1.1	7.1	0.6	15.3	1.0
Patents Issued	60.1	29.7	16.1	89.5	8.2	659.6	0.7	103.7	1.5
Infrastructure	52.8	24.7	2.8	1.3	0.9	5.6	8.4	11.0	10.3
Workforce Training	323.7	102.3	6.0	1.8	2.5	19.2	0.7	36.6	0.9
Human Capital Stock	73.4	27.2	5.3	3.1	2.2	5.6	1.0	10.4	2.7
Good Jobs - Income	67.9	29.5	6.8	4.1	3.0	5.7	0.8	10.9	2.2
Good Jobs - Titles	78.1	29.6	8.7	5.4	3.9	6.5	1.2	12.0	3.7
Good Jobs - Education	63.2	28.0	8.1	5.0	3.5	5.4	1.8	11.0	4.1
Total Jobs	70.5	27.2	5.4	3.1	2.2	5.6	1.0	10.3	2.7
Personal Income	94.4	38.4	5.7	3.1	2.4	7.9	1.3	13.8	0.5
Goals									
Supportive Business Climate	278.8	72.9	46.5	41.6	17.2	234.1	0.8	67.4	1.5
Create and Maintain Good Jobs	262.0	83.8	5.8	2.1	2.4	15.8	0.8	30.1	1.3
Create and Maintain Jobs	70.0	29.2	7.7	4.7	3.4	5.9	1.1	11.2	3.1
Highly Skilled Workforce	70.5	27.2	5.4	3.1	2.2	5.6	1.0	10.3	2.7
High Income and Wealth	94.4	38.4	5.7	3.1	2.4	7.9	1.3	13.8	0.5
Overall Absolute ROPI	176.3	53.1	22.7	19.0	8.6	100.0	1.0	36.1	1.7

* Other KTEC results are understated because clients were not surveyed. See text.

Table 6.3a
Absolute ROPI Measures
KTEC ROPI Measures Relative to Kansas State Growth
Upper Bound Simulation: Future Data Included, Samples Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC
Business Start-ups	766.8	589.5	51.7	164.2	44.7	1,565.4	(1.2)	371.5
Five Year Survivals	1,542.7	1,388.4	9.6	31.0	30.5	58.1	(1.2)	338.1
Federal Funds for (R&D)	411.1	354.8	84.9	58.8	32.6	8.2	(2.4)	102.4
Non-federal Funds for (R&D)	10,866.6	612.4	83.3	59.5	33.4	290.8	(1.6)	615.0
Taxes for Established Firms	461.9	585.1	6.6	12.9	5.5	13.1	(1.9)	132.4
Patents Issued	396.0	294.3	39.2	181.6	20.0	663.1	(2.4)	174.7
Infrastructure	364.6	257.1	(5.1)	(0.1)	(5.2)	1.0	(2.4)	61.4
Workforce Training	1,253.4	1,117.1	15.7	15.4	22.7	40.8	(1.2)	272.4
Human Capital Stock	481.1	280.4	4.5	10.0	3.7	8.4	(3.0)	74.1
Good Jobs - Income	498.7	299.8	5.6	12.0	4.2	9.6	(4.1)	78.5
Good Jobs - Titles	695.7	292.1	5.9	12.8	3.6	10.3	(6.0)	84.6
Good Jobs - Education	472.0	276.0	5.0	11.5	2.3	7.0	(4.9)	72.0
Total Jobs	581.4	280.6	3.8	10.1	3.2	9.1	(4.1)	77.8
Personal Income	694.3	405.5	9.0	18.1	9.5	17.6	(0.1)	110.2
Goals								
Supportive Business Climate	1,055.0	481.4	57.0	77.3	27.0	253.9	(2.1)	181.6
Create and Maintain Good Jobs	1,063.1	910.9	13.0	14.1	18.0	32.9	(1.6)	223.5
Create and Maintain Jobs	552.9	292.6	5.6	12.2	3.7	9.4	(4.8)	79.1
Highly Skilled Workforce	581.4	280.6	3.8	10.1	3.2	9.1	(4.1)	77.8
High Income and Wealth	694.3	405.5	9.0	18.1	9.5	17.6	(0.1)	110.2
Overall Relative ROPI	823.9	440.2	27.1	38.9	15.3	109.3	(2.3)	137.7

