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EXECUTIVE SUMMARY

How do Indiana's Metropolitan Statistical Areas (MSAs) compare to other MSAs in the country when examining the numbers and rates of patent productivity? What is the nature of patent activity in Indiana MSAs? In this report, Indiana MSAs are compared to other selected MSAs in the United States in terms of total numbers of patents, rates of change in patent issuance, rates of patents per 10,000 MSA employees, and types of patent activity. In addition, the production of patents in the drug, pharmaceutical, and medical systems category in the Indianapolis MSA is compared to that of San Diego, San Francisco, and Minneapolis–St. Paul.

The comparison delivers both good and bad news. Some Indiana MSAs reflect a relatively robust capacity for innovation, while others show less patent activity. The Indianapolis MSA issued 556 patents in 1998, ranked 34th among 316 MSAs, but reflected just one-ninth the overall patent activity in the top-ranked MSA in the nation, San Jose. Fort Wayne, with 140 patents in 1998, ranked 92nd in the nation. South Bend, Lafayette, Kokomo, Gary, and Elkhart were no better than 128th, but ranked in the upper one-half of all MSAs. Bloomington (20 patents), Terre Haute (16), and Muncie (10) issued the fewest patents among Indiana MSAs in 1998, and were ranked in the lower third of MSAs in the United States.

Some Indiana MSAs look better nationally when measured in terms of patents per 10,000 employees. Kokomo, with its manufacturing concentration, ranked 26th among 316 MSAs in 1998, while Lafayette and Indianapolis ranked 57th and 71st, respectively. South Bend, Elkhart, and Fort Wayne were in the top half of MSAs, Bloomington was right in the middle, ranked 158th, while Terre Haute, Gary, and Muncie were in the lower half of all U.S. MSAs.

Examined in terms of the number of patents in the top five categories for each MSA, all 10 Indiana MSAs demonstrated strengths in drugs, pharmaceuticals, and medical systems. Patents linked to automobiles were among the strengths in Elkhart, Fort Wayne, Indianapolis, Lafayette, Muncie, and South Bend. Strength in computer and data processing patents was reflected in Gary, Indianapolis, Kokomo, Lafayette, and Terre Haute.

Clearly, a major source of innovation for Indiana is its life science sector. Indianapolis is the leading MSA in the state, with 1,122 patents for the 1995 to 1999 period. While impressive, when compared to three MSAs with demonstrated strengths in the life sciences (Minneapolis–St. Paul, San Diego, and San Francisco), the Indianapolis MSA lags behind in annual production of life science patents and the variety of patents produced. More troubling is the trend of life science patents among the four MSAs. San Diego, San Francisco, and Minneapolis–St. Paul patents grew substantially in the late 1990s, while the Indianapolis MSA life science patent output dropped each year from 1996 to 1999. Even so, the innovative strength of the Indianapolis MSA is in drug production, with 620 patents from 1995 to 1999 exceeding those in San Diego, San Francisco, and Minneapolis–St. Paul. Its secondary strength is in molecular biology and microbiology.

Indiana policymakers need to identify, examine, and strengthen factors that can improve the production of innovative activity and patents within the state. Different levels and types of investments within the regions of the state, particularly infrastructure systems like transportation and education, should be investigated to determine their impact on different types and volumes of economic innovation. More focused investments by all four sectors—households, businesses, governments, and nonprofits—can help move Indiana innovations to the top tier of regions in the nation.

INTRODUCTION

Knowledge is the new basis for wealth. In the future when capitalists talk about their wealth they will be talking about their control of knowledge. Exactly how one controls knowledge is in fact a central issue in a knowledge-based economy.

—Lester Thurow (1999)

The economic health of regions and their cities depends on a supply of business firms and individuals with the capacity to adapt and innovate within a highly competitive global economic system. One basic measure of a region's success in supporting innovation is the number and type of patents obtained by its residents and its organizations. Patents are a widely accepted measure of the capacity of organizations, and their home regions, to create innovations (Acs and Audretsch 1989), but they reflect more than just a successful spirit of invention. Innovations and the property rights to them directly affect the income and economic vigor of regions. The region's record of innovative activity therefore is a critical component of its ongoing economic evolution. Policymakers have a vested interest in promoting public policies and making decisions that can improve the ability of individuals and organizations to create and implement new products and new processes. Decisions on public infrastructure, tax policy, the allocation of educational expenditures, and economic development incentives all affect the innovative capacity of regions.

Indiana is home to the core counties of 10 metropolitan areas that have generated a regular stream of patents and the potential innovative activity they reflect in a wide variety of scientific fields and business sectors. Each Indiana MSA (Bloomington, Elkhart, Fort Wayne, Gary, Indianapolis, Kokomo, Lafayette, Muncie, South Bend, and Terre Haute) shows evidence of innovative business activity, with concentrations in drugs and pharmaceuticals, medical systems, electrical and electronic components, automobiles, and computers and data processing. To be sure, the volume and nature of patents vary by region, and there are some surprising strengths shown by some perhaps unexpected MSAs in the state.

