The Bioscience Industry in Douglas County: An Analysis of Economic Impacts Opportunities and Challenges

Prepared for
The Lawrence Chamber of Commerce

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Chapter 1:
Introduction and Summary

Purpose

This study, commissioned by the Lawrence Chamber of Commerce, analyzes the current economic and fiscal impacts of the bioscience industry in Douglas County, evaluates the economic impacts of several potential growth scenarios for the industry over the next decade, and provides an analysis of both regional strengths and weaknesses that are likely to influence the industry's growth in the county.

Executive Summary

Size and Economic Impact of the Bioscience Industry in Douglas County

- Currently there are approximately 2,400 jobs in bioscience research and manufacturing in Douglas County. Bioscience employment accounts for an annual payroll of about $68 million.
- The indirect or multiplier effects of these jobs create another 1,300 jobs in the county and another $38 million of annual income.
- The University of Kansas (KU) dominates local bioscience employment, employing about 2,300 in this area.
- KU bioscience employment increased by 20.5 % between October 2000 and October 2003; from 1,897 to 2,285.
- Over the next 5 years KU anticipates adding nearly 60 new bioscience faculty positions; with 40 percent of these being highly productive senior faculty. Each additional faculty position is expected to contribute between 4 and 5 additional non-faculty bioscience employees.
- KU bioscience funded research project expenditures have increased from $16.6 million to $53.3 million between 1999 and 2004 (an increase of 321%).
- In the past year the attraction of two core bioscience firms-Deciphera and Serologicals-to Lawrence has been associated with an expansion of the average number of core bioscience firms from 6.8 in 2003 to 8 in 2004.
- In 2003 ES-202 data show that private sector core bioscience firms employed approximately 100 persons in Douglas County. Based on interviews with area bioscience firms we estimate that employment has grown to about 170 in 2004. This is, however, below the peak employment level attained in the early 1990s.
- Because of the small number of private sector bioscience firms fluctuations in the fortunes of one or two firms have contributed to significant instability in private sector employment over the last decade.

The Local Climate for Bioscience in Douglas County

- The business climate for bioscience firms in Douglas County has strengths and weaknesses.
- In general, firms report that the county's high-quality workforce and basic amenities such as education and transportation aid in bioscience development.

- On the other hand, firms have concerns about local government relations, KU relations, and lack of critical mass for the industry.
- Firms' expectations for their relationships with KU relationships differ from the reality they encounter. Firms cite bureaucracy, lack of centralized information, and assignment of intellectual property rights as problems in working with KU.

Projected Economic Impacts of Bioscience Industry Growth, 2004-2014

- We examined the impacts on Douglas County that would result from four different bioscience growth rate scenarios. These scenarios assumed that growth in bioscience jobs ranged from a compounded annual average rate of 1.0% per year to 8.5% per year and assumed rates of wage growth ranging from 1.8% per year to 2.5% per year.
- After ten years, bioscience growth would generate between 500 and 6,000 new jobs, including multiplier effects. It would also create between $30 million and $230 million in new annual income.

Chapter 2:
The Bioscience Industry

Introduction

Bioscience is not a category used by government statistical agencies in collecting or reporting economic data. Rather the bioscience industry cuts across standard classification schemes. This chapter begins by defining the scope of the bioscience industry for this report, and then considers characteristics of this industry in Kansas and the nation as a whole as a way of providing a context for subsequent analysis of the industry in Douglas County.

Definition

The Kansas Economic Growth Act (HB 2647) characterizes bioscience as comprising biotechnology and life sciences. While the term life sciences is used to refer to a wide range of basic research concerned with molecular, cellular, and genetic processes that underlie human, plant, and animal life, biotechnology refers to the application of knowledge and techniques derived from the life sciences to create products and services. Although the largest area of applications of bioscience is in the medical fields (diagnosing, treating and preventing diseases), it has a wide array of other actual and potential applications. These include agriculture, manufacturing, and even computing (Cortright and Mayer 2002, p. 6).

As the breadth of these applications suggests, it is not easy to measure the economic impacts of bioscience activity. Most government statistical efforts are organized by industry and bioscience is not a separate classification in the North American Industrial Classification System (NAICS,) which has been in use for the past several years, or in the Standard Industrial Classification (SIC) system, which it replaced. Instead, bioscience activity cuts across a wide swath of different industries. Although the NAICS offers highly disaggregated industry classifications, data are often available only for more aggregated groups which encompass both bioscience and non-bioscience activities.

Confronted with these difficulties government officials and academic researchers have adopted a variety of answers to the question of which industries should be included in bioscience. Table 2.1 summarizes the industries that the Kansas Economic Growth Act defines as bioscience and compares them with those enumerated by other states and in several academic studies. The industries included in the Kansas Economic Growth Act can be grouped into the following five broad categories (with NAICS codes in parentheses):

- Chemicals manufacturing (325193, 325199, 325311, 325320)
- Pharmaceuticals and medicine manufacturing (3254111, 325412, 325413, 325414)
- Medical and laboratory equipment and supplies manufacturing (333319, 334510, 334516, 334517, 339111, 339112, 339113, 339115)
- Research and development (541710)

- Diagnostic, testing, veterinary services, and medical services (541380, 541940, 621511, 621512)

Certain industries—pharmaceuticals and other bioscience products manufacturing and bioscience research and development—are common to all definitions of the industry, but there is less uniformity about whether to include other industries such as medical and laboratory equipment, chemicals manufacturing, and diagnostic, testing and medical services.[1] In this sense, the Kansas definition is relatively broad. The Kansas Economic Growth Act also includes all of NAICS industry 541710—Research and Development in the Physical, Engineering, and Life Sciences. In this case it is necessary to disaggregate further—to the seven-digit level—to exclude physical and engineering research and development that is likely unrelated to life sciences. One other important point to notice is that none of these definitions deals adequately with the contribution of higher education to bioscience.

For our purposes in studying the bioscience industry in Douglas County we will largely follow the industry definitions laid out by the Kansas Economic Growth Act, with the exception of nitrogenous fertilizer manufacturing and other basic organic chemical manufacturing both of which we exclude from our analysis. These industries are not closely linked to bioscience and are in any event not a significant factor in the Douglas County economy at present. In addition, we will exclude establishments in the diagnostic, testing and medical services industries that are primarily engaged in the provision of routine services rather than in biotechnology research and development.

Overview of the Bioscience Industry in Kansas and the Nation

Comparison of State and National Employment by Detailed Industry

How large is the bioscience industry in Kansas, and how does it compare to the industry nationally. Table 2.2 presents evidence on industry employment for the state and the nation drawn from federal statistics published in County Business Patterns (U.S. Census Bureau). Because of the small numbers of employers in some industries County Business Patterns does not report precise employment figures for all industries in Kansas, making it necessary to approximate these ranges with their midpoints. Overall employment in the state in 2001 was thus approximately 11,735. Reassuringly this total corresponds closely to the range of employment (11,000 to 13,000) estimated in an independent census of bioscience employers in the state recently completed for KTEC by Thomas P. Miller and

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[1] Battelle (2001, p. 8) compares state bioscience industry definitions from twenty-nine states. Of these twenty-two include Drugs and Pharmaceuticals (SIC 283), nineteen include Research Development and Testing Services (SIC 873), and seventeen include Medical Instruments (SIC 384). While these industries appear to be widely viewed as part of bioscience, others in the Kansas list are less widely accepted. Only ten states defined Agricultural and Organic Chemicals (SIC 286, 287) as part of bioscience, while only five included Animals/Veterinary Specialties (SIC 027 and part of 074), and just three included Medical Laboratories (SIC 807).

Associates (2003). For these same industries, national employment was a bit over 1.5 million, so Kansas accounts for approximately 0.68% of national employment.

The structure of the Kansas bioscience employment differs in a number of ways from the national industry. In the second and fourth columns of the table are reported respectively the share of employment in Kansas and the nation accounted for by each industry. The fifth column shows the ratio of these two percentages—which is often referred to as the location quotient. If an industry's employment share is the same in the state as it is nationally the location quotient would equal one. Locations quotients above one indicate industries that are relatively concentrated in the state, while location quotients less than one indicate industries in which the state's employment is relatively small.

Judged by overall employment the most important industries in the state are: veterinary services, diagnostic imaging centers, medical laboratories, pharmaceutical preparation manufacturing, and all other basic organic chemical manufacturing. Together these four industries account for over half of the state's bioscience employment. Looking at their location quotients it is apparent that all of these industries are also more important in the state industry than they are nationally. Other industries that are overrepresented in the state include nitrogenous fertilizer and ethyl alcohol manufacturing, and in-vitro diagnostic substance manufacturing. Although research and development in the physical, engineering, and life sciences accounts for over 5% of state industry employment, the state lags substantially behind the nation in this important component of life sciences, which makes up over 21% of national employment in the ensemble of industries classified as bioscience by the Kansas Economic Growth Act.

Since 1998, Kansas employment in bioscience has lagged behind national trends. In the nation as a whole employment in these industries increased by a little over 8% between 1998 and 2001. This rate of growth was slightly more rapid than employment growth for all industries, which saw employment grow by 6.5% over the same period. In Kansas, employment in the bioscience industries actually fell by close to 6%. Performance in different industries varied, however, as is detailed in Table 2.3. Among the most rapidly increasing industries in the state were diagnostic imaging centers, which more than tripled their employment, and surgical and medical implements manufacturing, which increased employment by more than 50%. Among those industries experiencing the greatest job losses were ophthalmic goods manufacturing which shrank more than 50%, and research and development in the physical, engineering, and life sciences, which fell by almost 20%.

Research and Development in the Bioscience Industry

Much of the recent interest in bioscience from policymakers and the public is a response to recent scientific advances in our understanding of genetic processes. The potential economic impacts of these advances are generally viewed as being quite large. While the impact of these advances may be diffuse much of the work in developing new technologies takes places within a small subset of the industries included in the Kansas Economic Growth Act's definition of bioscience. These research and technology intensive industries include pharmaceuticals and other medicine manufacturing as well as research and development in the life sciences.

A recent study conducted by researchers at the Brookings Institution (Cortright and Mayer 2002), examined this subset of technologically progressive industries in great detail. The technology intensive segment of the bioscience industry consists of two quite different components. Pharmaceuticals manufacturing is dominated by a small number of large, well-established, trans-national companies that integrate manufacturing, marketing, and research and development activities. Biotechnology research firms, on the other hand, tend to be small, recently established and concentrate their activities primarily in research and development. For the most part they do not manufacture the products that they develop; instead they sell or license them to big firms (Cortright and Mayer 2002, p. 7; Dibner 2000, p. 6). While the pharmaceuticals companies make significant profits, the biotechnology research companies so far appear to spend considerably more on research and development than they earn in revenues. Given these characteristics it is not surprising that the biotechnology research industry is quite volatile, with many companies entering and exiting the industry (Cortright and Mayer 2002, p. 8).

It is important to note that biotechnology research is quite risky and that time horizons are relatively long. Over the past 30 years only about 100 biotech-related drugs have actually reached the market and nearly all of the sales in this category are accounted for by the top ten such drugs. Thus there have been relatively few successes despite high levels of activity. Cortright and Mayer (2002, p. 9) report, for example, that the National Institutes of Health (NIH) fund about 25,000 research projects each year and about 5,500 patents are issued to researchers and companies for new biotechnology products and processes.

The geography of biotechnology research is highly concentrated. More than 60% of NIH funded research and close to two-thirds of biotechnology-related patents are accounted for by just nine metropolitan areas.[2] While Boston and San Francisco are the established leaders in biotechnology, San Diego, the Research Triangle area in North Carolina, and Seattle have emerged in recent years as important centers of activity. The pharmaceuticals industry tends to be centered in New York and Philadelphia and these cities also account for a good deal of research activity. However, they lag behind the biotechnology centers in measures of new technology commercialization, such as venture capital investments and Initial Public Offerings (IPOs).

For all of the dynamism of the biotechnology industry, there have been only small shifts in the location of activity over time. Over the past decade NIH funding has increased at an annual average rate of 7.8% per year, providing a significant infusion of funds into this burgeoning industry. Yet the distribution of research funding across major metropolitan areas has hardly changed. Only three cities experienced declines in their share of funds of one percentage point or more, while none of the other top-50 cities increased their share of funding by as much as one percentage point (Cortright and Mayer 2002, p. 19).

[2] These metropolitan areas are Boston, Los Angeles, New York, Philadelphia, Raleigh-Durham, San Diego, San Francisco, Seattle, and Washington/Baltimore.