Table 6.3b
Absolute ROPI Measures
KTEC ROPI Measures Relative to Kansas State Growth
Lower Bound Simulation: Future Data Not Included, Samples Not Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC
Business Start-ups	182.3	60.5	28.3	47.6	16.1	1,556.8	(0.2)	236.4
Five Year Survivals	403.9	126.1	4.4	1.6	2.9	24.5	(0.2)	44.5
Federal Funds for (R&D)	73.8	90.6	83.3	51.0	29.0	3.2	(0.8)	37.8
Non-federal Funds for (R&D)	1,925.8	58.8	25.6	2.1	3.4	146.3	(0.3)	113.5
Taxes for Established Firms	78.2	52.9	2.5	0.4	0.1	6.1	(0.4)	14.3
Patents Issued	58.6	28.2	14.6	88.0	6.7	658.1	(0.8)	102.2
Infrastructure	42.5	14.4	(7.5)	(9.0)	(9.4)	(4.7)	(1.9)	0.7
Workforce Training	322.8	101.4	5.1	0.9	1.6	18.3	(0.2)	35.7
Human Capital Stock	70.7	24.5	2.6	0.4	(0.5)	2.9	(1.7)	7.7
Good Jobs - Income	65.7	27.3	4.6	1.9	0.8	3.5	(1.4)	8.7
Good Jobs - Titles	74.4	25.9	5.0	1.7	0.2	2.8	(2.5)	8.3
Good Jobs - Education	59.1	23.9	4.0	0.9	(0.6)	1.3	(2.3)	6.9
Total Jobs	67.8	24.5	2.7	0.4	(0.5)	2.9	(1.7)	7.6
Personal Income	93.9	37.9	5.2	2.6	1.9	7.4	0.8	13.3
Goals								
Supportive Business Climate	277.3	71.4	45.0	40.1	15.7	232.6	(0.7)	65.9
Create and Maintain Good Jobs	260.7	82.5	4.5	0.8	1.1	14.5	(0.5)	28.8
Create and Maintain Jobs	66.9	26.1	4.6	1.6	0.3	2.8	(2.0)	8.1
Highly Skilled Workforce	67.8	24.5	2.7	0.4	(0.5)	2.9	(1.7)	7.6
High Income and Wealth	93.9	37.9	5.2	2.6	1.9	7.4	0.8	13.3
Overall Relative ROPI	174.6	51.4	21.0	17.3	6.9	98.3	(0.7)	34.4

* Other KTEC results are understated because clients were not surveyed. See text.

Table 6.4a
Cost-Effectiveness
Upper Bound Simulation: Future Data Included, Samples Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Business Start-ups start-ups per $M	6.4	4.9	0.4	1.4	0.4	13.1	0.0	3.1	0.0
Five Year Survivals survivals per $M	5.2	4.6	0.0	0.1	0.1	0.2	0.0	1.1	0.0
Fed. Funds for (R&D) $M per $M	6.5	5.6	1.4	1.0	0.6	0.2	0.0	1.7	0.1
Non-fed. Funds (R&D) $M per $M	1.7	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Taxes for Estab. Firms $M per $M	16.7	21.1	0.3	0.6	0.3	0.6	0.0	4.8	0.1
Patents Issued patents per $M	5.3	4.0	0.6	2.5	0.3	8.9	0.0	2.4	0.1
Infrastructure $M per $M	17.1	12.2	0.3	0.5	0.3	0.5	0.4	3.3	0.5
Workforce Training student-years per $M	1,071.4	955.0	15.0	14.7	21.0	36.5	0.6	234.1	2.5
Human Capital Stock person-years per $M	14,326.6	8,398.1	251.5	412.8	228.3	367.1	30.7	2,305.7	149.0
Good Jobs - Income job-years per $M	6,473.9	3,916.8	134.9	216.9	117.4	186.6	10.5	1,072.3	75.2
Good Jobs - Titles job-years per $M	6,557.8	2,792.5	122.5	186.7	100.8	163.6	11.5	856.0	76.2
Good Jobs - Education job-years per $M	4,713.8	2,783.1	115.3	179.1	88.2	134.8	17.3	774.6	75.6
Total Jobs job-years per $M	17,320.0	8,437.9	263.6	448.1	244.2	419.4	30.7	2,446.9	180.4
Personal Income	610.9	357.3	9.1	17.2	9.5	16.7	1.2	98.0	4.5

* Other KTEC results are understated because clients were not surveyed. See text.