This report focuses on utility patents (which are patents issued for new inventions) and seeks to answer three key questions. How do MSAs within Indiana compare to other MSAs in the United States in terms of various measures of patent activity? How innovative are the state's MSAs compared to other Midwestern MSAs and other selected MSAs with demonstrably high levels of patent activity? And how do Indiana's MSAs differ in terms of their predominant patent types?

REGIONS ARE KNOWN FOR THE INNOVATIONS THEY CREATE

An important landmark in the economic landscape of cities and regions is the generation of new knowledge by individuals and business firms. Information and knowledge are key components of the *new economy*, a term now used to describe the changing economic structure in many different business sectors due to the use of computers and information technologies to increase innovative activities and to promote the sectoral clusters that advance cooperative business linkages (Reuveny 2001). New information and knowledge creation also are important in the *old economy* of traditional manufacturing, service, retail, and professional sectors, where firms and their employees invent new methods of performing business functions or create new equipment and innovative work processes. Innovation has become a necessary ingredient for the economic competitiveness and success of regions (Storper 1997).

Cities and regions often are recognized for the presence of highly innovative firms that occupy a competitive niche nationally and internationally (Castells and Hall 1994). Consider, for example, the computer industry in Silicon Valley, advanced glass technologies around Corning, New York, or the biotechnology clusters in San Francisco and San Diego. For business firms and their home regions, there are valuable benefits to be captured by generating and exploiting new knowledge embedded in innovative products and processes (Audretsch and Feldman 1996). First, implementing new information, technological knowledge, and products can make a business organization more productive, and in turn perhaps lure to its region other firms interested in collaborating within innovative economic clusters. Second, generating new knowledge can create higher incomes and profits for business firms and improve the personal income of individuals working within the region.

Third, and perhaps most importantly, regions containing firms that rely on traditional means of doing business at the same time that firms in other regions adopt innovative ideas and techniques ultimately will face serious challenges to their competitive stature, especially in a rapidly globalizing economic system. Cities and regions must establish innovative and supportive environments that can enable individuals and business organizations to create and implement new knowledge, procedures, and processes (Baptista and Swann 1998).

INNOVATION CAN BE ESTIMATED BY MEASURING PATENT ACTIVITY

Even though new knowledge and ideas can affect a region's economic health, knowledge in and of itself is not easily measured. One of the primary tangible ways that individuals and firms express the creation of new technology and knowledge is by patenting the results of their knowledge (Griliches 1990). The U.S. Patent and Trademark Office (USPTO) grants patents to firms and individuals from the United States and foreign countries who wish to have their inventions patented in this country. Interestingly, a patent does not grant the inventor the right to make, sell, use, or import the invention, but rather grants protection so that others may not make, sell, use, or import the invention. Further, while individuals can apply for a patent, it is common for an individual to assign the patent to their employer, who ultimately will be the maker and seller of the invention. A patent is granted for 20 years beyond the date on which the application was first made. Periodic maintenance fees are due in order for the patent to remain active. USPTO classifies patents into six categories: design, plant, utility, reissue, defensive publications, and statutory invention registrations. Of the 163,000 patents granted in the United States in 1998 (both U.S. and foreign application origin), 90 percent were considered utility patents, which are patents granted solely for new inventions and processes. Of U.S. origin patents, nearly 90 percent of patents granted were utility patents. There are literally hundreds of different classes of utility patents (e.g., surgical instruments, electronic devices, and inorganic compounds) (USPTO 1999).

INNOVATIVE ACTIVITY AFFECTS THE WELFARE OF A REGION

Patents, as one indicator of a region's capacity for business innovation, can quickly and tangibly affect personal income within a region, as well as influence the underlying economic strengths of the region. This occurs in part because patents protect the products and services produced by individuals and business firms, who in turn use the grant of property rights to generate income and wealth through the marketplace. To demonstrate how income flows within a region can be affected in this way, consider the case of pharmaceutical patents.

On August 9, 2000, the U.S. Court of Appeals overturned a district court's ruling that would have allowed Eli Lilly and Company's patent on Prozac, an anti-depressant drug, to remain valid until 2003. Although Prozac as a share of Lilly sales had dropped from 34 to 26 percent between 1996 and 1999, the drug remained the number one prescribed anti-depressant in the world (Lilly *1999 Annual Report)*. Court action was precipitated by an application by Barr Laboratories, Inc. (among at least three other companies) to the U.S. Food and Drug Administration to market as its own anti-depressant the same active ingredient in Prozac, fluoxetine hydrochloride. Lilly claimed six patents on the drug stemming from a 1974 application to the USPTO. However, Barr Laboratories argued that the drug had been illegally double-patented, and the Court of Appeals agreed, shaving two years off the protection afforded Lilly by its patent (*Eli Lilly and Co. v. Barr Lab* 2000). Later, Lilly did obtain a six-month extension (Lilly press release 2000).