Table 2.1
Alternative Definitions of Bioscience

SIC Code	Industry Title	States										Others		
		KS	IL	NC	NY	OR	PA	TX	VA(1)	VA(2)	WA	San Diego	Bay Area	Niagra - Mohawk
2833	Medicinal Chemicals & Botanical Products	x	x	x	x	x		x	x	x	x		x	x
2834	Pharmaceutical Preparations	x	x	x	x	x		x	x	x	x		x	x
2835	In Vitro & In Vivo Diagnostic Substances	x	x	x	x	x		x	x	x	x		x	x
2836	Biological Products, (No Diagnostic Substances)	x	x	x	x	x		x	x	x	x		x	x
2869	Industrial Organic Chemicals, NEC	x												
2873	Nitrogenous Fertilizers	x												
2879	Pesticides and Agricultural Chemicals, NEC	x												
3559	Special Industry Machinery, NEC	x												
3821	Laboratory Apparatus & Furniture	x	x	x									x	x
3822	Auto Controls For Regulating Residential & Comml Environments			x									x	
3823	Industrial Instruments For Measurement, Display, and Control			x									x	
3824	Totalizing Fluid Meters & Counting Devices		x	x									x	
3825	Instruments For Meas & Testing of Electricity & Elec Signals			x									x	
3826	Laboratory Analytical Instruments	x		x									x	x
3827	Optical Instruments & Lenses			x									x	
3829	Measuring & Controlling Devices, NEC			x									x	
3841	Surgical & Medical Instruments & Apparatus		x	x	x	x		x	x	x	x		x	x
3842	Orthopedic, Prosthetic & Surgical Appliances & Supplies		x	x	x	x		x	x	x	x		x	x
3843	Dental Equipment & Supplies		x	x	x	x		x	x	x	x		x	x
3844	X-Ray Apparatus & Tubes & Related Irradiation Apparatus			x	x	x		x	x		x		x	x
3845	Electromedical & Electrotherapeutic Apparatus		x	x	x	x		x	x	x	x		x	x
3851	Ophthalmic Goods			x		x				x				
8071	Services-Medical Laboratories		x			x		x					x	x
8072	Dental Laboratories							x						x
8731	Services-Commercial Physical & Biological Research		x		x	x		x	x		x			x
8733	Noncommercial Research Organizations		x			x					x			x
8734	Services-Testing Laboratories		x								x			x

Table 2.1 (continued)

NAICS Code	Industry Title	States										Others		
		KS	IL	NC	NY	OR	PA	TX	VA(1)	VA(2)	WA	San Diego	Bay Area	Niagra - Mohawk
325188	All Other Basic Inorganic Chemical Manufacturing						x							
325193	Ethyl Alcohol Manufacturing	x												
325199	All Other Basic Organic Chemical Manufacturing	x					x							
325311	Nitrogenous Fertilizer Manufacturing	x												
325320	Pesticide and Other Agricultural Chemical Manufacturing	x												
325411	Medicinal and Botanical Manufacturing	x				x						x		
325412	Pharmaceutical Preparation Manufacturing	x				x						x		
325413	In-Vitro Diagnostic Substance Manufacturing	x				x						x		
325414	Biological Product (except Diagnostic) Manufacturing	x				x						x		
333319	Other Commercial and Service Industry Machinery Manufacturing	x												
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	x					x					x		
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables						x							
334516	Analytical Laboratory Instrument Manufacturing	x					x							
334517	Irradiation Apparatus Manufacturing	x					x					x		
339111	Laboratory Apparatus and Furniture Manufacturing	x				x	x					x		
339112	Surgical and Medical Instrument Manufacturing	x				x	x					x		
339113	Surgical Appliance and Supplies Manufacturing	x				x	x					x		
339114	Dental Equipment and Supplies Manufacturing					x	x					x		
339115	Ophthalmic Goods Manufacturing	x				x	x					x		
339116	Dental Laboratories					x	x					x		
541380	Testing Laboratories	x					x							
541710	Research and Development in the Physical, Engineering, and Life Sciences	x				x	x							
5417102	Research and Development in the Life Sciences											x		
541940	Veterinary Services	x												
621511	Medical Laboratories	x				x								
621512	Diagnostic Imaging Centers		x			x								

Source: See Appendix 2.1 for a full list of sources.

Note: NEC means Not Elsewhere Classified.

Table 2.2
Employment in Bioscience Industries, Kansas and U.S., 2001

NAICS Code	Industry Name	Kansas Number		Kansas Percent of State	U.S. Number	U.S. Percent of U.S.	Location Quotient
325193	Ethyl Alcohol Manufacturing	78		0.66	1,837	0.12	5.69
325199	All Other Basic Organic Chemical Manufacturing	750	[a]	6.39	78,308	4.98	1.28
325311	Nitrogenous Fertilizer Manufacturing	375	[a]	3.20	5,320	0.34	9.45
325320	Pesticide and Other Agricultural Chemical Manufacturing	60	[a]	0.51	14,319	0.91	0.56
325411	Medicinal and Botanical Manufacturing	175	[a]	1.49	27,479	1.75	0.85
325412	Pharmaceutical Preparation Manufacturing	1,204		10.26	139,828	8.89	1.15
325413	In-Vitro Diagnostic Substance Manufacturing	375	[a]	3.20	40,594	2.58	1.24
325414	Biological Product (except Diagnostic) Manufacturing	175	[a]	1.49	25,602	1.63	0.92
333319	Other Commercial and Service Industry Machinery Manufacturing	375	[a]	3.20	57,198	3.64	0.88
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	10	[a]	0.09	50,808	3.23	0.03
334516	Analytical Laboratory Instrument Manufacturing	10	[a]	0.09	34,877	2.22	0.04
334517	Irradiation Apparatus Manufacturing	0		0.00	12,572	0.80	0.00
339111	Laboratory Apparatus and Furniture Manufacturing	60	[a]	0.51	20,185	1.28	0.40
339112	Surgical and Medical Instrument Manufacturing	91		0.78	104,167	6.62	0.12
339113	Surgical Appliance and Supplies Manufacturing	672		5.73	90,045	5.72	1.00
339115	Ophthalmic Goods Manufacturing	175	[a]	1.49	26,753	1.70	0.88
541380	Testing Laboratories	680		5.79	98,422	6.26	0.93
541710	Research and Development in the Physical, Engineering, and Life Sciences	632		5.39	343,690	21.85	0.25
541940	Veterinary Services	3,031		25.83	231,862	14.74	1.75
621511	Medical Laboratories	1,297		11.05	109,714	6.97	1.58
621512	Diagnostic Imaging Centers	1,510		12.87	59,481	3.78	3.40
	TOTAL	10,225			1,513,580		

Source: Computed from County Business Patterns (U.S. Census Bureau)

Table 2.3
Employment Growth in Biosciences Industry, Kansas and U.S., 1998-2001

		Kansas			U.S.		
NAICS Code	Industry Name	1998	2001	Index, 2001 Relative to 1998	1998	2001	Index, 2001 Relative to 1998
325193	Ethyl Alcohol Manufacturing	58	78	134.48	1,975	1,837	93.01
325199	All Other Basic Organic Chemical Manufacturing	750 [a]	750 [a]	100.00	89,554	78,308	87.44
325311	Nitrogenous Fertilizer Manufacturing	375 [a]	375 [a]	100.00	5,923	5,320	89.82
325320	Pesticide and Other Agricultural Chemical Manufacturing	60 [a]	60 [a]	100.00	14,709	14,319	97.35
325411	Medicinal and Botanical Manufacturing	175 [a]	175 [a]	100.00	25,612	27,479	107.29
325412	Pharmaceutical Preparation Manufacturing	997	1,204	120.76	132,883	139,828	105.23
325413	In-Vitro Diagnostic Substance Manufacturing	375 [a]	375 [a]	100.00	36,453	40,594	111.36
325414	Biological Product (except Diagnostic) Manufacturing	175 [a]	175 [a]	100.00	22,163	25,602	115.52
333319	Other Commercial and Service Industry Machinery Manufacturing	684	375	54.82	56,056	57,198	102.04
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	10 [a]	10 [a]	100.00	53,825	50,808	94.39
334516	Analytical Laboratory Instrument Manufacturing	10 [a]	10 [a]	100.00	36,758	34,877	94.88
334517	Irradiation Apparatus Manufacturing	0	0		13,026	12,572	96.51
339111	Laboratory Apparatus and Furniture Manufacturing	60 [a]	60 [a]	100.00	16,838	20,185	119.88
339112	Surgical and Medical Instrument Manufacturing	60	91 [a]	151.67	101,977	104,167	102.15
339113	Surgical Appliance and Supplies Manufacturing	957	672	70.22	89,764	90,045	100.31
339115	Ophthalmic Goods Manufacturing	375 [a]	175 [a]	46.67	27,874	26,753	95.98
541380	Testing Laboratories	584	680	116.44	89,991	98,422	109.37
541710	Research and Development in the Physical, Engineering, and Life Sciences	931	632	67.88	275,141	343,690	124.91
541940	Veterinary Services	2,680	3,031	113.10	195,707	231,862	118.47
621511	Medical Laboratories	1,577	1,297	82.24	111,338	109,714	98.54
621512	Diagnostic Imaging Centers	394	1,510	383.25	44,981	59,481	132.24
	TOTAL	10,893	10,225	93.87	1,397,567	1,513,580	108.30

a Value estimated as midpoint of range of values reported in source

Appendix 2.1
Sources of Data for Table 2.1

States

VA1: An Analysis of Virginia's Biotechnology Industry, Center for Public Policy – Virginia Commonwealth University, March 1999, pp. 8-10.

VA2: Technology in Virginia's Regions, Virginia Center for Innovative Technology

OR: Portland Development Commission. *Bioscience Appendix*, Oregon Bioscience Association, July 2002, p. 7. Website: http://www.pdc.us/programs/ed/strategy/PDFs/bioscience-appendix.pdf

MD: Bioscience in Maryland, MDBIO, Inc. and the Maryland Department of Business and Economic Development.

IL: Technology and Economic Growth: The Structure and Performance of Technology- Intensive Industries in Illinois, Illinois Coalition.

NY: Gardner, Kent, *Will NYS Miss the Biotech Train?*, Gleason Center for State Policy.

PA: Pennsylvania Bioscience Industry Report, Pennsylvania Bio, p. 25. Website: http://www.pa-bio.org/Pennsylvania%20Bio%20Report.pdf

WA: The Economic Impact of Technology-Based Industries in Washington State, Technology Alliance.

NC: The High Technology Industries in North Carolina, North Carolina Department of Commerce.

TX: The Texas Healthcare Technology Industry, Texas Healthcare and Bioscience Institute.

Other studies

Battelle Memorial Institute, State Science and Technology Institute, et al., State Government Initiatives in Biotechnology, 2001. Website: http://www.bio.org/speeches/pubs/battelle.pdf

Bay Area: Joint Venture: Silicon Valley Network. Website: http://www.jointventure.org/resources/index/append_b.html

San Diego: DeVol, Ross, Perry Wong, Junghoon Ki, Armen Bedroussian, and Rob Koepp, America's Biotech and Life Science Clusters: San Diego's Position and Economic Contributions, June 2004, pp. 70-73.

Niagra Mohawk Economic Development. Website: http://www.shovelready.com/need/clusters/bio_bio.PDF

Chapter 3:
The Growth and Future of Private Sector Bioscience Firms in Douglas County

Introduction

Previous chapters discussed the growth of the bioscience industry at the state and national levels. This chapter examines private sector bioscience in Douglas County. How important has the industry been historically, how important is it today, and what are its prospects for growth?

County-level data are necessary to answer these questions. Unfortunately, the data sources used in earlier chapters for national and state-level analysis were not very useful for Douglas County—either the data were not available on a county level or the relevant SIC and NAICS codes were suppressed due to confidentiality concerns. However, a source that was available was the ES-202 file for Unemployment Insurance payroll taxes.[3] The data contain firm-level reports on wages and employment. For confidentiality reasons, data can be revealed in this report only for groups of firms large enough to conceal information about individual firms.

In addition to collecting employment and wage data, we also interviewed seven Douglas County bioscience firms (four in R&D and three in manufacturing). The Lawrence Chamber of Commerce gave use contact names, and we made appointments to talk with firm owners and managers. The interviews addressed why firms chose Douglas County as a location, the manager's level of satisfaction with operating in the county, and the firm's future prospects.

History of Bioscience Employment

As was pointed out in Chapters 1 and 2, bioscience activities are *not* always well-distinguished by the industry codes that are the standard for state and national data collection. Our firm-level ES202 data listed all Douglas County firms having industry codes defined by the Kansas Economic Growth Act. We examined each such company to distinguish which of them actually were operating in the bioscience arena. When necessary to resolve ambiguities, we looked up the firm's web site or, in a few cases, made telephone calls.

The firm-level ES202 data revealed an interesting pattern. For Douglas County, the industries defined by codes listed the Kansas Economic Growth Act fell into two very distinct categories: export based and local consumer based. Export based industries target regional, national, or even international markets. As the goods and services flow out of the county, income and profits flow in. Most economists believe that export based industries are the main stimulants to growth in the local economy. Local consumer-based industries on the other hand serve primarily the population living in the area. These industries are best thought of as responding to growth rather than creating growth on their own. In general, the bioscience R&D firms and manufacturers in Douglas County are part of the export base. In contrast, the laboratory, testing, and veterinary service firms in Douglas County primarily serve local consumers.

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[3] We are grateful to Dr. John Leatherman at Kansas State University for making these data available. The original source of the data is the Kansas Department of Labor.

We will refer to Douglas County bioscience R&D and manufacturing firms as *core bioscience firms* and it is these firms on which we concentrate for the rest of the chapter. Table 3.1 presents more detail on how the bioscience firms in Douglas County fit within the KEGA definitions.

Historically, the bioscience industry in Douglas County has been comprised of several very small research and development firms (fewer than ten employees) along with a few manufacturers of moderate size (10-300+ employees). During the 1990s, the industry sustained one R&D firm in the 10-100 employee range, but that firm no longer operates in the area. There has rarely been much connection between the manufacturing firms and the R&D firms – that is, the manufacturing firms generally are not spin-offs of the research effort.

Table 3.2 summarizes changes in the number of private sector firms, jobs and average wages in Douglas County since 1990. For 1990 through 2003 the table relies on ES-202 data. The 2004 figures are estimates based on the 2003 data and information gleaned from interviews with area bioscience firms. During the past year the attraction of two core bioscience firm—Deciphera and Serologicals—has been associated with an expansion of the average number of core bioscience firms from 6.8 to 8, reversing the effects of several earlier departures. We estimate that the combination of expansion at existing firms and the addition of new firms has increased employment to 170 in 2004 from a level of 100 in 2003. Private sector employment is still below the peak employment levels achieved in the early 1990s, but the new additions suggest that the industry is now on a positive trend. To put the size of the industry in perspective, Douglas County reported about 2600 businesses of all kinds and 37,500 private-sector jobs in 2001 (U.S. Census Bureau, *County Business Patterns 2001*).

Changes in the number of bioscience jobs in Douglas County (Figure 3.1) generally have been due to the activities of one or two firms each year. Therefore, projections of industry growth cannot be based on history. More telling is the information gathered from firm interviews. While a number of the core bioscience firms expect that they will remain small, a few indicated that they expected to add jobs over the next 10 years. It is likely that the entry of new firms and exit of existing ones will be an even more important factor in determining the rate of private sector employment growth during the next decade.

In general, the core bioscience firms pay wages substantially above the county average. Take 2001, for example, the last year for which *County Business Patterns* comparison data are available. In that year, Douglas County core bioscience jobs paid an average of about $2,700 per month (Table 3.2), compared with an all-industry county average $1,900. However, the jobs paid slightly less than the average Douglas County manufacturing wage of $2,800 per month.

Characteristics of Douglas County Bioscience Firms

We turn now to the results of our interviews with Douglas County bioscience firms. We interviewed seven firms during the summer of 2004. All of the firm owners and managers with whom we spoke were very forthcoming about their firms' customers and competitive advantage, their views on the Douglas County Business climate, the climate for bioscience firms in particular, and the interaction of the business climate and their prospects for growth.