Table 6.4b
Cost-Effectiveness
Lower Bound Simulation: Future Data Not Included, Samples Not Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Business Start-ups start-ups per $M	1.5	0.5	0.2	0.4	0.1	13.0	0.0	2.0	0.0
Five Year Survivals survivals per $M	1.4	0.4	0.0	0.0	0.0	0.1	0.0	0.2	0.0
Fed. Funds for (R&D) $M per $M	1.2	1.4	1.3	0.8	0.5	0.1	0.0	0.6	0.0
Non-fed. Funds (R&D) $M per $M	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Taxes for Estab. Firms $M per $M	2.8	1.9	0.1	0.1	0.0	0.3	0.0	0.5	0.1
Patents Issued patents per $M	0.8	0.4	0.2	1.2	0.1	8.8	0.0	1.4	0.0
Infrastructure $M per $M	4.8	2.2	0.2	0.1	0.1	0.5	0.8	1.0	1.0
Workforce Training student-years per $M	276.3	87.3	5.1	1.6	2.1	16.4	0.6	31.2	1.6
Human Capital Stock person-years per $M	2,166.6	802.6	156.6	91.3	65.3	164.5	30.7	306.5	109.7
Good Jobs - Income job-years per $M	872.5	379.2	87.6	52.6	37.9	73.5	10.5	139.8	41.7
Good Jobs - Titles job-years per $M	728.9	276.4	81.5	50.4	36.5	60.6	11.5	112.0	43.5
Good Jobs - Education job-years per $M	622.2	275.3	79.3	49.4	34.6	53.5	17.3	108.0	50.5
Total Jobs job-years per $M	2,083.4	804.0	158.5	90.6	66.0	164.3	30.7	303.7	110.3
Personal Income	82.9	33.7	5.0	2.7	2.1	7.0	1.2	12.2	2.8

* Other KTEC results are understated because clients were not surveyed. See text.

Table 6.5a
ROPI Measures Excluding Largest Single Observation
Upper Bound Simulation: Future Data Included, Samples Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Goals									
Supportive Business Climate	92.5	54.5	54.6	54.9	23.5	253.8	0.8	61.3	2.9
Create and Maintain Good Jobs	133.2	41.8	7.0	15.3	13.7	31.3	0.8	20.8	2.4
Create and Maintain Jobs	49.3	16.5	8.9	16.4	7.1	14.0	1.1	10.1	5.9
Highly Skilled Workforce	47.9	14.6	6.4	13.7	5.8	13.0	1.0	8.9	5.1
High Income and Wealth	59.9	18.7	7.0	17.7	7.3	17.4	1.3	11.2	1.4
Overall ROPI (excluding largest observation)	75.5	33.9	26.1	31.3	14.0	110.4	1.0	31.2	3.3
Overall ROPI (including largest observation)	827.2	443.5	30.4	42.2	18.6	112.6	1.0	141.0	3.3

Table 6.5b
ROPI Measures Excluding Largest Single Observation
Lower Bound Simulation: Future Data Not Included, Samples Not Weighted

Indicators	CTT	NIAR	HBC	CECASE	AMI	ARMF	Other KTEC*	All KTEC	Kansas Growth
Goals									
Supportive Business Climate	17.3	33.5	44.2	24.7	15.4	231.2	0.8	47.8	1.5
Create and Maintain Good Jobs	6.0	4.7	3.9	2.1	1.3	11.8	0.8	3.8	1.3
Create and Maintain Jobs	3.8	3.6	7.0	4.6	2.9	4.7	1.1	3.4	3.1
Highly Skilled Workforce	2.9	2.6	4.8	3.0	1.8	4.4	1.0	2.6	2.7
High Income and Wealth	3.5	3.1	4.8	3.0	1.8	6.3	1.3	3.1	0.5
Overall ROPI (excluding largest observation)	9.3	15.7	21.2	12.1	7.5	97.8	1.0	21.3	1.7
Overall ROPI (including largest observation)	176.3	53.1	22.7	19.0	8.6	100.0	1.0	36.1	1.7

* Other KTEC results are understated because clients were not surveyed. See text.

7. Conclusions and Recommendations of the IPPBR ROPI Staff

Chapter Summary

1. KTEC as a whole, as well as each individual KTEC program examined here (Applied Research Matching Fund and the five Centers of Excellence), makes very substantial contributions to Kansas economic development, as measured in terms of business climate, jobs, good jobs, and other development goals.

2. The various programs display large differences in effectiveness, as measured by their ROPI values realized as of 1993. To a large extent, the programs with very high ROPI values also have large-scale interactions with a single successful firm. Therefore these differences depend in large part on the blind chance that the single firm succeeds or fails; they may not tell us very much about differences in potential returns from future investments in the various programs.

3. The ROPI study provides limited information about differences in the internal processes of KTEC programs. The programs differ in scope, in case load, in their focus on technology production, in their focus on small firms versus large firms, in their cost recovery mechanisms, and in their orientation toward internal versus external clients. This study makes no evaluation of the connection between processes and outcomes; that might be followed up more systematically in a future evaluation.