On the day the U.S. Court of Appeals handed down its decision, Lilly's stock price fell 31 percent while Barr Laboratories stock price rose by 68 percent. Within two weeks, the market value of Eli Lilly stock dropped from nearly $110 to below $70 per share, with a negative rippling effect on personal income and investment portfolios throughout the Central Indiana region and the nation. Yet during this same period, Lilly's progress in tests of Zovant, an anti-sepsis drug, had a substantial positive effect on its market value (O'Brien 2000).

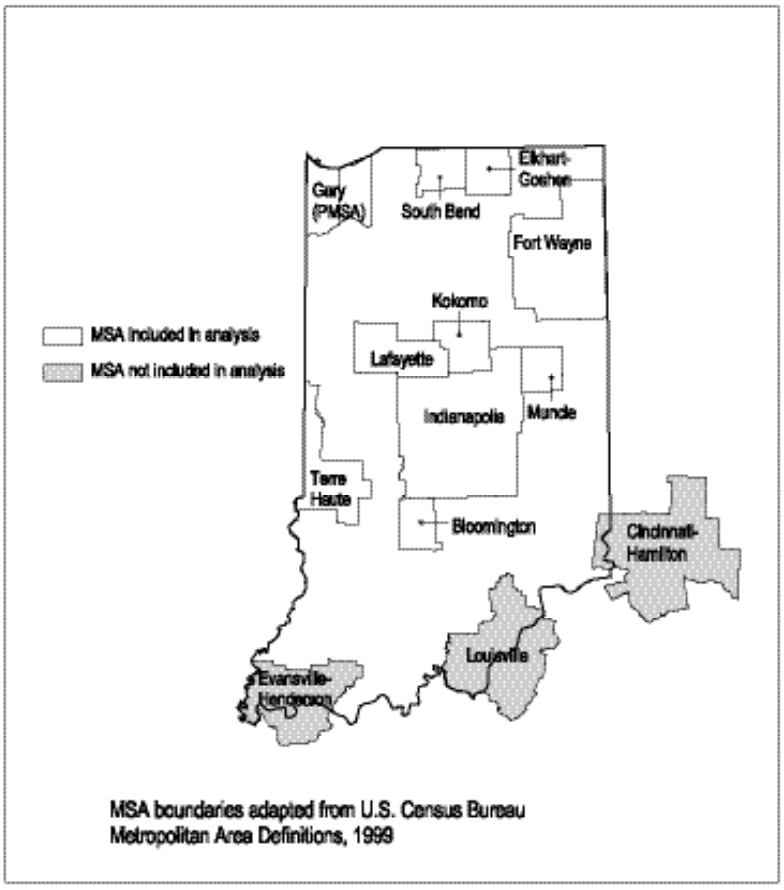
This story suggests that the rise and fall of patents can directly affect the economic well-being of firms, and indirectly influence the economic health of the broader region (Audretsch and Feldman 1996). Policymakers, public officials, and business leaders should be interested in the capacity of cities and regions to provide environments that can enable innovative activity. One relatively simple way of comparing the underlying ability of regions to promote innovation is to look at the level of patent activity over time.

INDIANA'S MSAs GENERATE DIFFERENT QUANTITIES OF PATENT ACTIVITY

When examining patents as an indicator of innovative activity, an MSA is a useful geographic classification because it reflects a level of economic integration and therefore captures spillover effects of knowledge innovation that a county-by-county analysis would not (Ó hUallacháin 1999). An MSA describes a geographic area consisting of a central city with a population of at least 50,000 surrounded by a densely populated area that is socially and economically integrated. So typically an MSA refers to an aggregate of counties containing the county of the core city along with the qualifying surrounding counties. Surrounding counties are included in an MSA if they meet requirements such as population density and minimum urban population. In Indiana, there are 10 MSAs contained fully within the state, and parts of three other MSAs that cross state boundaries (U.S. Census Bureau 2001).
For this analysis, the major focus is on the 10 MSAs completely within Indiana. Figure 1 depicts these MSAs in Indiana. As shown in the following tables, while there are commonalities in patent trends among the 10 Indiana MSAs, the volume, rate, and dominant classes of patent activity in these MSAs differ in sometimes surprising ways.[1]

[1] Patent data for all tables were adapted from U.S. Patent and Trademark Office. Office for Patent and Trademark Information, April 1999 and United States Patent and Trademark Office. Technology Assessment and Forecast (TAF) Branch June 1, 2000.