Customers and Suppliers

Firms that sell globally and spend locally drive local economic development. Such firms pull revenue into the community from their customers in regional, national, and international markets and then distribute funds to suppliers, shareholders, and employees. The higher the percentage of suppliers, shareholders, and employees that are *local,* the more money will be recycled in the community and the higher the multiplier effects.

All of the bioscience firms that we interviewed do help drive economic development. Both R&D and manufacturing firms serve national and international customers, mostly consisting of large pharmaceutical and medical supply firms. In addition, some of the R&D firms have pulled in grant and contact funding from federal and state agencies.

Both the R&D and manufacturing firms feel confident that they can maintain their customer base. On the negative side, many of the firms face substantial competition (national and international) in the general lines of products and services that they produce. However, both manufacturing and R&D firms believe they will compete successfully because of the uniqueness of their specific products and processes, because of their intellectual property, and because of their ability and willingness to customize products and services to fit customer needs.

Turning to the question of suppliers, most of the firms look to local markets when they can. The firms use local janitorial and business services. The manufacturers buy most of their input materials from suppliers in the Midwest for price and quality reasons. However, most firms reported that the highly specialized inputs that they use are not produced in Douglas County. Attracting specialized suppliers will require larger concentrations of bioscience employers than are currently present in Douglas County.

On the income side, employees and many shareholders are local. Only one of the firms is publicly traded. For the other firms, most of the major shareholders live in Douglas County and many of them are involved in the firms' day-to-day operations. Production employees for manufacturers are recruited locally and, for the most part, live in Douglas County. Professional employees are recruited in national marketplaces, but some of the firms look at KU graduates first.

In summary, Douglas County bioscience firms have substantial linkages to other parts of the Douglas County economy—mostly through employees and shareholders who in turn spend their income in Douglas County—and to a limited degree through the supply chain.

Reasons to Locate in Douglas County

The firm owners and managers with whom we talked located in Douglas County for a variety of reasons and those reasons varied depending on whether the firm was an R&D firm or a manufacturer.

Two of the manufacturing firms that we interviewed located in the area because the owners lived in Douglas County and had roots here. The other firm located here for more traditional site selection reasons: workforce, transportation, and availability of raw materials.

Most of the R&D firms were recent start-ups and only one had been located in Douglas County for more than ten years. All of the R&D firms had a KU link – KU faculty and/or former KU students were involved in the firm start-ups and many remain involved in current operations. It is fair to say that the KU connection is the reason these firms located in the area--after all, KU attracted the faculty and students. But as we discuss later, KU has not played a great role in facilitating the expansion or success of many of these firms.

Several firms (both manufacturing and R&D) cited reasonable business costs and a high-quality labor force as reasons to locate or stay in the area.

Douglas County Business Climate for Bioscience Firms

We asked firms a series of questions about the Douglas County business climate (Table 3.3). In general, firm owners and managers liked the county's workforce and basic amenities such as education and transportation. Most felt that it was easy to attract employees to the area and few thought that top level scientist and managers would feel isolated living in the Douglas County area.

However, firms felt that the Douglas County business climate for bioscience faltered in several areas. Areas of concern included local government relations, KU relations, and lack of critical mass for the industry.

Local government

Four of the interviewed firms felt that an anti-growth business attitude had developed within the City of Lawrence. Tempering this, few of the firms thought that city policies had actually had a negative impact on their businesses, and one of the firms said that the City of Lawrence government, although not pro-growth in general was pro-bioscience-growth. Some firms also stated concerns about high property taxes (a state, city, county, and school district issue). [4]

Relationships with KU

Many of the interviewees wanted to talk at length about their relationships with KU. In general, firms felt that KU did a poor job of outreach to the business community. Their expectations for their KU relationships often differ from the reality they encounter.

Many firms reported that it is awkward to work with KU--they had trouble finding the right people to talk with and they resented the bureaucracy that was involved.

Several firms identified problems in negotiating the transfer of intellectual property rights. The respondents believe KU holds on too tightly to its IP rights, and that this interferes with partnering or licensing. According to one respondent, "KU needs to be unshackled in interacting with the community. KU doesn't realize that a small piece of a huge pie is better than a big piece of nothing."

Some firms felt that lack of cooperation between KU's Lawrence campus and the Medical Center in Kansas City hampered business relations. According to another respondent "we always seek collaborators, but most have been in other locations because major non-profits including KU Med won't deal with small business."

The firm owners cited models of university-business cooperation such as Research Triangle, San Diego, and Wisconsin and seemed to believe that the intellectual seeds started in universities in these areas had a much better chance of reaching fruition. At least one of the R&D firms is considering relocation to an area with what the owner believes is a better public-private sector relationship.

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[4] Business property taxes in Kansas are in fact relatively high for this region for firms that do not receive tax abatements or other tax incentives (Burress, Oslund, and Middleton, 2004).

We point out that these comments present only one side of the story; we have not interviewed KU administrators on these topics. Parties negotiating over “pieces of the pie” are naturally in a competitive relationship and each could think the other is too demanding. Also, KU may not perceive its mission as being exactly the same as what these firms expect.

All of the firms felt that KU has a substantial number of top scientists and offers considerable intellectual capacity. But many felt that this intellectual capacity has not historically been translated into successful start-up firms.

Critical Mass

A final concern about the Lawrence-Douglass county bioscience environment is simply its size. None of the firms felt that there was a critical mass of bioscience activities in the Douglas county area or even the greater Kansas City area. Several firms said that Lawrence/Douglas County does not have the infrastructure to support pharmaceutical and bioscience industry start-ups. In particular, access to venture capital and to specialized business services—licensing attorneys, intellectual property management, contract research organizations, and equipment repair and maintenance firms--is lacking. In addition, specialized pharmaceutical manufacturing firms are scarce or lacking in the region. R&D firms often sub-contract for manufacturing, and one firm said that the manufacturing offshoot of its R&D efforts will probably be located elsewhere because of lack of local capacity.

Summary

Overall, Douglas County has strengths and weaknesses for bioscience firms. Its strengths center on competitive basic business costs, high quality labor, and a high quality research university. Its weaknesses center on poorly-developed university-private sector relations and on lack of critical mass. As one respondent said “there is a lot of potential in this area, but somebody needs to make it happen and be held accountable. Kansas is providing the right ingredients, but that doesn’t mean the mix is right.”

Table 3.1
Douglas County Bioscience Firms and Their Relationship to KEGA

KEGA defined industry	Role in Douglas County
Chemicals manufacturing (325193, 325199, 325311)	Firms in these NAICS codes currently do not exist in Douglas County.
Pharmaceuticals and medicine manufacturing (3254111, 325412, 325413, 325414)	Firms in these NAICS codes exist in Douglas County and form part of the core export base.
Medical and laboratory equipment and supplies manufacturing (333319, 334510, 334516, 334517, 339111, 339112, 339113, 339115).	Firms in these NAICS codes exist in Douglas County and form part of the core export base.
Research and development (541710)	Firms in these NAICS codes exist in Douglas County and form part of the core export base.
Diagnostic, testing, medical services, and veterinary services (541380, 541940, 621511, 621512)	The Douglas County firms in these NAICS codes are oriented to the local market and are not part of the export base. Examples include offices that perform routine mammograms and blood work, and veterinarians who serve local pet owners.

Source: Policy Research Institute. Based on confidential ES202 Data, Kansas Department of Labor.

Table 3.2
Jobs and Wages in Core Bioscience Firms

Annual and monthly averages	1990	1995	1997	1999	2001	2003	2004 (est)
Average annual jobs	305	555	465	233	259	103	170
Average annual number of firms	9.3	7.6	8.7	7	8.3	6.8	8
Average monthly wages ($)	1,857	2,073	2,225	2,494	2,708	2,777	2,800
Average monthly wages adj. inflation ($)	2,487	2,460	2,549	2,784	2,890	2,863	2,800

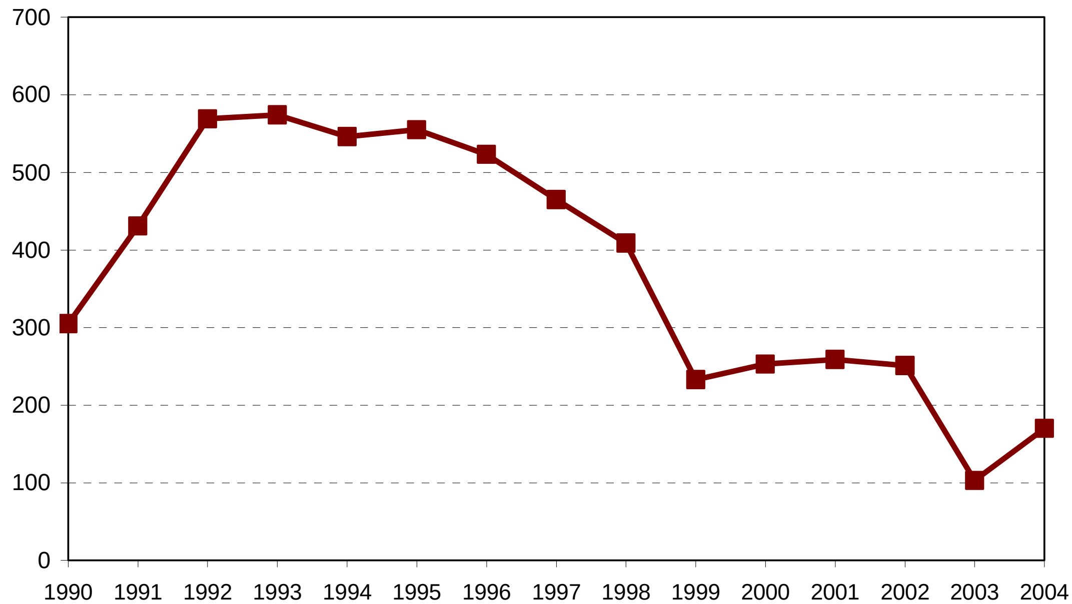
Source: Calculation by Policy Research Institute based on confidential ES202 Data, Kansas Department of Labor. Inflation adjustment based on GDP deflator, U.S. Bureau of Economic Analysis.

Table 3.3
Interview Responses on Lawrence/Douglas County Business Climate

	Not Answered	Strongly Disagree	Disagree	Agree	Strongly Agree
Lawrence (Douglas County) has a high quality workforce.				6	1
It's easy to find qualified and available employees in Lawrence (Douglas County) when you need them.			2	5	
K-12 schools in Lawrence (Douglas County) are high quality.	1			4	2
Lawrence (Douglas County) offers good transportation options for shipping.	2		1	3	1
Property taxes at my location are affordable.	1	2	2	2	
KU makes a real effort to reach out to the business community.		2	4	1	
Douglas County has a critical mass of bioscience firms.		7			
City government (Lawrence) has had a negative effect on my business.			5	1	1
The current Lawrence city government is anti-growth.	1	1	1	4	
Top level managers and scientists feel isolated in Lawrence.		2	4	1	

Source: Policy Research Institute. Based on seven firm interviews.

Figure 3.1
Total Employment in Core Bioscience Firms in Douglas County
1990-2004



Source: Policy Research Institute. Based on on confidential ES202 Data, Kansas Department of Labor.

Chapter 4:
Bioscience Activity at the University of Kansas

Introduction

The University of Kansas (KU) is a major factor in bioscience activity in the Lawrence, Douglas County area. Faculty and academic staff employed by the University attract large quantities of external funding and produce new innovations that have the potential to be spun off into commercial enterprises. This chapter begins by describing the current size of KU's bioscience efforts and places them in the context of recent past growth. The second section of the chapter discusses the likely future growth of bioscience activity at the University, while the concluding section analyzes in greater detail the channels through which funded bioscience-related research affects the broader economy.

Past and Current Bioscience Activity at the University of Kansas

Measuring University Bioscience Activity

Two measures of the University's bioscience activity suggest themselves: (1) employment and (2) research expenditures. But identifying which individuals and which research expenditures to include in bioscience activity is not simple.

In addition to research, university employees are engaged in a range of other activities, most importantly teaching, university administration, and service to the community, the state and their academic disciplines. Thus, while some departments—such as biology and pharmaceutical chemistry—are clearly part of the University's bioscience efforts, not all of their employment is directed toward bioscience research.

In addition, which research activities should be counted as contributing to bioscience activity is not always clear-cut. For example, faculty in the school of engineering (who would ordinarily not be included in a count of bioscience faculty) may have expertise relevant to the development of medical devices or imaging equipment. These and other linkages may not be evident from the titles of funded research projects or the sources of funding for these activities.

Despite the difficulties of classifying research activities, officials at the KU Center for Research (KUCR) do classify funded research projects by primary area, and their classification scheme includes a category for life science grants. This classification relies in part on objective characteristics like the funding source, department of the investigator, and key words in project titles, but the ultimate decision about classification is made on a case-by-case basis.

Bioscience Employment

The University's employment statistics report headcounts, full time equivalent employment, and payroll expenditures for different categories of employees organized by academic department or unit of affiliation. We defined bioscience employees to include all employees in a small group of *bioscience departments*, plus all individuals who were not in *bioscience departments* but were linked to one or more funded research projects classified as bioscience related by KUCR. Individuals were linked to a funded project if they were identifies as a Primary Investigator (PI), Co-Primary Investigator (Co-PI) and/or were paid for some part of the year from a funded project.

We defined *bioscience departments* based on the level of bioscience grant activity of faculty and academic staff affiliated with them. Table 4.1 lists all university units with faculty or staff linked to bioscience funded research projects. In the table units are listed in descending order of bioscience "density"—that is the fraction of faculty and academic staff linked to bioscience funded research projects. We chose to define as bioscience departments the twenty-six units in which 20% or more of the faculty and academic staff were linked to bioscience funded research projects. This list includes all the units that we classified on *a priori* grounds as bioscience related, plus a number of others that we did not initially expect to emerge as important contributors to bioscience research.

Table 4.2 shows recent growth in bioscience employment at the University from October 2000 through October 2003. Earlier data are not available because they were collected under a different classification scheme. The table shows the growth in employment in each of six employment categories—faculty, academic staff, unclassified professionals, student employees, student hourly employees, and other. In each case employment is measured both in terms of the number of employees, or "headcount," and, except for student hourly employees, converted into a full-time equivalent number of employees to adjust for part-time employment. In addition to the employment numbers we also include total payrolls for each employment category except the student hourly employees.