4. ROPI is only one type of evidence about the performance of KTEC programs. It can supplement but not replace other types of evidence, including anecdotal evidence and accounting evidence. ROPI is a measurement, and like any economic measurement there is a significant degree of error or uncertainty attached.

5. ROPI is very well suited to making relative evaluations (e.g. comparisons across economic development programs). But in the short run, the ROPI method will not be as well suited to absolute evaluation (e.g. studying whether KTEC should be expanded or continued or abolished) because policy-makers do not have base-line information for comparison.

6. Recommendations for KTEC funding include continued support from the legislature, support for all six programs examined, full funding for ARMF, performance-based incentives for the Centers, and increased reliance on external funding such as client support and out-of-state grants.

7. Recommendations for KTEC operations call for client pay-backs, better collection of data from clients, and better organization of accounting data from KTEC programs.

8. Recommendations for improvements in the ROPI method include creating a more representative panel, improving survey and other data collection methods, improving the sub-models that link data to results, and including evaluations of processes as well as outcomes.

Introduction

This chapter summarizes what we, the authors, think we have learned in the course of this study. It also presents some recommendations for enhancing the effectiveness of KTEC programs and for facilitating the ROPI process. The present chapter is based entirely on opinions developed by the authors of this report. We emphasize the fact that these opinions are not necessarily accepted by KTEC, nor by KTEC-supported agencies, nor by individual members of the representative panel, nor by the University of Kansas, nor by IPPBR as a whole.

Evaluations of KTEC Program Outcomes

KTEC as a whole, as well as each individual KTEC program examined here (Applied Research Matching Funds and the five Centers of Excellence), makes very substantial contributions to Kansas economic development, as measured in terms of business climate, jobs, good jobs, and other development goals.

The various programs display large differences in effectiveness, as measured by their ROPI values realized as of 1993. We believe that these differences are real, and not mere artifacts of the measurement process. In particular, the lower bound ROPIs measured for each of the top three programs (CTT, NIAR, and ARMF) are higher than the upper bound ROPIs measured for each of the remaining three programs (Higuchi, CECASE, and AMI).

However, a sensitivity analysis reveals that the major differences between Centers depend in each case on a single successful firm (out of scores of firms that were assisted). Therefore, these differences depend in large part on the blind chance that the single firm succeeds or fails; they may not tell us very much about differences in potential returns from future investments in the various programs. That is, the measured differences might easily go in a different direction during a future evaluation.

It is also important to understand that these differences are stated in terms of realized or *achieved* returns on public investment; that is, in terms of jobs already in place and

sales already made or projected.[13] All of the programs have anticipated or *potential* returns on previously-made public investments that are not included in this measurement of ROPI.

Another conceptual problem in comparing outcomes across these programs occurs because each program has a different time horizon. In general, the programs with lower realized 1993 ROPIs also tend to have longer planning horizons. They invest relatively more in projects that can potentially provide larger public returns, further in the future, than do programs with higher 1993 ROPIs. If some of these potentially high returns are realized in the future, then the relative ranking of programs will change.

Evaluation of KTEC Processes

Since this ROPI evaluation looks mainly at the *outcomes* of these programs and not at the *process*, we cannot provide a systematic diagnosis of what (other than blind chance) might be causing the differences in outcomes between programs. At the same time, this ROPI study does reveal some significant information about differences in the internal process followed by the programs. Programs differ in scope, in case load, in their focus on technology production, in their focus on small firms versus large firms, in their cost recovery mechanisms, and in their orientation toward internal versus external clients. We discuss these differences in process without any analysis of the relationship between processes and outcomes. Perhaps the differences in process can be followed up more systematically in a future evaluation.

1. *Program Scope*

Two programs, CTT and ARMF, seek to address many of the business needs of their clients, either directly or through referrals. They do not focus merely on their technology assistance needs. The other four programs appear to be more sharply focused on technology (and less focused on general business assistance).

2. *Case load*

The three top-scoring programs (CTT, NIAR and ARMF) appear to handle more individual cases than CECASE, AMI, and Higuchi. Handling more cases leads to more opportunities for success. On the other hand, handling fewer cases leads to concentrating more resources on each case, increasing the probability of success for a given case.

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[13] The upper bound measure assumes however that jobs and sales *now in place* will continue for seven years into the future; see chapter 5.

3. *Technology production versus technology transfer*

The Centers appear to vary in the relative amount of basic or academically publishable research they perform, as opposed to applied development and technology transfer. This study does not measure academic outputs because they are not listed among the economic development goals or indicators approved by the representative panel. Still, it is our impression that some centers place much higher priority than others on academically publishable work. Academic research might support economic development goals by keeping Center personnel well acquainted with leading-edge technology. On the other hand, it also might impede economic development by diverting resources.