Figure 1: Indiana Metropolitan Statistical Areas



Considered in terms of the actual number of utility patents, the Indiana MSAs do not compare very favorably to the U.S. metropolitan regions responsible for the largest quantity of annual patents. Table 1 presents the total number of utility patents granted for each Indiana MSA for the years 1990 and 1998, along with the total and average annual percentage growth for the eight-year period and, for purposes of comparison, the MSAs with the largest number of patents in the United States in 1998 also are shown. The Indianapolis MSA had the most patents granted for both time periods among Indiana MSAs, followed by Fort Wayne, South Bend, and Lafayette. The Muncie MSA had the fewest. Compared to the national average annual growth rate of 6.8 percent, the Kokomo, Bloomington, and Indianapolis MSAs all were above the national average. However, even though the Indianapolis MSA had the largest number of patents granted in both 1990 and 1998, the Kokomo MSA had the highest average annual growth rate. And while the Muncie MSA had the fewest patents granted, it had the fifth highest growth

rate of the 10 Indiana MSAs. From an interregional perspective, average annual patent growth in Kokomo and Bloomington *exceeded* annual rates in much larger metropolitan areas such as Boston, Chicago, Los Angeles, and Minneapolis. The Indianapolis MSA annual patent growth was greater than that of both Chicago and Los Angeles.

Table 1: Number of Utility Patents, Indiana MSAs and Top National MSAs

	1990	1990 Rank	1998	1998 Rank	Total Growth	Average Annual Growth
Top Five MSAs						
San Jose, Calif.	1,295	5	4,931	1	280.8%	18.2%
Boston, Mass.	2,051	2	3,687	2	79.8%	7.6%
Chicago, Ill.	2,086	1	2,959	3	41.9%	4.5%
Los Angeles, Calif.	1,586	3	2,335	4	47.2%	5.0%
Minneapolis–St. Paul, Minn.	1,154	7	2,051	5	77.7%	7.5%
Indiana MSAs						
Indianapolis	318	38	556	34	74.8%	7.2%
Ft. Wayne	110	84	140	92	27.3%	3.1%
South Bend	51	124	76	128	49.0%	5.1%
Lafayette	50	126	65	136	30.0%	3.3%
Kokomo	28	181	56	146	100.0%	9.1%
Gary	53	121	55	149	3.8%	0.5%
Elkhart-Goshen	37	156	51	155	37.8%	4.1%
Bloomington	10	243	20	226	100.0%	9.1%
Terre Haute	16	215	16	247	0.0%	0.0%
Muncie	7	271	10	273	42.9%	4.6%
U.S. Totals	**47,497**		**80,416**		**69.3%**	**6.8%**

SIX INDIANA MSAs ARE IN TOP 100 FOR PATENTS PER 10,000 EMPLOYEES

Raw patent counts do not consider the effects of population and employment in a region, and annual growth rates are misleading because of the substantially smaller yearly quantities of patents in the Indiana MSAs as compared to the top MSAs. Another useful arrangement of patent data is to transform the counts into the number of utility patents per 10,000 persons employed in each MSA in 1990 and 1998. This controls for the size of the MSA's general employment base. Additionally, to draw a better picture of Indiana's innovative activity, the Indiana MSAs can be compared with other MSAs in the Midwest and the United States. Table 2 lists the patents per 10,000 employees and the rank of the Indiana MSAs when compared to the 316 national MSAs that have available patent data.[2] The top five national MSAs in terms of patents per 10,000 employees also are presented, along with a set of other selected MSAs within the Midwest and elsewhere.

[2] Employment data used in Table 2 are adapted from United States Bureau of Labor Statistics. February 11, 2001.

Table 2: Indiana and Selected National MSA Patents per 10,000 Employees

	1990		1998	
	Patents per 10,000 Employees	National Rank	Patents per 10,000 Employees	National Rank
Top Five MSAs				
San Jose, Calif.	16.0	4	53.2	1
Boise City, Idaho	5.6	58	34.2	2
Rochester, N.Y.	17.0	3	31.5	3
Rochester, Minn.	8.5	15	30.1	4
Dutchess County, N.Y.	8.4	19	28.7	5
Other Selected MSAs and Indiana MSAs				
Trenton, N.J.	23.2	1	22.7	8
Boston, Mass.	12.1	9	20.9	10
Raleigh-Durham, N.C.	4.9	75	13.8	17
Saginaw-Bay City-Midland, Mich.	18.3	2	12.9	20
Minneapolis–St. Paul, Minn.	8.2	21	12.5	23
Brazoria, Tex.	15.6	5	11.7	24
Kokomo	6.3	46	11.4	26
Madison, Wis.	4.3	96	10.0	36
Seattle, Wa.	5.1	71	9.5	39
Cincinnati, Ohio	5.6	58	8.8	43
Dallas, Tex.	5.1	71	8.2	50
Lafayette	6.5	41	7.4	57
Chicago, Ill.	5.6	58	7.4	57
Houston, Tex.	5.9	49	7.1	64
Cleveland, Ohio	5.9	49	7.1	64
Indianapolis	4.5	87	6.8	71
Milwaukee, Wis.	5.8	53	6.4	76
St. Louis, Mo.	3.6	114	5.9	87
South Bend	4.3	96	5.7	91
Elkhart-Goshen	4.6	83	5.5	99
Fort Wayne	4.8	77	5.4	100
Los Angeles, Calif.	3.7	112	5.4	100
Columbus, Ohio	3.0	129	4.3	133
Bloomington	1.9	194	3.4	158
Kansas City, Mo.	1.9	194	2.6	186
Terre Haute	2.5	162	2.4	199
Louisville, Ky.	3.0	129	2.3	207
Nashville, Tenn.	1.6	221	2.1	218
Gary	2.0	187	1.9	239
Muncie	1.3	244	1.7	249
U.S. Rates Overall	**3.9**		**6.1**	