Total life science employment at KU, by our definition, was slightly less than 2,300 persons or just over 1,300 FTE in October 2003.[5] The lower FTE reflects the fact that student hourly employees are not included in the FTE calculation and that many other student employees work half-time or less. Faculty made up 349 of the bioscience employees (or about 15% of the total) in 2003 (see Figure 4.1) and there were an additional ninety-three academic staff in this total. Average full-time salaries for bioscience faculty were around $73,000 per year and $64,000 for academic staff, while average unclassified salaries were a little less than $38,000.[6]

Since 2000, total bioscience employment at KU has increased by about one-fifth. Most of this increase is due to growth in unclassified employees and students. The number of academic staff positions remained almost unchanged and the number of faculty positions grew by just 6%, increasing from 329 to 349. One possible explanation for this is that rising levels of grant activity allowed the university to leverage small increases in faculty employment into greater increases in total employment.

[5] Another recent study reported a higher total bioscience employment at KU, giving a figure of 3,086 people engaged in bioscience-related activities. This total does not, however, differentiate faculty and academic staff (most of whom have Ph.D.s) from classified staff and graduate and undergraduate student employees. Given the very different roles that these different groups of employees play it is clearly important to count them separately. Moreover, the criteria used to identify "bioscience employees" were not clearly spelled out in this study and appear to us to be broader than desirable for our purposes.

[6] These figures are derived by dividing the total payroll figure for each category by the FTE employment total.

Bioscience Funded Research Activity

Funded bioscience-related research activity at the University of Kansas has increased more rapidly than has bioscience employment over the past few years. Table 4-3 and Figure 4.2 summarize data on funded research projects that KUCR classifies as bioscience-related for Fiscal Years 1999 through 2004. Each Fiscal Year ends on June 30 of the corresponding calendar year (so Fiscal Year 2004 encompasses expenditures between July 1, 2003 and June 30, 2004).

For the years covered by the employment data in Table 4.2, expenditures on bioscience-related funded research increased from $34.5 million to $53.3 million, an increase of 54%, compared to the approximately 20% growth in bioscience employment in these same years.

Over the full period covered by the data the growth in funded research has been even more impressive. Starting from a relatively low base, expenditures have increased more than three-fold since Fiscal Year 1999.

Projections of Future Growth in Bioscience Employment

To assess the likely factors influencing future growth in bioscience activity at the University of Kansas members of the research team interviewed Provost David E. Shulenburger about anticipated growth in bioscience employment over the next five to ten years.

The primary driver of expansion in bioscience activity at the University will be the addition of new faculty in bioscience-related units of the University. There are two developments that are likely to contribute to increased faculty numbers in the future. The first is tuition enhancement. The University is now two years into a five year program in which increases in tuition are being invested in the hiring of additional faculty across all parts of the University. In total, over the five years tuition enhancement funds are expected to fund a net increase 100 new tenure-track faculty positions. To date about 30 of these positions have been filled, while the remaining 70 are expected to be hired over the next three years. Provost Shulenburger estimates that about half of the new position—50—will be in bioscience-related areas. Because newly hired faculty have not yet had the opportunity to fully develop their research programs it is expected that the additions in bioscience over the previous two years have not yet had time to influence the growth of supporting staff and student employment.

The second development that will contribute to expansion in faculty numbers is the Kansas Economic Growth Act, passed during the 2004 legislative session. This bill calls for the creation over the next five years of sixty new faculty positions at the University of Kansas (Lawrence Campus), the KU Medical Center, and Kansas State University. While the precise allocation of these positions across the different campuses has not been spelled out yet, the Provost estimates that between twenty and twenty-four will likely be located on the Lawrence Campus. Faculty positions funded by the Kansas Economic Growth Act will be filled by highly accomplished senior researchers at or near the level of distinguished professors. Thus these individuals are expected to be more than usually productive scholars and researchers. In particular, The Provost anticipates that bioscience faculty hired with Economic Growth Act Funds will be considerably more productive in terms of obtaining research funding and generate higher levels of employment of supporting staff and students than is true for current bioscience faculty.

Effects of Funded Research on Douglas County Economy

Grants and awards brought in by KU faculty have a significant impact on Douglas County. The main impact is through the jobs and income received by individual workers supported by the grants. Table 4.4 shows the breakdown of grant dollars by categories by year since 1999.

Around 45% of grant dollars go to wage, salaries, and fringe benefits (Figure 4.3). These dollars primarily end up as household income in Douglas County, though some of it leaks away as pay to in-commuters. Other dollars leak away as income taxes and payroll taxes. These leakages are accounted for in the impact model used in Chapters 6 and 7.

Around 36% of grant dollars go to materials and services purchased for the research (or "other direct costs" in university parlance.) These dollars largely go to vendors that are outside Douglas County. Although a small portion does remain in the county, the impact model assumes conservatively that these dollars have no local impacts.

Close to 19% of grant dollars go to overhead charged by KU for administering grants and providing research facilities (or "Indirect costs" in KU parlance). The major part of these dollars ends up funding salaries, partly in individual departments and partly in central administration. The modeling procedures used in Chapters 6 and 7 capture the impacts of funded research on departmental personnel expenditures but not other expenditures.

Table 4.3 and 4.4 indicate that total KU LS grant dollars experienced a robust 23% annual growth rate during 1999-2004 – or 21% after correcting for inflation. However, omitting the big jump of 1999-2000 lowers the real growth rate to around 11% per year. Correcting for inflation lowers it again, to about 9.5% per year – still an extremely rapid rate.

Taken alone, this indicator would suggest very optimistic growth prospects for the Douglas County bioscience sector, especially at KU. In particular, continued real growth at 9.5% for ten years would lead to an additional $62.8 million in annual local income from grants (plus multiplier effects).[7]

The rapid growth of grant funding in recent years has been supported by an increasing emphasis on grantsmanship by the KU administration that has led to increasing ratios of grants and grant dollars per bioscience faculty member. We expect that these ratios will level off when they become competitive with top-ranked universities.

Another factor encouraging rapid expansion in grant funding at KU has been the general expansion of funding for Life Science research at the national level, especially through the National Institutes of Health (NIH). This growth in opportunities has greatly facilitated growth in KU grants. It is unlikely that NIH funding will continue to grow so quickly in the future given political pressures arising from large federal budget deficits.

[7] Compounding 9.5 % annual growth implies an increase in total grant funding of $137.8 million over ten years, of which about 46% (see Table 4.4) are labor costs. The remained pays for materials and services or university overhead.

Table 4.1
Faculty, Academic Staff and Unclassified Professionals in Departments with any Bioscience Funded Research, 2003

Department or Unit	Total Employment	Life Science Grant Principal Investigator	Life Science Grant Employee	Percentage Life Science Grant Principal Investigator
		Bioscience Departments		
Kansas Applied Remote Sensing	12	5	6	41.7
Kansas Biological Survey	28	12	9	42.9
Medicinal Chemistry	28	10	9	35.7
Mass Spectrometry Lab	3	2	0	66.7
NMR Lab	3	2	0	66.7
Pharmaceutical Chemistry	30	12	8	40.0
School of Pharmacy	3	1	1	33.3
Higuchi Biosciences Center	106	16	52	15.1
Division Of Biological Sciences	101	41	19	40.6
Human Develop & Family Life	27	9	6	33.3
Bureau of Child Research	179	37	62	20.7
Pharmacology & Toxicology	11	6	0	54.5
Natural History Museum & Bio Diversity Center	40	11	10	27.5
Molecular Graphics/Modeling Lab	2	1	0	50.0
Chemistry	63	16	11	25.4
Speech-Language-Hearing	17	6	1	35.3
Animal Care Unit	3	1	0	33.3
Mechanical Engineering	13	4	0	30.8
SPED-Special Education	41	10	2	24.4
Psychology	35	10	0	28.6
Health, Sports & Exercise Science	19	5	0	26.3
Museum of Anthropology	4	1	0	25.0
Geography	21	5	0	23.8
Anthropology	17	4	0	23.5
Chemical and Petroleum Engineering	19	4	0	21.1
Biochemical Research Service Lab	5	1	0	20.0
All Bioscience Departments	830	232	196	28.0

Table 4.1 (continued)

Department or Unit	Total Employment	Life Science Grant Principal Investigator	Life Science Grant Employee	Percentage Life Science Grant Principal Investigator
	Non-Bioscience Departments			
Public Administration	11	2	0	18.2
Geology	23	4	0	17.4
Social Welfare Administration	6	1	0	16.7
Policy Research Institute	13	2	0	15.4
Center for Campus Life	7	1	0	14.3
Graduate School/ International Programs	7	1	0	14.3
Electrical Engineering & Computer Science	33	4	0	12.1
Center for Research on Learning	170	5	14	2.9
Provost Office	18	2	0	11.1
Student Health Services Admin	28	2	1	7.1
Aerospace Engineering	11	1	0	9.1
Civil/Environmental/Architectural Engineering	34	2	1	5.9
Social Welfare	126	9	2	7.1
Sociology	18	1	0	5.6
KANU Radio	21	1	0	4.8
Pharmacy Practice	23	1	0	4.3
Kansas Geological Survey	74	3	0	4.1
Communication Studies	25	1	0	4.0
Mathematics	51	1	1	2.0
Physics and Astronomy	41	1	0	2.4
All Non-Bioscience Departments	740	45	19	6.1
All Departments	1,570	277	215	17.6

Source: University of Kansas, Office of Institutional Research and Planning

Table 4.2
Bioscience Employment at the University of Kansas, 2000-2003

	2000	2001	2002	2003	% Growth 2000-2003
			Headcount		
Faculty	329	351	341	349	6.1
Academic Staff	91	92	92	93	2.2
Unclassified	367	431	440	513	39.8
Classified	132	138	142	136	3.0
Student	504	557	601	622	23.4
Student Hourly	473	488	492	572	20.9
Other	1	1	0	0	-100.0
TOTAL	1,897	2,058	2,108	2,285	20.5
			Full-Time Equivalent Employees		
Faculty	310.4	323.1	317.5	324.3	4.5
Academic Staff	84.5	85.6	86.5	87.7	3.9
Unclassified	330.6	393.7	405.9	464.3	40.4
Classified	128.3	134.8	134.2	129.1	0.6
Student	246.2	291.2	326.9	330.4	34.2
Student Hourly	NA	NA	NA	NA	
Other	0.8	1	0	0	-100.0
TOTAL	1,100.7	1,229.3	1,271.0	1,335.8	21.4
			Total Payroll		
Faculty	$20,831,883	$22,339,006	$22,303,773	$23,558,107	13.1
Academic Staff	5,043,504	5,434,703	5,431,761	5,624,093	11.5
Unclassified	11,863,412	14,104,343	15,029,777	17,507,909	47.6
Classified	3,363,610	3,643,182	3,701,345	3,622,086	7.7
Student	6,660,841	7,801,770	9,145,554	10,117,231	51.9
Student Hourly	NA	NA	NA	NA	
Other	16,430	26,000	0	0	-100.0
TOTAL	$47,779,680	$53,349,004	$55,612,210	$60,429,426	26.5

Source: University of Kansas, Office of Institutional Research and Planning

Table 4.3
Bioscience Funded Research Projects and Expenditures, Fiscal Years 1999-2004

	Projects		Expenditures	
Fiscal Year	Number	Index (1999=100)	Dollars	Index (1999=100)
1999	437	100.0	$16,581,851.67	100.0
2000	581	133.0	31,522,630.42	190.1
2001	574	131.4	34,554,837.60	208.4
2002	595	136.2	40,700,093.73	245.4
2003	661	151.3	47,592,226.25	287.0
2004	680	155.6	$53,292,401.92	321.4

Source: University of Kansas Center for Research

Note: The Fiscal Year begins July 1 of the preceding calendar year.

Table 4.4
Bioscience Grants, University of Kansas, Lawrence Campus,
By Expenditure Category
($Million)

FY	Labor	Materials and Services	University Overhead	Total	Count
1999	$7.70	$6.20	$2.60	$16.60	436
2000	14.60	10.80	6.10	31.50	581
2001	15.80	12.20	6.60	34.60	574
2002	18.80	13.90	7.90	40.70	595
2003	21.20	17.50	8.80	47.60	661
2004	24.00	19.10	10.20	53.30	680
TOTAL	$102.20	$79.80	$42.30	$224.20	3,527

Source: Based on data provided by KU Provost’s Office.
Notes: Based on KUCR definition of LS grants. See Text.