4. *Large versus small firms*

The several programs vary in the relative attention they pay to large versus small firms. NIAR for example serves some very large aircraft firms (as well as many small firms). ARMF, on the other hand, focuses largely on small firms and start-ups. It might be argued that the Centers should concentrate their efforts on small firms rather than large firms for two reasons. First, Center efforts may be too small in proportion to projects conducted by large firms to make a substantial difference in the outcomes, but not too small to make a critical difference for small firms. Second, if large firms have more capital and access to technology than small firms, then large firms may have less need for assistance from the Centers. Our study did not collect sufficient data on this issue to draw any firm conclusions. This issue is closely related to the question of the attribution of causality to KTEC intervention, an issue we have earmarked as meriting additional research.

5. *Cost recovery*

The programs are evolving various methods to recover part of their costs from the clients. At least one Center director expressed the belief that his Center could eventually become self-supporting. In any case, with other things being equal, increases in self-support will *necessarily* lead to increases in ROPI (because it reduces the Kansas-cost denominator). A future study of additional opportunities for cost recovery by the Centers might be helpful.

6. *External versus internal clients*

The Centers vary in their reliance on casework with external clients as opposed to in-house projects intended to create spin-offs. A future study might compare the relative ROPI from these two types of projects within a single Center.

Evaluations of the ROPI Method

One major purpose of this study was to apply ROPI for the first time to an actual evaluation of a government agency. The ROPI staff has gained considerable insight into

the evaluation process as a result of this exercise, and the ROPI method has been improved substantially. But a more important question remains open: is the ROPI method useful to Kansas taxpayers?

Any final evaluation of the ROPI method itself will lie in the hands of ROPI consumers (i.e. the readers of this report), not in the hands of its producers (i.e. the authors of this report). However, we, as authors, would like to contribute our own point of view to the discussion.

ROPI is only one type of evidence about the performance of KTEC programs. It can supplement but not replace other types of evidence, including anecdotal evidence and accounting evidence. ROPI is a measurement and like any economic measurement there is a significant degree of error or uncertainty attached. The ROPI method is a new measurement system, and therefore our understanding of its limitations is incomplete.

ROPI is very well suited to making relative evaluations (e.g. comparisons across economic development programs). The ROPI method will clearly identify programs that are completely counterproductive (because they have a negative absolute ROPI rate). Also, ROPI can identify programs that are questionable (they have a negative relative ROPI); in other words, it can identify programs that are less effective than a given standard of comparison.

In the short run, the ROPI method will not be as well suited to absolute evaluation (e.g. studying whether KTEC should be expanded or continued or abolished) because policy-makers do not have all the base-line information they need. In particular, we do not know what ROPI rates for economic development are obtainable from alternative uses of the public expenditures. Some alternatives worth examining might include property tax reductions targeted to manufacturing and improvements in vocational education. In the long-run, we hope to perform ROPI studies of some of these alternative means of economic development.

The ROPI method has some disadvantages, especially with regard to costs. Building a ROPI model has significant start-up costs. And even after the basic model has been developed and applied to a given agency, we believe that continued involvement by economists will be needed during future applications by the same agency. Less formal methods of evaluation are probably less costly than ROPI. On the other hand, the ROPI method is probably not appreciably more expensive than ordinary benefit-cost analysis. If the ROPI model is used widely, we should expect the unit costs of a ROPI study to come down; there are potential economies of scale.

A potential limitation of the methodology used in this report follows from the dependence of the client survey on the cooperation of program administrators. Most

importantly, the assistance of the Center directors was needed to obtain mailing lists of clients plus cover letters to clients endorsing the survey. Negotiating the details of this assistance consumed significant amounts of time and energy. Fortunately for the study, all Centers directors did eventually provide the help we needed. Without that assistance, this study would have been impossible.

Recommendations of the Authors

We make several recommendations for action concerning KTEC funding, KTEC operations, and improvements in the ROPI method. We believe that these recommendations are firmly rooted in empirical evidence, including a) the contributions of KTEC to economic development, as measured by ROPI results; b) the preliminary findings about KTEC internal processes; and c) the documented experiences of the researchers in applying the ROPI method. The recommendations are discussed below and are summarized in Tables 7.1, 7.2, and 7.3. We want to state again that, while the recommendations have empirical foundations, they also include an element of the authors' opinions.

Recommendations Concerning Funding

Our recommendations address continued funding of KTEC by the legislature and reallocation of funds within KTEC.