The effects of location within recognized high-tech regions are shown in the rankings, such as San Jose's Silicon Valley, Boston's Route 128, and Raleigh-Durham's Research Triangle Park. Nevertheless, six Indiana MSAs were in the top 100 MSAs in the nation. Considering all 316 MSAs in 1998, two Indiana MSAs were in the top quintile (Kokomo and Lafayette), four were in the second quintile (Indianapolis, South Bend, Elkhart, and Fort Wayne), two were in the third quintile (Bloomington and Terre Haute), and two were in the fourth quintile (Gary and Muncie). Kokomo's 11.4 patents per 10,000 employees ranked 26 out of 316 MSAs in the United States. Although the Indianapolis MSA had the highest number of patents granted among Indiana MSAs in both 1990 and 1998, its national ranking per 10,000 employees among all MSAs was 41 spots behind the Kokomo MSA in 1990 and 45 spots behind in 1998.

During the eight-year period examined here, there also was volatility in the individual Indiana MSA patent rates and national rankings. Between 1990 and 1998, the Kokomo, Indianapolis, South Bend, and Bloomington MSAs improved their overall national rankings. Although not every Indiana MSA advanced in the national rank, all except the Terre Haute and Gary MSAs experienced a positive growth in patents per 10,000 employees. The Kokomo MSA experienced an 81 percent increase in its patent rate, the highest percentage growth of the 10 Indiana MSAs. Kokomo also outranks several other MSAs that are not only in close proximity to Indiana but also many that provide direct economic competition to Indiana MSAs (e.g., Madison, Milwaukee, Cleveland, and Chicago). But Kokomo was not the only example of comparative strengths. The Lafayette MSA outranked the Chicago MSA in 1990, although it lost 16 spots to tie with Chicago in 1998. The South Bend, Elkhart, and Fort Wayne MSAs ranked close together in 1990 and 1998 and consistently outranked the Columbus, Ohio, and Louisville, Kentucky MSAs.

How did growth in patents per 10,000 employees in Indiana MSAs compare to the nation? Between 1990 and 1998, the national measure of patents per 10,000 employees increased by 56 percent from 3.9 to 6.1. More Indiana MSAs exceeded the U.S. growth rate in 1990 than in 1998. Kokomo, Lafayette, Indianapolis, South Bend, Elkhart, and Fort Wayne all exceeded the U.S. patent rate in 1990, while the Bloomington, Terre Haute, Gary, and Muncie MSAs were below the national rate. By 1998, only Kokomo, Lafayette, and Indianapolis exceeded the U.S. rate, and the South Bend, Elkhart-Goshen, and Fort Wayne MSAs all fell below the national rate. Among the MSAs that fell below the U.S. rate in 1998, only South Bend and Bloomington improved their national ranking. So, from 1990 to 1998, the overall productivity of Indiana MSAs relative to the national rate weakened.

PATENT TYPES BY INDIANA MSAS INDICATE DIFFERENT INNOVATIVE ACTIVITIES

Despite this slight decline from 1990 to 1998, the patent numbers still indicate that a sizeable volume of innovative activity is occurring among Indiana MSAs. What is the nature of these innovations, and how do they vary among the MSAs within the state? A detailed answer to this question is beyond the scope of this analysis, but it is possible to present a broad profile of the top patent types within each of Indiana's metropolitan regions.

To develop this profile, however, it is necessary to briefly explain the patent classification system, and show how patent categories were aggregated to summarize the nature of innovative activity in Indiana MSAs. USPTO classifies patents into 471 classifications, under which are multiple sub-classifications (USPTO 1999). In the Indiana MSAs, patents were granted in at least 240 of the 471 classifications. To facilitate comparisons across Indiana MSAs, the patent classifications for each MSA were grouped into 44 broader classifications based on general similarities, and the total number of granted patents from 1995 to 1999 was counted for the 44 groupings.