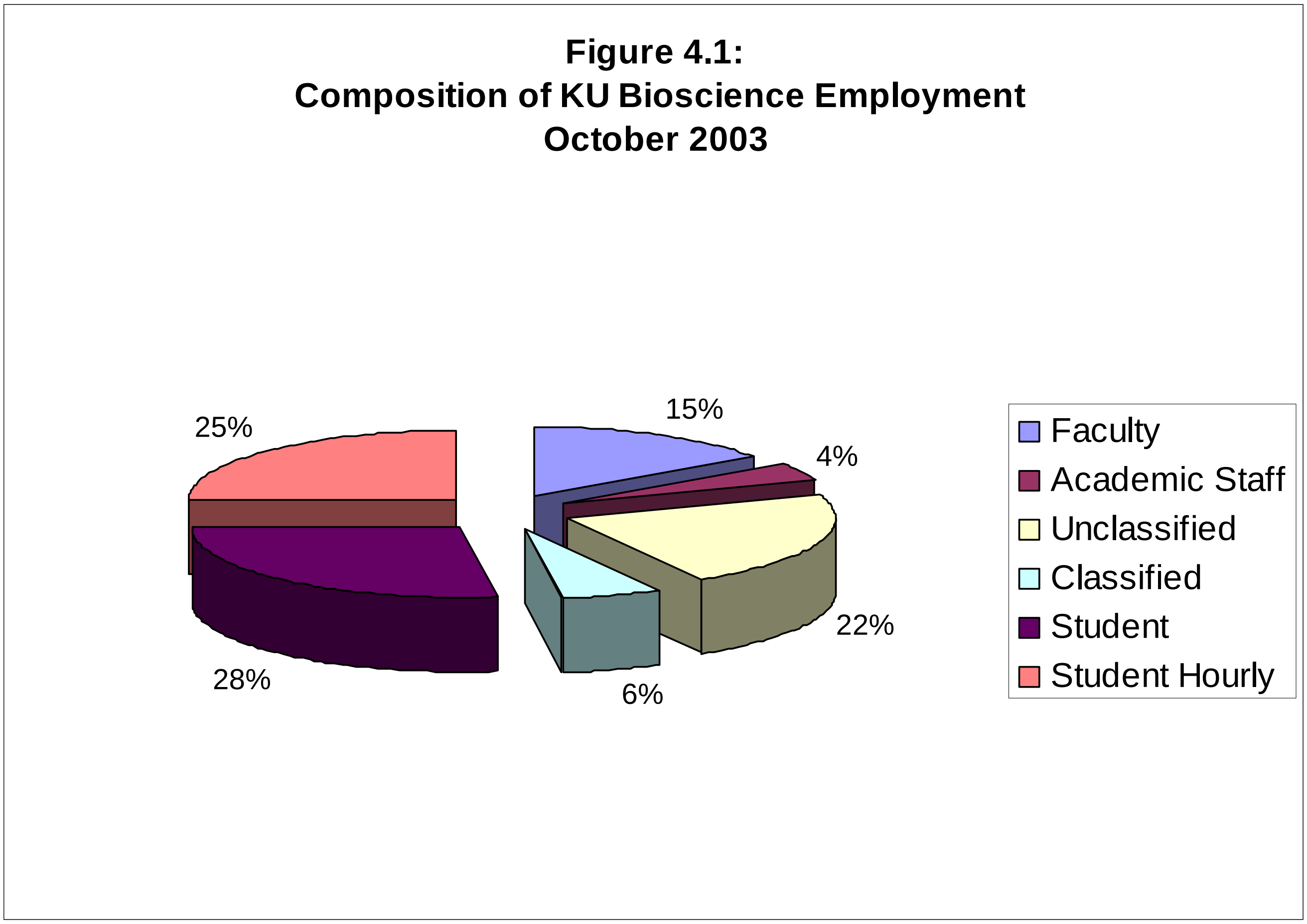


Figure 4.1:
Composition of KU Bioscience Employment
October 2003
25%
15%
4%
22%
6%
28%
Faculty
Academic Staff
Unclassified
Classified
Student
Student Hourly

Figure 4.2
Growth of KU Bioscience Grants and Expenditures
Fiscal Years 1999-2004

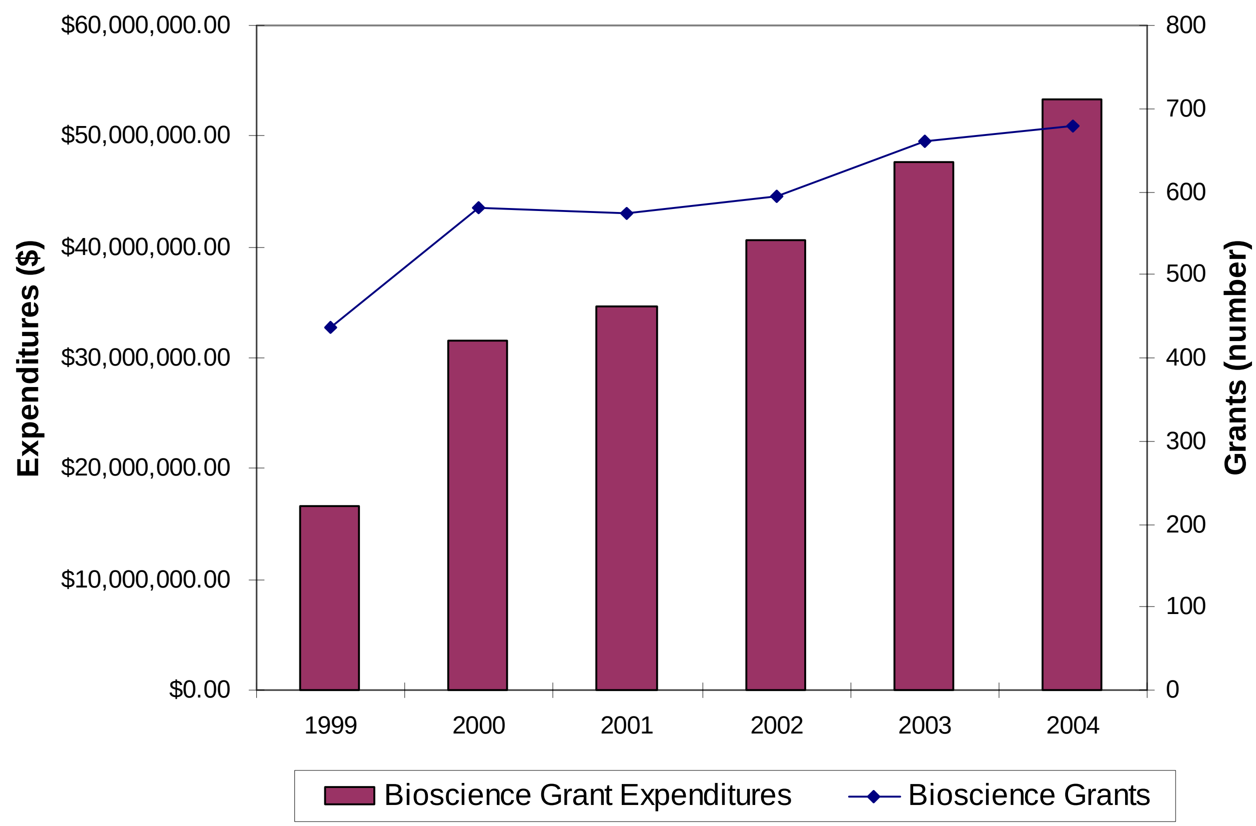
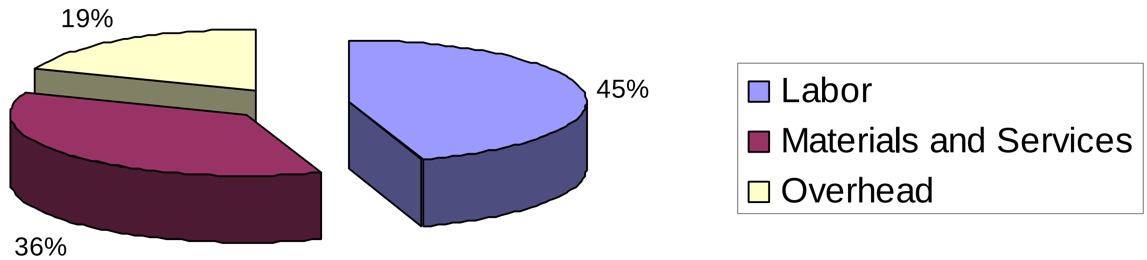


Figure 4.3
Breakdown of University Bioscience Research Expenditures
Fiscal Year 2004



Chapter 5:
Growth Scenarios

Introduction

The impact model described in the two following chapters starts with a "growth scenario" for the bioscience sector, meaning a possible pattern for changes in employment and income over time. This chapter develops and discusses four alternative growth scenarios for the Life Science sector in Douglas County.

We use the term "scenario" to indicate that these growth paths are not predictions or forecasts, but simply provide alternative sets of assumptions. However, for each scenario we do provide an underlying "story," or explanation of how it was arrived at. Our discussion of these stories does cast some light on which of the various scenarios may be most likely to come to pass.

The scenarios can be described as:

1. Low Growth Scenario
2. Medium Growth Scenario
3. High Growth Scenario
4. Economic Growth Act (EGA) Scenario.

General assumptions and background information

So far as possible, the general approach is the same in all four scenarios. A number of data sources were consulted. The detailed definition we used for "bioscience" necessarily differs for each data source, as explained in Chapter 1.

Treatment of wage rate growth

Within a given scenario, we assume that there is a single rate of growth in wages per employee that is the same for all classes of employees and for all years. Across scenarios, the rate of wage growth increases with the rate of employment growth – reflecting the idea that higher wages are needed to attract the extra workers needed for faster growth.

Table 5.1 gives some background data on the rates of employment growth and wage rate growth in bioscience industries during 1990 to 2001, using data from the Cluster Mapping Project for the Biopharmaceutical Subcluster plus the Medical Devices Cluster. It shows a U.S. real wage growth rate of 1.8% in biosciences. Note that real wage rate growth in all other U.S. sectors was around 1% per year.

Treatment of employment growth

The background stories have different starting points in the various scenarios, but in each case we will derive an average annual growth rate for combined employment in the private sector and at KU. The purpose is to provide some comparability with actual experience in other developing Life Science clusters. In particular, Table 5.1 shows employment growth rates during 1990-2001 for the bioscience sector in Madison, Wisconsin, the Research Triangle in North Carolina, San Diego, and the U.S. as whole. It also shows the non-bioscience growth rate for the U.S.

Between 1990 and 2001, the Wisconsin bioscience cluster was growing more slowly than the U.S. bioscience cluster as a whole (though faster than non-bioscience industries). When examined more closely, it turned out that the Biopharmaceutical portion of the industry was actually declining in Wisconsin, while the Medical Devices portion was growing faster than the U.S. average.

The San Diego bioscience cluster is a large and well-established center mainly specializing in medical devices. Its negative employment growth during 1990-2001 suggests that relatively slow growth is a real possibility even in successful bioscience centers.

The successful Research Triangle bioscience cluster includes the Research Triangle Institute, which may be the best example in the world of a bioscience technology growth center created largely through government policy. Out of some 250 science research parks in the U.S., no other park has been as successful. Therefore we view the Research Triangle employment growth rate (2.2% per year) as an optimistic target.

KU employment multipliers

We will assume that growth in bioscience personnel at KU is entirely driven by growth in bioscience faculty members. Other categories of workers are supported by grants obtained by faculty, or by tuition paid by students who are attracted to KU by the faculty. We assume that the ratios of other workers to faculty members will remain constant (after a possible one-time adjustment described below).

We treat part-time undergraduate student positions separately from other workers. This is necessary because the two categories are treated differently in the impact model and workforce model, as discussed in Chapters 6 and 7. In particular, we assume that new undergraduate student positions do not directly attract either new in-migrant students or workers into the local labor market, or new dependents. However, the dollars spent by student employees do have multiplier effects.

Based on employment data provided by KU, we estimated the following multipliers between faculty members and other employees:

1.5 part time undergraduate employees per faculty member
3.6 other employees per faculty member

These multipliers were calculated from actual employment during fiscal years 2000 through 2003. They includes:

- all employees in narrowly defined bioscience departments (See Chapter 4 for a list) or on grants they received, plus
- all employees on grants that addressed bioscience topics, where the faculty Principal Investigator (PI) was in a non-bioscience department.

The multipliers were fairly stable by year during 2000-2003. The multiplier in non-bioscience departments for “other employees” was very similar to that in bioscience departments, but there was a higher ratio of undergraduate part-time employees to faculty in non-bioscience departments (around 2.4).

For projecting to future years, there are reasons to believe that this multiplier may change. First, about 15 new bioscience assistant professors were hired during 2002-2003 using tuition enhancement funds. These faculty members were too early in their careers to produce any grants. The total number of these faculty positions will eventually expand to 50. Second, and more significantly, it is anticipated that 24 new distinguished professors will hired in the future using Kansas Economic Growth Act (EGA) funds. These professors are expected to be much more productive than average. Based on conversations with KU administration, we estimate that they will produce 5 times as many additional employees per faculty member as do average employees. After correcting for these changes we estimate future year multipliers at:

1.8 part time undergraduate employees per faculty member
4.6 other employees per faculty member

The 2004 basis

All scenarios assume the same starting point. In calendar 2004 we project 363 KU faculty members in bioscience. The recent historic high is 351 and KU plans to hire about twelve new bioscience faculty members per year over the next three years (see Chapter 4). Other KU staff numbers are determined using the final multipliers given above. KU payroll in bioscience is determined by its actual 2003 bioscience payroll, increased in proportion to the additional staff. This leads to a total KU bioscience staff of 2,203 (plus 653 part-time undergraduate student employees). The KU payroll is estimated at $61.4 million annually.

For calendar year 2004 we project an average private sector employment of 170. This is based on partly on our interviews with local bioscience firms and partly on ES202 data. Since 1998 the data show an unsteady but non-growing bioscience employment in Douglas County of around 200 (see Chapter 3).

We project an average private sector salary in bioscience of $33,600, based on a 1998-2003 real wage average from Douglas County ES202 data. By comparison, data compiled by Harvard University's Institute for Strategy and Competitiveness' Cluster Mapping Project (Harvard University 2004) shows a U.S. average of $47,700 for 2001, but we think that lower-than-average wages would be plausible for Douglas County.

Multiplying the employment by the average wage leads to a private sector payroll of $5.7 million.

Low Growth Scenario

In this scenario, KU as planned adds thirty-five bioscience faculty members over the next three years based on tuition enhancement (See Chapter 4). We assume as a worse case that no additional bioscience faculty members are added in the next ten years. The mean growth rate assuming a base of 363 is about 10% over ten years or an average of about 1% per year.

We also assume 1% growth in the private bioscience sector. This would be a rather disappointing performance, lagging well behind the 1.5% experienced in U.S. bioscience during 1990-2001.

We assume that real wages grow at 1.8%, the relatively low rate observed in the U.S. bioscience cluster as a whole during 1990-2001.

Growth rate assumptions for all scenarios are shown in Table 5.2. Table 5.3 shows the total ten-year increment in jobs for each scenario and Table 5.4 show the increment in wages and salaries.

Medium Growth Scenario

In this scenario, KU as adds the thirty-five bioscience faculty members planned tuition enhancement. It also adds faculty members based on Economic Growth Act enhancements. The statewide total has been estimated at sixty new positions. The KU administration believes KU logically should receive around 40% of those positions, or twenty-four (see Chapter 4). We assume that no other bioscience faculty members are added in the next ten years. The growth of fifty-nine from a 2004 base of 363 over ten year's yields an average of about 1.5% per year compounded. This is about the same as the U.S. average growth rate for bioscience during 1990-2001.

Based on the interviews in Chapter 3, existing local bioscience firms plan to add about thirty-four jobs over the next ten years, from a base of 170 jobs, or about 1.8% per year. In this scenario we will assume that there is a slight degree of entrepreneurial optimism in these projections, so that private sector jobs also grow at the U.S. bioscience average rate of 1.5% per year.

Wages grow at 2.1%, the moderately high rate experienced in the Research Triangle bioscience cluster.

High Growth Scenario

In this scenario, both private sector and KU employment grow at 2.2%, the rate historically achieved by the successful Research Triangle bioscience cluster.

Wages grow at 2.3%, the relatively high growth rate observed in the Madison bioscience cluster.