1. *State allocation of funds*

The future of KTEC depends in large part on funding decisions that will be made by the Kansas legislature. These decisions are likely to be based on the legislators' perceptions; not only their perceptions about KTEC's effectiveness, but also their perceptions about the effectiveness of other economic development programs, about the importance of economic development in general, and about the importance of competing demands for scarce dollars from the Kansas government. Since our study has addressed only the first of these issues (KTEC effectiveness), any blanket recommendation on KTEC's future funding made by us would be presumptuous.

However, we will venture a conditional or partial recommendation. Our study shows that the KTEC program has been effective, and demonstrates this effectiveness with clear evidence. We believe that this evidence has been presented with a degree of conceptual and numerical precision which, while not perfect, nevertheless is superior to the existing evidence for the effectiveness of any other economic development program in Kansas (and perhaps in any state of the U.S.). Therefore, if the Kansas legislature does continue to fund economic development programs, then in our opinion it should give a high priority to continued funding for KTEC.

If KTEC continues to be funded, all six programs examined in this report are effective and should continue to be supported. Each program has a significant degree of riskiness, in the sense that economic development results, whether measured by ROPI or by some other terms, are likely to vary substantially across time. However, the portfolio of six programs working together is significantly less risky than the individual programs acting separately would be.

Increased state funding seems justified for the ARMF program, at least in the short run, in the event that approved ARMF applications should exceed appropriations. This program seems to be quite productive, is developing a client pay-back system, and has a substantial potential to become fully client-supported in the long-run.

2. *KTEC internal allocation of funds*

The great degree of variation in ROPI values measured for the six programs suggests that KTEC might consider reallocating its budget between Centers in the future so as to encourage stronger efforts toward economic development. Since there appears to be a large element of blind chance in the success of different programs, it would probably be a mistake to condition all future funds on past successes. At the same time, some degree of conditionality would certainly increase the incentive for the Centers to concentrate their efforts on economic development as opposed to competing institutional goals. In particular, KTEC action may be needed to strengthen incentives for Centers to do more technology transfer in proportion to training or academic research.

As noted earlier, increasing the fraction of support coming from other than state government sources increases ROPI. It follows that KTEC should create incentives (if possible) to encourage each program to gradually increase its reliance on support from clients as well as on out-of-state grants.

Recommendations Concerning KTEC Operations

Our recommendations call for client pay-backs, better collection of data from clients, and better organization of accounting data from KTEC programs.

1. *Requirements for client firms*

To the extent that program clients are being subsidized by the state, and to the extent that success of the client's project can be measured, the client's contract should, in some cases, require pay-backs to the program (conditionally on success of the project). This would be more appropriate for medium and large projects than for some very small projects undertaken by some of the Centers. We have already noted that pay-backs will improve ROPI. There is evidence from the ARMF program that most clients will not be deterred by moderate pay-backs if the payments are conditioned on success of the project.

Since clients are receiving a subsidized public good, it is entirely appropriate to require clients to participate in follow-up impact surveys. Again, there is evidence from the ARMF program that clients will generally cooperate in follow-up surveys if they are notified of the requirement in advance. Further evidence is provided by the relatively good response rate experienced in the Centers of Excellence surveys that we administered.

It would be helpful to provide the clients with notice of the full government subsidy implicit in the program services. If possible, an estimate of the amount or percent of costs paid by subsidy should be provided to each client. This notice will help to motivate any pay-back arrangements as well as the impact survey.

It may also be helpful to provide potential clients with previous impact survey results. This would not only serve as a marketing tool, but would also explain concretely what the follow-up surveys will contain.

These arrangements should be recognized in the contracts between KTEC and the various programs.

2. *Accounting systems*

KTEC central financial statements were professionally prepared and quite helpful to this study. The Centers' financial statements were much harder to interpret. The information required by the accounting systems at the universities where the Centers are located does not appear to be sufficient for ROPI calculations. KTEC may wish to establish accounting standards for the Centers. The Centers may want to consider professional assistance in preparing their financial reports.

The programs appear to have an inadequate accounting basis for attributing costs back to clients. In some programs, a great mass of accounting detail is available, but it has not been analyzed so as to establish costs per client. In other programs, the accounts appear to be incomplete. Whether or not client charge-backs are actually implemented, it would helpful to develop such an accounting basis. This information could assist the programs in their internal budget allocations. It could also be helpful for motivating clients on questions such as impact reporting and future profit-sharing or pay-backs. And, it will be helpful in future ROPI measurement.