Once the patents were counted, the 44 groups were again aggregated into 23 groups that captured some commonality among the classifications. For example, the *Drug, Pharmaceuticals and Medical Systems* grouping includes 39 specific USPTO classifications such as body treating chemicals, surgery, prostheses, organic compounds, chemistry, and biology. While most of the groupings encompass a wide variety of classifications and are easily understood, several of the groupings are not so intuitive. The *Electrical and Electronic Components* grouping includes a wide range of classifications such as power plants, circuit breakers, power delivery controls, and automatic temperature regulators. Table 3 shows the five groupings that received the most patents for each Indiana MSA. The parenthetical numbers are the total quantities of patents for 1995 to 1999.[3]

[3] Assessments of the types of patent activity categorized by metropolitan area are available only from USPTO for years 1995 through 1999.

Table 3: Top Five Patent Classifications of Indiana MSAs (Number of Patents), 1995–99

Bloomington	Drugs, pharmaceuticals, and medical systems (42)	Electrical and electricity (11)	Communication, television and educational presentations (6)	Machines (5)	Fluid, gas, and hazardous material processes (4)
Elkhart-Goshen	Drugs, pharmaceuticals, and medical systems (50)	Automobiles (28)	Electrical and electricity (27)	Materials (22)	Buildings and enclosures (17)
Fort Wayne	Electrical and electricity (154)	Automobiles (94)	Materials (54)	Steel, metal, and glass processes (53)	Drugs, pharmaceuticals, and medical systems (34)
Gary	Electrical and electricity (32)	Steel, metal, and glass processes (32)	Drugs, pharmaceuticals, and medical systems (20)	Computer, data processing, optics, and printing (18)	Machines (17)
Indianapolis	Drugs, pharmaceuticals, and medical systems (1,122)	Electrical and electricity (340)	Communication, television and educational presentations (265)	Computer, data processing, optics, and printing (96)	Automobiles (95)
Kokomo	Electrical and electricity (107)	Communication, television and educational presentations (52)	Computer, data processing, optics, and printing (32)	Drugs, pharmaceuticals, and medical systems (24)	Steel, metal, and glass processes (20)
Lafayette	Drugs, Pharmaceuticals, and Medical Systems (150)	Electrical and electricity (33)	Automobiles (32)	Computer, data processing, optics, and printing (25)	Machines (16)
Muncie	Automobiles (13)	Drugs, pharmaceuticals, and medical systems (11)	Electrical and electricity (4)	Illumination (3)	Recreational items (3)
South Bend	Automobiles (58)	Drugs, pharmaceuticals, and medical systems (51)	Electrical and electricity (49)	Machines (31)	Materials (19)
Terre Haute	Computer, data processing, optics, and printing (9)	Drugs, pharmaceuticals, and medical systems (9)	Materials (9)	Machines (8)	Refrigeration, warehousing, and packaging (7)

The top five patent categories of the state's MSAs based on counts for 1995 to 1999 are tied to the dominant economic structure of Indiana. The top three activities in Elkhart-Goshen, Lafayette, Muncie, and South Bend are the traditionally strong businesses and manufacturing groupings in Indiana (pharmaceuticals, automobiles, and electrical and electronic equipment). All 10 Indiana MSAs had substantial patent activity in the *Drugs, Pharmaceuticals, and Medical Systems* grouping. With the presence of the Eli Lilly headquarters, it is not startling that Indianapolis is the leader for this group. Yet Indianapolis also has the highest number of automobile patents (95), while Ft. Wayne has the second largest (94). Nine of the 10 MSAs show patent activity in the *Electrical and Electronic Component* grouping; only Terre Haute did not have this grouping among its top five. Six of the 10 MSAs had patent activity in the *Automobile* grouping.

Computers, Data Processing, Optics, and Printing and *Machines* also are important patent groupings for Indiana MSAs. Each grouping is represented five times as one of the top patent classifications. *Refrigeration, Warehousing, and Packaging*; *Illumination; Fluid, Gas, and Hazardous Material Processes; Buildings and Enclosures;* and *Recreational Devices* are less prevalent, with each represented in only one MSA. These particular groupings represent innovative activity in areas other than those most associated with Indiana's economy.

The fact that most of the top patent groupings tend to be clustered around three or four categories suggests that Indiana MSAs are focused on the traditional business processes that have formed the core economic strengths of the state—manufacturing, electrical machinery, and the life sciences. In the absence of comparable national or MSA data, it is difficult to judge the strength of Indiana MSA's patenting activity in the top groupings. However, given the region's strength in drugs, pharmaceuticals, and medical systems, it is useful to compare Central Indiana's leading MSA, Indianapolis, to other MSAs in the United States that also have demonstrated competencies in life sciences, such as San Diego, San Francisco, and Minneapolis–St. Paul. San Diego and San Francisco both have major geographical clusters of biotechnology firms, while the Minneapolis–St. Paul region is home to innovative medical firms such as Medtronic and Boston Scientific.