EGA Growth Scenario

In this scenario, bioscience jobs in Douglas County grow at a rate of 8.5% per year. This rate is taken from the study used to justify the Economic Growth Act.

Consequently, 2,951 new bioscience jobs are created in Douglas County in the next ten years. In addition, there would be 875 new part time undergraduate student positions that do not count as part of these 2,951 jobs.

Wages are assumed to grow at 2.3%, a figure somewhat higher than the rate assumed in the high growth scenario.

Background growth and wages

Real Douglas County wage rates outside the bioscience sector are assumed to grow at the U.S. average rate during 1990-2001, or 1% per year. (This assumption figures into the multipliers for calculating indirect income and employment effects.)

For purposes of the unemployment model, we will need to specify the job growth that would take place in the absence of any large increases in the bioscience sector. We will assume that background jobs grow at the rate of 2% per year, which equals the approximate rate of population growth in Douglas County over the last decade. (Note that this employment growth rate is faster than the low and medium growth scenarios, but the wage rate growth is slower.)

We assume that the base Douglas County employment in 2004 is 54,000 jobs, inclusive of bioscience jobs.[8]

[8] In fact there are quite a range of estimates for Douglas County jobs. The PUMS data estimate shows 53,488 jobs in Douglas plus Miami counties for 2000. The corresponding number for 2004 would be expected to be somewhat larger. The 2004 release of the IMPLAN model shows 65,000 jobs for Douglas County alone. Monthly employment data from Kansas Department of Human Resources currently show Douglas County with around 56,000 jobs. In all cases job counts include part-time as well as full-time jobs but detailed concepts and measurement methodologies differ. However, the exact benchmark used in the model is not very important.

Table 5.1
Average Growth Rates for Life Science Industrial Clusters (1990-2001)

Region	Employment Annual Rate	Real wage Annual Rate
San Diego, California bioscience cluster	-0.20%	1.30%
Madison, Wisconsin bioscience cluster	1.20%	2.30%
Research Triangle, North Carolina bioscience cluster	2.20%	2.10%
U.S. bioscience cluster	1.50%	1.80%
U.S., all other sectors	2.20%	1.00%

Source: Policy Research Institute

Notes: Calculated from Harvard University (2004) data. “Life Science” defined as biopharmaceutical subcluster plus medical devices cluster.

Table 5.2
Growth Scenarios for Douglas County
Growth Rates

Scenario	Employment Annual Rate	Real Wage Annual Rate
Low Growth	1.00%	1.80%
Medium Growth	1.50%	2.10%
High Growth	2.20%	2.30%
EGA Growth	8.50%	2.50%

Source: Policy Research Institute

Notes: See text for assumptions and definition of “Life Science” cluster.

Table 5.3
Growth Scenarios for Douglas County
Life Science Industrial Cluster (2004-2014):
Basis and 10-year Increments for Employment Growth

Scenario	Private Sector	KU Faculty	KU Staff*	Subtotal	Student Workers**
Basis (2004)	170	363	1,670	2,203	653
Low Growth increment	18	35	161	232	63
Medium Growth increment	28	59	271	356	106
High Growth increment	42	89	409	540	160
EGA Growth increment	228	486	2,237	2,951	875

SOURCE: Policy Research Institute

Notes: See text for assumptions and definition of “Life Science” cluster

* includes Graduate Research Assistants

** part time undergraduates

Table 5.4
Growth Scenarios for Douglas County
Life Science Industrial Cluster (2004-2014):
Basis and 10-Year Increments for Payroll Growth
($Million)

Scenario	Private Sector	KU Faculty and Staff*	Student Workers**	Total
Basis (2004)	$5.70	$60.40	$1.20	$67.30
Low Growth increment	1.80	19.50	0.40	21.80
Medium Growth increment	2.50	26.20	0.50	29.20
High Growth increment	3.20	34.30	0.70	38.30
EGA Growth increment	11.40	121.10	2.40	134.90

Source: Policy Research Institute

Notes: See text for assumptions and definition of "Life Science" cluster

* includes Graduate Research Assistants

** part time undergraduates

Chapter 6:
Economic Impact Modeling

Introduction

This Chapter describes our models and assumptions for projecting the economic impacts of bioscience industries on Douglas County.

The impact model starts with a "growth scenario," meaning a pattern of employment and income in the bioscience sectors over time. Several alternative scenarios were developed in Chapter 5. This Chapter explains our methods for inferring the total impacts that would result in Douglas County if those scenarios were actualized. Chapter 7 provides our empirical findings.

In economic impact parlance, the scenarios describe the "direct effects" of biosciences. We use economic multiplier models to estimate the sum of all other effects (the "indirect effects"). The impact, or total effect, of bioscience industries equals the sum of the direct effects and the indirect effects. Multipliers are simple ratios between total effects and direct effects.

Indirect effects include "backward linkages" – purchases from local suppliers (and from their suppliers and so on), plus "forward linkages" – income paid to households and then expended on local goods and services, as well as impacts on local government. In turn, part of this money is recycled in the local economy, leading to additional impacts. The trail of money is followed through a large number of rounds, but in each round much of the money leaks out of Douglas County to pay for expenditures from outside sources. A multiplier summarizes this entire process. (As a simplification, we assume that the process is effectively complete within one year.)

Examples of how this is used in concrete cases are:

> Total employment impact in 2006 equals 2006 bioscience employment in the scenario plus 2006 indirect employment. Total employment in 2006 is estimated by multiplying the bioscience employment scenario by an employment-employment multiplier (which is specific to the bioscience sector).
>
> Total population impact in 2006 equals 2006 total employment impact, multiplied by the population-employment multiplier.

This chapter explains where the multipliers come from.

Overview of models

The impact model works in two stages.

In the first stage, multipliers from an IMPLAN input-output model of Douglas County are used to find total effects on employment, wages, tax revenues, and output by industry. This is done in two steps. First, impacts other than new construction and capital investment are estimated directly using multipliers on annual bioscience employment and income in the same year. Next, impacts due to new construction and investment are estimated from *changes* in bioscience employment and income rather than from the annual level. This reflects the principle that new construction responds to increases in population rather than the level of population.

In the second stage, additional multipliers are used to estimate effects on variables such as population, in-migration, and commuting patterns. These multipliers are mainly from PUMS data (Census Public Use Microfile Sample), a 5% subsample of the year 2000 Census of Population data set.

General assumptions

With the exception that the unemployment model does not allow negative unemployment to occur, all models are linear. In other words, whenever the direct effect is doubled, the total effect is also doubled. This has a number of economic implications. It assumes that:

Local non-bioscience wages and prices of land and housing are not affected by bioscience growth.
Local travel time and road congestion are not affected by bioscience growth.

These assumptions are justified as long as bioscience growth is small in comparison with the total Douglas County economy. However, if bioscience growth is unexpectedly large (as described e.g. in the bioscience EGA Scenario), then local prices will rise and negative feedback will set in. In that case, this impact model would tend to overstate positive impacts and understate negative impacts.

Real wage rates in bioscience are assumed to increase at the constant annual rates, given in Table 5.2 for each scenario. Real wages in all other sectors increase at 1% per year (which was the average during 1990-2001). Also there is background growth in the labor force (unrelated to bioscience) of 2% per year.

KU part-time jobs for undergraduates are assumed to have no economic effects, other than through the additional payroll that is generated.

New construction at KU is treated as in indirect effect of growth. Purchases by KU from Douglas County sources are assumed minimal.

All new jobs are filled. There are no job vacancies.

New jobs (other than undergraduate student jobs) are filled by in-migrant workers, in-commuting workers, and unemployed pre-existing residents in fixed proportions. New in-migrants bring in new dependents in fixed proportions.

Detailed channels of influence

The model tracks a chain of step-by-step relationships that begins with new bioscience employment described in the scenarios. The steps are as follows.

1. In each year, new bioscience jobs and new bioscience payroll are calculated from the basis levels of jobs and payroll, using the assumed growth rates. (They can be broken out by KU versus non-KU employer. “New” refers to gains net of losses.)

2. Cumulative total bioscience jobs and payroll in that year are calculated by summing up new bioscience jobs and payroll for that and all previous years.

3. Cumulative total jobs and income in Douglas county in that year are calculated using IMPLAN multipliers.

a. The cumulative total of all jobs and income before any new construction takes place occurs are based on cumulative total of bioscience jobs and payroll.
b. Jobs and income that depend on construction are based on differences between (the cumulative jobs and income that year before construction takes place) and (the cumulative total jobs and income in the previous year).
c. Cumulative total jobs an income in the given year equal the sum of jobs and income before and after construction takes place.

4. Unemployment is analyzed in three separate labor markets, depending on the required level of education: advanced degree, B.A. or no B.A. Total effects on Douglas County jobs in each year are broken out by labor market as follows.

a. Total new jobs are calculated as the difference between cumulative total jobs that year and cumulative total jobs in the previous year.
b. Total new jobs are allocated between labor markets in fixed proportions. However the proportions are different for bioscience jobs, indirect jobs generated by multiplier effects, and background jobs. The shares are derived from PUMS data (see Table 6.3).

Bioscience jobs are assumed to be distributed like all KU jobs.
Indirect jobs are assumed distributed like non-KU jobs.
Background jobs are assumed distributed like all jobs.

5. Effects on unemployment are calculated separately for the three labor markets. The general procedure is as follows:

a. New hires are calculated as employment growth plus quits. The exit rate is estimated in Appendix 6.1.
b. New hires are allocated to unemployed prior residents, in-migrants, and in-commuters in the fixed proportions given in Table 6.3. (See Appendix 6.1 for the detailed model and assumptions.) However, if too few unemployed prior residents are available, the excess demand is filled from the other two sources.

6. The change in population of dependents is calculated by multiplying the change in local workforce in each labor market by the number of dependents as shown in table 6.4. The change in total population equals the change in work force plus the change in number of dependents.

We assume that in-commuters have no local dependents, and we assume that numbers of out-commuters are not affected by bioscience development.

A descriptive flowchart for the impact model is given in Figure 6-1.

The IMPLAN Model

IMPLAN models are produced by a private company for all counties, regions, and states of the U.S. The models are flexible data sources, but they have to be applied to a particular situation by a trained analyst.

IMPLAN is an input-output or SAM (Social Accounting Matrix) model. This means that the core of the model consists in

1. A set of defined sectors, and
2. Estimates of the dollar flows of all transactions between sectors, and between each sector and the outside world (on a one-year basis).

The sectors generally cover the entire regional private economy, plus households, government, and nonprofits. Sectors are defined as far as possible in terms of industry codes (SIC or NAICS). IMPLAN has 507 sectors. However the number of sectors actually used varies between regions because some sectors may be locally absent. Only 194 sectors are active in Douglas County.

Applications of the model usually depend on two key assumptions:

1. Input purchases by each sector from each sector or outside source are a constant share of revenues for the purchasing sector (and the shares add up to 100%).

2. Dollars flowing into the region in each sector (usually because of sales outside the region) are fixed (i.e. "exogenous"). These are taken as the direct effects.

With just these two assumptions, it is mathematically simple to calculate the total effect after a given amount of new dollars initially injected into the region percolate through the regional economy.[9]

The main difficulties in using an IMPLAN model usually come in deciding how the sectors need to be modified to fit the problem at hand, and deciding on how to model the direct effects. We also encountered questions in applying the IMPLAN model to investment and new construction.

The most important multiplier in the IMPLAN model relates the injection of new income into Douglas County to the total income that results after recycling household expenditures and taxes. That multiplier is about 1.6.

To establish multipliers for new construction, we assumed that new construction is driven by the increase in population, and that population has been growing proportionately with the workforce at 2% per year. The IMPLAN model gives a total workforce of 65,400. It also gives value added (total labor and proprietors income and business taxes) in industries that produce new construction of $112 million per year. This includes construction at KU as well for construction for businesses, households, and other government units. From these assumptions we can estimate that each increase of the total jobs by one job in Douglas County generates about $86,000 in new income in the construction industry (but only for one year). Since there were about 2,700 jobs in new construction, a steady increase of one additional new non-construction job each year would keep around two people employed in construction.

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[9] In vector and matrix notation, let E = vector of exogenous sales, X = vector of local production, A = matrix giving ratios of local intermediate demands to local outputs, then

$X = (I-A)^{-1}E$.

PUMS data modeling

For many purposes, the 2000 Census 5% sample (PUMS) data provide the most detailed picture of households that is available. As in any survey, there are limitations in the data that must be handled by making assumptions or modeling.[10] See Appendix 1 for a description of the most important data model, which is a steady state growth model for Douglas County.

We used PUMS data to get local information on:

- Share of workforce (and of KU workforce in particular) by education: advanced degree, BA, no BA.
- Share of workforce by current and past residency: incommuters, inmigrants who arrived within the last 5 years, older residents.
- Share of population by employment status: employed, unemployed, not in workforce.
- Numbers of dependents per inmigrating worker.
- Average salaries by education and workforce status

Unemployment modeling

The unemployment model is explained in Appendix 6.1. There is a separate model for each of three labor pools or markets: advanced degrees, BA, and non-BA. In the model, unemployment depends mainly on the following parameters:

- the rate at which new jobs are generated from all sources (namely the scenario, the multiplier effects, and also the assumed background growth.)
- the rate at which local persons not in the labor force join the labor force
- the rate at which new hires are selected from the local workforce
- the rate at which people leave the local labor force through retirement or out-migration
- the rate at which in-migrants flow in into the pool of unemployed.

All of these parameters have been estimated from empirical data (mainly PUMS data, with the aid of several assumptions). However none of the parameters are known very accurately and also the model itself is highly simplified. A sensitivity analysis showed that the outcomes are somewhat sensitive to

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[10] One issue is that for data confidentiality reasons Douglas County data are merged with Miami County data in the PUMS dataset. We believe this problem does not seriously affect the usefulness of parameters we derived from PUMS sources, for a number of reasons.

- The parameters we used are based on ratios rather than totals – e.g. the number of dependent per worker. PUMS data for other Kansas regions show that these ratios are reasonably stable across Kansas regions.
- 78% of the population and workforce in the PUMA is in Douglas County rather than Miami County, so the estimates will tend to be dominated by Douglas County data.
- We are generally able to distinguish KU employees by their employment in higher education.
- The main uses we made of the PUMS data are in the workforce model, which is intended to be illustrative rather than predictive. (The economic impact model is mainly based on IMPLAN data.)

the parameters. Therefore the results should be viewed as giving a merely *qualitative* idea of the effect of a change in scenario (i.e. a change in the growth rates of bioscience employment and income).