Recommendations for Improvements in the ROPI Method

We believe that the ROPI method can be improved for future KTEC applications in a number of ways. Suggested improvements include creating a more representative panel, improving survey and other data collection methods, improving the sub-models that link data to results, and including evaluations of processes as well as outcomes.

1. *The ROPI panel*

ROPI goals and weights should come from a truly representative panel. We believe that the ROPI panel that participated in this study did indeed represent most sectors of the Kansas electorate. But the method of selection of the panel (appointed by KTEC) could make its representativeness open to question. Ideally, the panel would be appointed by the governor and/or the legislature. Moreover, the selection of goals and weights should be preceded by an opportunity for open testimony by members of the general public. To the extent that Kansas is a representative democracy, no other source for the basis of evaluation can be viewed as fully legitimate.

The selection of goals and weights by the panel should be an iterative process. The results of previous ROPI studies should be available to the panel when it selects new goals and weights. It would be helpful to have some stability in the ROPI panel membership, so that weights and goals (the basis for evaluation used by ROPI) does not change too abruptly.

2. *Client surveys*

We have already suggested that program contracts with clients should provide for follow-up surveys. The design of the survey form should be a cooperative effort of the KTEC staff and survey experts. In order to keep the burden on firms to a minimum, the surveys should be brief (two pages), should be standardized across programs to the fullest extent possible, and should, of course, promise confidentiality. KTEC should be free to change the survey form over time, in light of developing experience.

Follow-up surveys should be routine, probably annual. They should be administered and performed by third-party or outside agencies. This is the only method which can create comparable data across programs, without any appearance of bias. Care should be taken to avoid multiple surveys of firms that use more than one KTEC program. This may require cooperation with other agencies, e.g. MAMTC. And surveys should be restricted to major clients (e.g. clients requiring more than a certain number of hours of work).

3. *Modeling improvements*

Perhaps the most important technical step in the development of ROPI would be to improve the model for the attribution of the degree of causality between the client firm's outcomes and the KTEC intervention. The model used in this report is defensible, but it can surely be improved. This question is especially critical in the case of large firms and large projects. Attributing a given percentage of influence to KTEC seems inherently less plausible as the size of the project expands in relation to the size of the intervention.

It is also important to improve the methods for measurement of the upper and lower bounds on ROPI. The existing bounds are very broad. If possible, they should be narrowed.

Although we have tried to build a comprehensive impact model for Kansas, it is certainly possible that the model used in this report may omit some important channels through which KTEC efforts can affect economic development goals. The model might be improved by additional research, after getting input from program directors on what they view as the main channels of influence.

The ultimate goal of any ROPI study is to produce an evaluation of a government program in terms that will be persuasive to the general public. The public acceptance of a ROPI measurement will depend not only on the public perception that goals and weights were adopted in a fair and democratic manner; but also on the public perception that the economic modeling component of ROPI was performed in a competent, accurate, and unbiased manner. It follows that the economic modeling component needs to be transparent, publicly documented, and open to public criticism. Moreover, the economic modeling should ideally be performed by an independent agency which has a professional reputation to protect, and which has no other institutional interests at stake.

4. *Evaluation of processes*

ROPI is purely an evaluation of program outcomes; it needs to be supplemented with a method for evaluating program processes. However, much of this process evaluation can be conveniently built into the ROPI framework. For example, the survey of firms could ask questions about client satisfaction and prompt suggestions for changes in the programs. Follow-up studies could examine operational processes as well as ROPI-type outcomes.

Future Developments in the ROPI System

We conclude with a discussion of the potential uses of the ROPI method. We are not proposing at this point that ROPI actually be applied to other uses–that recommendation would be premature, since the application to KTEC has yet to be thoroughly discussed and validated by policy-makers in the state. We are simply discussing the capacity of ROPI.

We believe that the presently-existing ROPI model could potentially be applied to other free-standing economic development programs in Kansas. Some changes in the ROPI computer model would be needed so as to incorporate new data sources; but the existing structure of goals, indicators, and bridge models does not need serious modification.

The existing ROPI model could also be applied to the economic development components of programs which have primary goals other than economic development. An example would be an analysis of the tax structure. However, the evaluation in this case could be only partial: it could not address any goals other than economic development goals.

The ROPI model could also be extended and applied to much more general governmental activities in Kansas or elsewhere. In each case, a new structure of goals and a new set of economic models will have to be developed. ROPI is not offered as a panacea for the problem of evaluating government programs, because each new type of government program to be evaluated will entail substantial development activity on the ROPI model. Moreover, each new application of the ROPI model will have its own particular limitations in terms of validity, accuracy, and reliability.