How does the production of life science patents in Indianapolis stack up against these leading MSAs? While clearly a top innovator in Indiana, Indianapolis lags behind these nationally leading MSAs in life science innovations. Figure 2 graphically shows the yearly life science patents trends for the Indianapolis, Minneapolis–St. Paul, San Diego, and San Francisco MSAs from 1995 to 1999. Life science patents include various innovations in classes such as chemistry, dentistry, drugs, organic compounds, multicellular organisms, prostheses, and surgery. From the standpoint of total life science innovations, not only does Indianapolis have the fewest patents each year, but the number of patents declined every year from 1996 to 1999. In contrast, during the 1995 to 1998 period, San Diego and San Francisco both experienced sharp increases in life science patents, from about 220 in 1995 to more than 650 in 1998. Minneapolis–St. Paul also experienced a consistent increase in life science patents every year from 1996 to 1999. The trend depicted here suggests that the Indianapolis MSA is losing ground compared to more productive regions in the creation of drug, pharmaceutical, and medical systems innovations. This negative comparison is not completely because of population size or the number of firms doing business in the regions. Table 4 lists the population and number of business establishments in each of these four MSAs, and then provides a normalized patent rate per 100 firms. As it shows, the Indianapolis and Minneapolis–St. Paul MSAs have about the same rate of life science patents per 100 firms, but both MSAs lag behind San Diego and San Francisco.

Figure 2: Drug, Pharmaceutical, and Medical Systems Patents in four U.S. MSAs, 1995–99

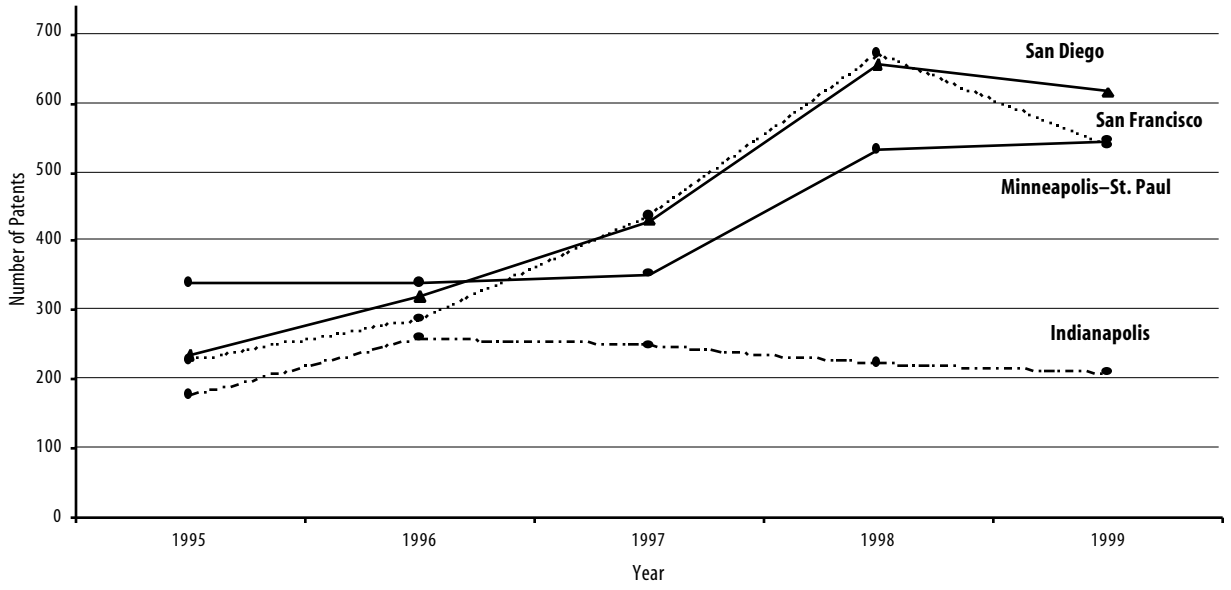


Table 4: Comparison of MSA Counties, Populations, Establishments, and Normalized Patent Rates

MSA	No. of Counties	1997 Population	1995 Business Establishments	1995–99 Life Science Patents	Patents per 100 Firms
Indianapolis	9	1,503,468	40,000	1,122	2.8
San Francisco	3	1,662,005	60,000	2,177	3.6
San Diego	1	2,722,650	60,000	2,282	3.8
Minneapolis–St. Paul	13	2,792,137	75,000	2,120	2.8

Source: MSA population and establishment data adapted from *State and Metropolitan Data Book 1997–1998*, U.S. Bureau of the Census. Patent data from Center for Urban Policy and the Environment, adapted from U.S. Patent and Trademark Office, *Patenting In Metropolitan and Non-Metropolitan Areas of the United States Breakout by Technology Class 1995–1999 Utility Patent Grants*.