A key assumption in the model states what is known as a "natural rate hypothesis." Under this assumption, local unemployment tends to a natural rate unless it is disturbed by changes in the driving pattern of growth. The main force that drives unemployment towards its natural rate is the net in-migration of new workers. When unemployment increases and the labor market is slack, fewer new workers arrive; when unemployment declines and the market is taut, more new workers arrive.

In our model, the natural rate is constant over time.[11] The natural rate is set at the value it held in PUMS data for the year 2000, which was a moment of historically low unemployment in Douglas County.

[11] In actuality, the natural rate of unemployment is likely to depend on national employment conditions and other factors, but the point of our model is illustrate relationships, not predict the future. Showing any outside changes in the natural rate would simply make our findings harder to understand.

Appendix 6.1:
An employment source model

A steady-state growth model for year 2000 PUMS data

We consider a single labor market (e.g. employees with advanced degrees)
We assume constant growth rate in all variables at r=2% per year (an approximate historic population growth rate for Douglas County).
"In-migrant" refers to someone who arrived during the last 5 years.
The unemployed are two kinds: in-migrants and prior residents.

We assume during each year that:

1. The rate of exiting the local labor force is constant across employment categories (say, s). s will be calculated as shown below.
2. A fixed share (say t) of the employed in-migrant workers become "prior resident" worker.
3. Employed people do not become unemployed.
4. Additions to the unemployed come from two sources: new in-migrants and prior residents joining the workforce.
5. In the steady state, new in-migrants joining the unemployed just equal unemployed in-migrants getting jobs.

In particular, let:

I = employed in-migrants this year
X = in-migrants who get jobs this year
qI = in-migrants who become employed prior residents
sI = employed in-migrants who leave the labor force
(1+r)I = employed in-migrants next year = I + X – sI – qI

Therefore, since I is known from PUMS data we can calculate:

(1) $X = (r + s + q)I$

Let:

P = employed prior residents this year
sP = employed prior residents who leave the labor force
Y = unemployed prior residents who get jobs this year
(1+r)P = employed prior residents next year = P + qI + Y – sP

Since P and I are known from the PUMS data, we can calculate

(2) $Y = (r + s)P - qI$

Let

U = unemployed people this year
sU = unemployed people who leave the labor force
V = prior residents not in the labor force who become unemployed (i.e. start seeking work)

W = new in-migrants joining the unemployed.

In the steady state only, we also assume
W = unemployed in-migrants getting jobs
$(1+r)U$ = unemployed people next year = $U - sU - Y + V + W - W$

Therefore since U and Y are known we can calculate:

(3) $V = (r + s)U + Y$

Let:
C = in-commuters this year
sC = in-commuters who leave the local labor force
Z = new in-commuters who get jobs this year
$(1+r)C$ = in-commuters next year = $C - sC + Z$.

Therefore, since C is known from PUMS data we can calculate:

(4) $Z = (r+s)C$

To calculate q in the steady state, note that q
= remaining in-migrants who got jobs 5 years ago/total in-migrants present this year
$= (r+s+q)[I/(1+r)^4](1-s)^4/I = (r+s+q)(1-s)^4 / (1+r)^4$ (from equation (1)).

Hence

(5) $q = (r+s)(1-s)^4 / (1+r)^4 / [1 - (1-s)^4 / (1+r)^4]$.

Estimation of the rate of leaving the local labor force (s)

The two possible ways of leaving the labor force are ex-migration and local retirement (including involuntary retirement due to death). We will assume that all who retire locally die locally, so the local retirement rate is related to the local death rate for adults. Also, the (gross) ex-migration rate equals the in-migration rate plus the net ex-migration rate.

So we define the exit rate:

(5) $s = d + e$, where

d = local retirement and death rate for the local work force
e = gross ex-migration rate for the local work force.

We can estimate e by labor market for Douglas plus Miami counties from PUMS data. We will assume it is the same for Douglas County alone.

We can estimate d by assuming it equals the Douglas County aggregate death rate (in recent years around 0.005)

See Table 6.6 for results.

Note: in the actual impact model, we let s be higher for unemployed people than for other workers. This makes sense because unemployed people are more likely than other workers to be seeking work outside of the region. In the absence of data on exits for unemployed people, we treated it as a calibration parameter and used it to reconcile the dynamic model below with existence of a steady state over time.[12]

[12] The calibrated values of exit rates for the unemployed were around 0.1 for non-B.A.s, 0.2 for B.S.s, and 0.6 for advanced degrees. These results are consistent with the idea that mobility increases with education, and also helps explain why the unemployment rate is so low for workers with advanced degrees.

A dynamic employment model

In the following, we adopt the notations that:

X(t) refers to the value of X during year t;

U(t) refers to the value of U at the beginning of year t;

X(2000) refers to the value of X(2000) estimated from the PUMS data as above;

and so on for other variables.

We assume:

1. All categories of workers continue to leave the labor force at the rate s.

2. Prior resident workers continue to join the unemployed at a rate determined by background steady state growth. Hence prior resident who start seeking work is given by:

(6) $V(t) = (1+r)^{t-2000} V(2000)$.

3. We define

(7) E(t) = total year t employees = C(t) + I(t) + P(t).

(Note that E(t) is completely determined by the scenario.).

We define new hires as increased employment plus exits, or

(8) H(t) = total new hires during year t = E(t+1) – E(t) + sE(t).

(Note that new hires might be negative, but that case doesn't arise in our application so we will ignore it.)

Net new hires normally come from three sources: in-commuters, in-migrants, and the unemployed prior residents. We assume hires are in proportion to steady state rates of hires from those sources. Hence as long as workers are available to be hired, we would tentatively have:

(9a') X(t) = xH(t), where x = X(2000)/H(2000)

(9b') Y(t) = yH(t), where y = Y(2000)/H(2000)

(9c') Z(t) = zH(t), where z = Z(2000)/H(2000).

However, these formulas are modified below for the case where no local unemployed workers are available.

4. We assume a natural rate of unemployment for locally employed people. For simplicity we define

(10) u(t) = U(t)/[U(t) + E(t)]

$u^* = u(2000)$.

We assume that approach to the natural rate is regulated by in-migration. We no longer make the steady state assumption that new in-migrants joining the unemployed = unemployed in-migrants getting jobs. Instead we define w(t) = net increase in unemployed in-migrants due to in-migration less hires during year t, and we assume

(11) $w(t) = -p(u(t)-u^*)[U(t) + E(t)]$,

where p ($0<p<1$) regulates the speed of approach to the natural rate.[13]

5. Hence beginning-of-period unemployment has dynamics are given by:

(12) $U(t+1) = U(t) + V(t) – sU(t) – Y(t) + w(t)$.

However note that by definition unemployment U(t+1) cannot be negative. Therefore we define

(13) m(t) = available unemployed workforce (at end of period)
$= U(t) + V(t) – sU(t) - p(u(t)-u^*)[U(t) + E(t)]$.

and we assume:

(9b) $Y(t) = MIN [yH(t), m(t)]$.

To pick up the slack when there are not enough unemployed people, we assume:

(9a) $X(t) = [x/(x + z)] [H(t) – Y(t)]$

(9c) $Z(t) = [z/(x + z)] [H(t) – Y(t)]$.

[13] Based on an informal examination of Douglas County employment data since 1995, it took about three years of steady growth to bring the 1996 unemployment peak down to the 1999 trough. Therefore p = 0.35 per year is a reasonable guess.

Table 6.1
Workforce by Job and Education Status, 2000

Migration and employment status	Education			Total
	No B.A.	B.A.	Advanced degree	
Unemployed	2,439	343	99	2,881
Employed in-migrant	12,038	3,702	2,010	17,750
Employed, prior resident	17,474	5,742	4,017	27,233
Employed in-commuter	6,553	1,380	868	8,801
TOTAL	38,504	11,167	6,994	56,665

Source: Policy Research Institute

Notes: Based on PUMS data for Douglas and Miami Counties. Out-commuters are not included.

"In-migrants" lived outside the counties in 1995.

"Prior residents" lived inside the counties in 1995.

"In-commuters" lived outside the counties in 2000.

"Employed" held a job inside the counties in 2000.

Table 6.2
Workforce Shares by Job and Education Status, 2000

	Education		
Migration and employment status	No B.A.	B.A.	Advanced degree
Unemployed	6.30%	3.10%	1.40%
Employed in-migrant	31.30%	33.20%	28.70%
Employed, prior resident	45.40%	51.40%	57.40%
Employed in-commuter	17.00%	12.40%	12.40%
TOTAL	100%	100%	100%

Source: Policy Research Institute

Notes: Based on PUMS data. Out-commuters are not included.

“In-migrants” lived outside the two counties in 1995.

“Prior residents” lived inside the two counties in 1995.

“In-commuters” lived outside the two counties in 2000.

“Employed” held a job inside the two counties in 2000.

Table 6.3
Estimate Parameters for Workforce Model

		Education		
Symbol	Meaning	No B.A.	B.A.	Advanced degree
x	hiring share of in-migrants	0.472	0.347	0.182
y	hiring share for unemployed prior residents	0.483	0.389	0.127
z	hiring share of in-commuters	0.414	0.460	0.126
	total hiring shares	1.000	1.000	1.000
t	rate at which in-migrants become prior residents	0.036	0.036	0.033
s	rate of leaving the labor force	0.066	0.066	0.056
r	background growth rate	0.020	0.020	0.020

Source: Policy Research Institute
Notes: See text.

Table 6.4
Labor Market Demand Shares by Source of Jobs, 2000

Source of jobs	Education: No B.A.	B.A.	Advanced Degree	Total
Bioscience scenario (direct effect)	0.386	0.263	0.351	1.000
Indirect effect	0.748	0.173	0.079	1.000
Background	0.713	0.181	0.105	1.000

Source: Policy Research Institute

Notes: Based on PUMS data for Douglas and Miami Counties.
Out-commuters are not included.

“In-migrants” lived outside the counties in 1995.

“Prior residents” lived inside the counties in 1995.

“In-commuters” lived outside the counties in 2000.

“Employed” held a job inside the counties in 2000.

"Bioscience" modeled as all higher education employment

"Indirect effect" modeled as all other employment

"Background" modeled as all employment

Table 6.5
Dependency Ratios by Labor Market, 2000

Source of workers	No B.A.	B.A.	Advanced degree
in-migrants	0.360	0.323	0.542
prior residents	0.552	0.551	0.562
in-commuters	0.000	0.000	0.000

Source: Policy Research Institute

Notes: See text. Based on PUMS data for Douglas and Miami Counties. Entries are mean number of dependent per worker. Where there are two wage earners, dependents are allocated between workers in proportion to wages. See Table 6.4 for definitions of labor source.

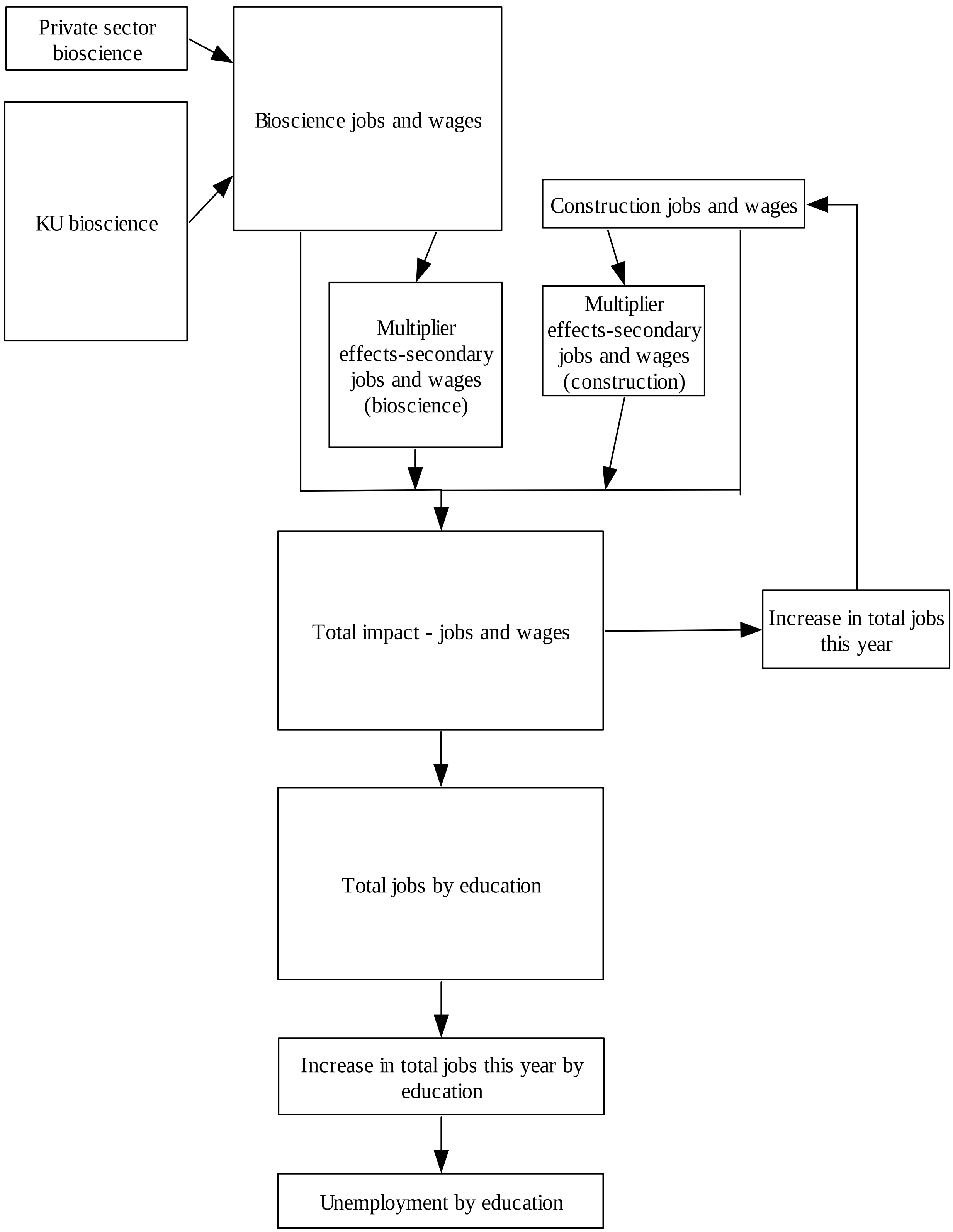
Table 6.6
Estimated Exit Rates, 2000

	Education			
	No B.A.	B.A.	Advanced Degree	All
5 year exmigration rate estimate	0.303	0.304	0.267	0.299
1 year exit rate estimate	0.066	0.066	0.059	0.065

Source: Policy Research Institute

Notes: See text. Exmigration rate based on PUMS data for Douglas and Miami Counties.