However, ROPI does provide a rigorous framework for evaluation which removes some of the conceptual limitations of benefit-cost analysis. In particular, ROPI provides a unified method for incorporating distributional goals as well as efficiency goals into a single analysis. It also potentially provides a way of making that analysis legitimate and acceptable for a broad constituency within the framework of a representative democracy. The authors are hopeful that this potential can be widely realized.

Chapter 7 Appendix Follows

Table 7.1
Recommendations for KTEC Funding

- If the legislature continues to support economic development efforts, then it should continue to support KTEC.
- The six programs examined (i.e. five Centers of Excellence and the Applied Research Matching Fund) are effective and should continue to be supported by KTEC.
- The ARMF program should be fully funded.
- KTEC should, to some extent, apply performance-based incentives to funding of programs such as the Centers.
- KTEC should create incentives (if possible) to encourage each program to gradually increase its reliance on support from clients as well as on out-of state grants.

Table 7.2
Recommendations Concerning KTEC Operations

- Contracts between program agencies and clients should provide for:
  - periodic economic impact surveys.
  - pay- backs to the agency (for profitable projects) for firms that have received substantial assistance.
- Contracts between KTEC and program agencies should provide for accounting systems that will, among other things, support attribution of public costs to particular clients.

Table 7.3
Recommendations for Improving ROPI Process

- The goals and weights for economic development should be determined by a truly representative ROPI panel.
- The ROPI client survey questionnaires should:
  - be standardized across programs to the fullest extent possible.
  - be designed by KTEC staff and survey specialists.
  - be brief (two pages is ideal).
  - promise confidentiality.
  - gather customer satisfaction and program improvement data in the same survey with economic impact data.
- The survey process should be administered so that:
  - it is performed by an impartial third party.
  - it is repeated periodically, probably annually.
  - it avoids redundant surveys.
  - it is restricted to major clients.
- Additional development work should concentrate on:
  - improving the model of causal attribution.
  - seeking tighter upper and lower bounds on ROPI.
  - providing additional goals and indicators.
  - examining relative effectiveness of differing internal administrative processes followed by the several program agencies.

REFERENCES

Barke, Richard P. 1990. "Technology and Economic Development in the States: Continuing Experiments in Growth Management" in Schmandt and Wilson, eds. (1990), pp. 97-126.

Burress, David; Mohamed El-Hodiri; and V.K. Narayanan. 1993. *An Evaluation Model to Determine the Return on Public Investment (ROPI) for the Kansas Technology Enterprise Corporation*, University of Kansas, Institute for Public Policy and Business Research, Research Report No. 196.

Griliches, Zvi. 1989. "Patents: Recent Trends and Puzzles," *Brookings Papers on Economic Activity*, pp. 291-319.

Griliches, Zvi. 1988. "Productivity Puzzles and R&D: Another Non-Explanation," *Economic Perspectives* 2, Fall, pp. 9-22.

Griliches, Zvi. 1990. "Patent Statistics an Economic Indicators: A Survey," *Journal of Economic Literature* 28, December, pp. 1661-1707.

Griliches, Zvi. 1992. "The Search for R&D Spillovers," *The Scandinavian Journal of Economics* 94 (Supplement), pp. S29-48.

Hatry, Harry. 1990. *Monitoring the Outcomes of Economic Development Programs: A Manual*, Washington, DC: Urban Institute Press.

Kamieniecki, Sheldon and Lackie, Paula. 1992. "Measuring High-Technology Capacity Across the 50 States," *Policy Studies Review* 11(1), Spring, pp. 110-117.

Kansas Technology Enterprise Corporation. 1992. *Scope of Services: 1992-1993*, Topeka: Kansas Technology Enterprise Corporation.

Minnesota Department of Trade and Economic Development. 1988. *State Technology Programs in the United States*, St. Paul: Minnesota Department of Trade and Economic Development.

Mansfield, Edwin. 1991. "Social Returns from R&D: Findings, Methods, and Limitations," *Research Technology Management* 34, November-December, pp. 24-27.

Malecki, Edward J. 1990. "Technolgical Innovation and Paths to Regional Economic Growth" in Schmandt and Wilson (1990), pp. 97-126.

Saaty, Thomas L. 1980. *The Analytic Hierarchy Process (Planning, Priority Setting, Resource Allocation)*, New York: McGraw Hill.

Schmandt, Jurgen and Wilson, Robert H. 1988. "State Science and Technolgy Policies: An Assessment," *Economic Development Quarterly* 2(2), May, pp. 124-137.

Schmandt, Jurgen and Wilson, Robert H., eds. 1990. *Growth Policy in the Age of High Technology: The Role of Regions and States*, Boston: Unwin Hyman.

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