Figure 6.1
Structure of the Impact Model



Chapter 7:
Economic Impact Results

Introduction

This chapter describes results for the four growth scenarios. The impact model produces a very large quantity of information. For example, if we wanted to look at fully detailed dollar purchases between all sectors of the county economy, we would need to examine around (200 input sectors) x (200 output sectors) x (10 years) x (4 scenarios), leading to some two million data items. Clearly a much higher level of summarization is needed. In the tables, we show each scenario, for the years 2004, 2007, 2010, and 2014. In some tables we also include a background model representing Douglas County as it would be in the absence of any bioscience employment. All of the tables are broken out for labor markets distinguished by required levels of education (advanced degree, B.A., non-B.A.). The variables shown include:

Total new income
Total new jobs
Average wage per new job
Total unemployment
The unemployment rate

Jobs and income

The model shows that bioscience is presently contributing around 3300 jobs and $100M in income in Douglas County. Note that this income is measured by place of work, not by place of residence; around 10% of this income is received by incommuters who live outside Douglas County.

The IMPLAN model leads to income-income multiplier of around 1.6.[14] In other words, a dollar of new household income received from a source outside the county leads to an additional 60 cents of income within the county, after accounting for all effects due to local purchases and taxes.

The IMPLAN model leads to a job-income multiplier of around thirty-five jobs per $1 M per year. In other words, a permanent stream of household income in the amount of $1M per year received from a source outside the county leads to an additional thirty-five jobs within the county, after accounting for all effects due to local purchases and taxes. (Part time undergraduate student jobs on campus are excluded from these numbers.) However, these multipliers decline over time because average real wages rates are increasing.

These multipliers imply that the indirect effects of bioscience growth are smaller than the direct effects. Thus, the bioscience sector presently generates around $67 million in direct income per year and 2,300 jobs. The indirect impacts are adding around $39 million per year and 1,300 jobs. If in the bioscience sector eventually generates $180 million in income per year and 5,000 jobs, then the indirect impacts could add another $100 million per year and 3,000 jobs.

In addition to these impacts, there are impacts that result directly and indirectly from construction activities. In general, new construction does not respond to levels of jobs, workers and families that are

[14] The exact multipliers vary with the ratio of wages in the bioscience sector and other sectors.

already here -- instead it responds to the net additional jobs, workers and families who need additional houses, schools, and workplaces. Unless the build up of bioscience is extremely rapid, this kind of effect is expected to add no more than 3% to 5% of additional income and jobs.

The model shows that jobs caused indirectly grow at a higher rate than jobs caused directly in the bioscience sector. The reason is that wages are growing faster in biosciences than in other sectors. Consequently, the dollars spent locally by one bioscience worker employ an increasing number of non-bioscience workers as time wears on.

There are very large differences between the particular scenarios. The Low Growth scenario shows about a 13% increase in bioscience-related jobs over the next ten years. The extremely high growth "Economic Growth Act" (EGA) scenario shows an increase of 1250 to 200%

In-commuters and in-migrants

Based on the estimates developed in Chapter 6, the major part of any new jobs created in the ten years by bioscience will be filled by people who do not currently live in Lawrence. Around a sixth of the jobs are likely to be filled by persons who commute to Douglas County from another county. Close to half of the jobs are likely to be filled by people who did not live in Douglas County five years before being hired. Around 40% of the jobs will go to more senior residents.

In our model, the number of these newcomers is proportional to the number of new bioscience jobs. That is simply an assumption and not a research finding. However previous research on immigration patterns in general has consistently shown a strong relationship between creation of new jobs and the amount of new in-migration and in-commuting.

Unemployment

The unemployment model suggests an important finding: unless it is extremely rapid, growth in the bioscience sector may not have very significant impacts on unemployment rates. Even in the Economic Growth Act scenario, there are only moderate reductions in unemployment rates for persons without BA degrees. Individuals with advanced degrees are noticeably helped by rapid growth, but they constitute less than 4% of the local pool of unemployed persons. Moreover, their unemployment rates are typically very low to start with. Consequently, a bioscience development policy is probably not an effective way to bring down the unemployment rate.

As noted in the previous chapter, the unemployment model is sensitive to its parameters and assumptions. However the lack of a strong effect on unemployment follows from the impact model as well from the unemployment model. The main direct effect of a bioscience policy is to increase the demand for jobs requiring an advanced degree. While there are multiplier effects in the markets for individuals with B.A.s or less, these effects are smaller than the direct effect.

This model provides reasons to be skeptical of claims that a bioscience policy would have a strong effect on the rate of unemployment in Douglas County. Many of the new jobs created in bioscience would tend to be filled by persons with advanced degrees who move here from other cities.

Population growth

In a full-employment economy, currently existing Douglas County residents would already have a job if they wanted one. In that case, in the long run each new job would lead eventually to a new in-migrant or a new in-commuter. In our actual economy, there is a 3 or 4% unemployment rate, so not all new jobs are taken on net by newcomers – but in the long run all but a few percent will be. Generally speaking, population growth is driven by job growth.[15] Moreover, based on the dependency ratios developed in Chapter 6, in the long run each new worker added to the workforce brings about 0.4 new dependents into Douglas County.

From these two considerations, we can estimate population growth caused by a scenario as about 1.4 times the projected growth in jobs. If bioscience adds 800 new jobs directly and indirectly over the next ten years, then it will add about 1,100 people to the population. If it adds 3,000 jobs, then it will add around 4,200 people.

Fiscal impacts

The IMPLAN model assumes that taxes and government services increase in proportion to local income. Therefore the model does not examine the balance between detailed taxes and cost of services (which is referred to as "net fiscal incidence"). In general, however, in Douglas County as well as elsewhere, households are likely to pay less in taxes than they consume in services, while businesses tend to pay more than they consume.[16] Therefore, business-led population growth tends to more than pay for itself; while population-led growth (e.g. from growth in out-commuting population) tends to increase the local tax burden.

It is important to notice however that the University of Kansas is unlike other businesses in being exempt from most taxes. Therefore growth at KU does not have the beneficial revenue consequences that follow from private sector growth. To the extent that a growth scenario depends more on KU growth than on private sector growth, the fiscal impacts would be expected to be less favorable for local government and local taxpayers.

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[15] It is driven by growth in out-commuting workers as well as by growth in local jobs, but impacts of out-commuting workers are not part of this study.

[16] This point has been supported by the Lawrence Tax Abatement Model, which does perform a detailed fiscal impact analysis.

Table 7.1
Bioscience-related Jobs and Income: 2004 Basis
(Multiplier effects omitted)

	Jobs		*Total Income ($M)*	*Average Annual Wage ($000)*	
Employer	excluded	included	included	excluded	included
University of Kansas					
Faculty	363		23.6	64.9	
Non-Faculty (includes graduate assistants)	1,670		36.9	22.1	
Part-time undergraduates		545	1.2		1.8
KU Subtotal	2,033		61.6	29.7	
Private sector	170		5.7	33.6	
Total or Average	2,203	545	67.3	30.6	1.8

Source: Policy Research Institute

Notes: See Chapters 3 and 4 for explanation of source data. Bioscience jobs are narrowly defined.
Part-time student jobs are not included in the impact model, but their income is included.

"Included" and "excluded" refers to the treatment of part-time undergraduates.

Table 7.2
Bioscience-related Jobs

	Low		Medium		High		EGA	
Year	Number	Index	Number	Index	Number	Index	Number	Index
				Bioscience-related jobs				
2004	2,203	1.000	2,203	1.000	2,203	1.000	2,203	1.000
2007	2,269	1.030	2,303	1.046	2,351	1.067	2,813	1.277
2010	2,338	1.062	2,408	1.093	2,510	1.139	3,594	1.631
2014	2,433	1.105	2,556	1.161	2,738	1.243	4,980	2.261
				Indirect jobs (multiplier effects)				
2004	1,130	1.000	1,130	1.000	1,130	1.000	1,130	1.000
2007	1,191	1.054	1,235	1.093	1,290	1.142	1,776	1.571
2010	1,256	1.111	1,333	1.179	1,428	1.264	2,354	2.082
2014	1,348	1.193	1,475	1.305	1,636	1.447	3,427	3.032
				Total jobs				
2004	3,333	1.000	3,333	1.000	3,333	1.000	3,333	1.000
2007	3,461	1.038	3,539	1.062	3,642	1.093	4,590	1.377
2010	3,594	1.078	3,741	1.122	3,938	1.182	5,947	1.784
2014	3,781	1.134	4,031	1.209	4,374	1.312	8,407	2.522

Source: Policy Research Institute

Notes: See text for explanation of scenarios.

Table 7.3
Bioscience-related Income (millions of dollars)

	Growth Rate Scenario							
	Low		Medium		High		EGA	
Year	$M	Index	$M	Index	$M	Index	$M	Index
				Bioscience-related income				
2004	$67.30	1.000	$67.30	1.000	$67.30	1.000	$67.30	1.000
2007	$73.20	1.087	$74.90	1.113	$76.90	1.143	$92.60	1.376
2010	$79.50	1.181	$83.40	1.239	$87.90	1.306	$127.40	1.892
2014	$88.90	1.320	$96.20	1.429	$105.00	1.561	$194.80	2.894
				Indirect income (multiplier effects)				
2004	$33.00	1.000	$33.00	1.000	$33.00	1.000	$33.00	1.000
2007	$35.80	1.086	$37.20	1.126	$38.80	1.176	$53.40	1.619
2010	$38.90	1.180	$41.30	1.252	$44.30	1.341	$73.00	2.210
2014	$43.50	1.317	$47.60	1.441	$52.80	1.599	$110.50	3.349
				Total income				
2004	$100.30	1.000	$100.30	1.000	$100.30	1.000	$100.30	1.000
2007	$109.00	1.087	$112.10	1.117	$115.80	1.154	$146.00	1.456
2010	$118.50	1.181	$124.70	1.243	$132.20	1.318	$200.30	1.997
2014	$132.40	1.319	$143.70	1.433	$157.80	1.573	$305.40	3.044

Source: Policy Research Institute

Notes: See text for explanation of scenarios.

Table 7.4
Bioscience-related Annual Wage Rates

	Growth Rate Scenario							
	Low		Medium		High		EGA	
Year	$M	Index	$M	Index	$M	Index	$M	Index
				Bioscience-related income				
2004	$30.60	1.000	$30.60	1.000	$30.60	1.000	$30.60	1.000
2007	$32.20	1.055	$32.50	1.064	$32.70	1.071	$32.90	1.077
2010	$34.00	1.113	$34.60	1.133	$35.00	1.146	$35.40	1.160
2014	$36.50	1.195	$37.60	1.231	$38.40	1.255	$39.10	1.280
				Indirect income (multiplier effects)				
2004	$29.20	1.000	$29.20	1.000	$29.20	1.000	$29.20	1.000
2007	$30.10	1.030	$30.10	1.030	$30.10	1.030	$30.10	1.030
2010	$31.00	1.062	$31.00	1.062	$31.00	1.062	$31.00	1.062
2014	$32.30	1.105	$32.30	1.105	$32.30	1.105	$32.30	1.105
				All income				
2004	$30.10	1.000	$30.10	1.000	$30.10	1.000	$30.10	1.000
2007	$31.50	1.046	$31.70	1.052	$31.80	1.056	$31.80	1.057
2010	$33.00	1.095	$33.30	1.107	$33.60	1.115	$33.70	1.119
2014	$35.00	1.163	$35.70	1.185	$36.10	1.199	$36.30	1.207

Source: Policy Research Institute

Notes: See text for explanation of scenarios. Wages rates include part-time jobs, which are more prevalent in the bioscience sector.

Table 7.5
Total Unemployment

Year	Background	Growth Rate Scenario			
		Low	Medium	High	EGA
		Advanced degree workers			
2004	62	62	62	62	62
2007	65	69	67	64	13
2010	69	75	71	67	0
2014	75	82	77	73	0
		B.A. workers			
2004	213	213	213	213	213
2007	226	230	226	222	160
2010	240	246	241	235	99
2014	260	268	261	253	0
		Non-B.A. workers			
2004	1,519	1,519	1,519	1,519	1,519
2007	1,610	1,618	1,605	1,592	1,396
2010	1,710	1,721	1,705	1,689	1,254
2014	1,852	1,865	1,845	1,824	952
		Total workers			
2004	1,794	1,794	1,794	1,794	1,794
2007	1,901	1,918	1,898	1,878	1,569
2010	2,019	2,042	2,016	1,991	1,353
2014	2,186	2,214	2,183	2,150	952

Source: Policy Research Institute

Notes: includes unemployment effects due to background growth as well as scenarios. See text.

Table 7.6
Unemployment Rate (Percent)

	Growth Rate Scenario				
Year	Background	Low	Medium	High	EGA
		Advanced degree workers			
2004	0.9	0.9	0.9	0.9	0.9
2007	0.9	0.9	0.9	0.9	0.2
2010	0.9	1.0	0.9	0.9	0.0
2014	0.9	1.0	0.9	0.9	0.0
		B.A. workers			
2004	1.9	1.9	1.9	1.9	1.9
2007	1.9	2.0	1.9	1.9	1.4
2010	1.9	2.0	1.9	1.9	0.8
2014	1.9	2.0	1.9	1.9	0.0
		Non-B.A. workers			
2004	4.0	4.0	4.0	4.0	4.0
2007	4.0	4.1	4.0	4.0	3.4
2010	4.0	4.1	4.0	4.0	2.9
2014	4.0	4.1	4.0	4.0	2.0
		All workers			
2004	3.2	3.2	3.2	3.2	3.2
2007	3.2	3.3	3.2	3.2	2.6
2010	3.2	3.3	3.2	3.2	2.1
2014	3.2	3.3	3.2	3.2	1.3

Source: Policy Research Institute

Notes: includes unemployment effects due to background growth as well as scenarios. See text.

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