Despite this lag, the Indianapolis MSA does exhibit some strengths when the life science category is divided into more specific classes (see Table 5). For instance, within the life sciences, the Indianapolis MSA produced 620 patents from 1995 to 1999 in the drugs, bio-affecting and body treating compositions class, which accounts for more than one-half the total number of life science patents produced in the MSA. Indianapolis was the leader in this class among the other three MSAs. Another comparative strength in the Indianapolis MSA is in organic compounds

(199 patents, second among the four MSAs). However, in other life science classes, Indianapolis was considerably behind. In the surgery class, for example, the Minneapolis–St. Paul MSA was by far the leader, with two-thirds of its total patent count comprised of surgery patents. With their clusters of biotechnology firms, both San Diego and San Francisco had a substantially larger number of patents in the molecular biology and microbiology class. Although the Indianapolis MSA had 143 patents in this class, San Diego and San Francisco had four times this number. For most of the life sciences, the Indianapolis MSA had a smaller quantity of patents in each class and a less differentiated set of patent innovations than these three other leading MSAs.

Table 5: Type and Number of Patents in Drug, Pharmaceutical, and Medical Systems Category, 1995–99

Type of Patents	**Metropolitan Statistical Areas**			
	Indianapolis (1,122)	**Minneapolis–St. Paul (2,120)**	**San Diego (2,282)**	**San Francisco (2,177)**
Chemistry of hydrocarbon compounds		8	2	11
Chemistry of inorganic compounds		7	4	22
Chemistry: analytical and immunological testing	16	24	38	39
Chemistry: molecular biology and microbiology	143	107	643	622
Chemistry: natural resins or derivatives; peptides or proteins	41	15	146	140
Compositions	8	52	13	7
Dentistry		37	39	10
Drugs, bio-affecting and body treating compositions	620	188	571	483
Multicellular living organisms	9	20	28	27
Optics: eye examing, vision testing, and correction	2	8	23	12
Organic compounds	199	103	289	131
Prosthesis	10	131	42	45
Surgery	65	903	377	572
Surgery: kinesitherapy	2	9	12	11
Surgery: light, thermal, and electrical application	3	460	21	36
Surgery: splint, brace, or bandage	4	48	33	9
Undertaking			1	

SOURCE: Data adapted from U.S. Patent and Trademark Office. *Patenting In Metropolitan and Non-Metropolitan Areas of the United States Breakout by Technology Class 1995–1999 Utility Patent Grants*.

INNOVATION IN INDIANA MSAs CAN CREATE STRATEGIC REGIONAL ADVANTAGES

Considering patents as a measure of innovation permits us to view Indiana's metropolitan areas as laboratories that are producing a regular supply of new knowledge, products, devices, and processes. From this perspective, Indiana MSAs contribute a substantial number of innovations to the global economy. Of course, without additional detailed analysis we cannot know how or even whether the patents devised within Indiana MSAs actually are used, for they may be applied strategically to exclude an invention's use by parties other than the inventor. To that end, companies may obtain patents as pre-emptive strikes, applying for them in the early stages of development to protect research rather than to exploit the resulting product of the research (Banerjee et al. 2000).

However, in the absence of better ways to gauge new knowledge growth, the number of patents granted does tell us something about the innovative activity that is occurring within the state's metropolitan areas. And in this regard, Indiana MSAs are active players in the creation of innovation. The Indianapolis MSA alone accounted for nearly one percent of total U.S. patents in both 1990 and 1998. In particular, of the 10 Indiana MSAs in this analysis, the Kokomo MSA, despite its small size, seems to be a relative leader in innovative activity, outranking larger MSAs such as Indianapolis and Chicago in terms of normalized patent rates. The activity in Kokomo seems to be a hybrid connection of electronics, electrical machinery, and computer technology linked to automobile manufacturing. Overall, the state's MSAs show clear strengths in drugs, pharmaceuticals, and medical systems, driven by the presence of life science firms in most of the individual MSAs. Even compared to other nationally prominent MSAs in the life sciences, the Indianapolis MSA is a leader in drug innovations, with other strengths in organic compounds and molecular biology. For other Indiana MSAs, electrical and electronic components reflect another strength.

Given the quantity and types of innovations generated by Indiana MSAs, state and local policymakers and business leaders should seek information about the firms and organizations creating these patents and the characteristics of the state and its regions that allow such innovative activity to thrive and continue. Investments by all four sectors of the Indiana socioeconomic system—households, governments, businesses, and nonprofits—are crucial to improving the climate of innovation and creativity in the state. Are there particular kinds of investments by these sectors that can enhance productive innovation? One extremely positive recent development is the award of $105 million by the Lilly Endowment to Indiana University to fund the INGEN (Indiana Genomics) initiative, which is designed to exploit new knowledge in genomics and proteomics (protein expression). Regarding the strategic niche of life sciences, public investments in education, laboratory, telecommunications, and health facilities are also likely contributors to the state's innovative capacity. To the extent Indiana's investments in these sectors fall behind national trends, policymakers may want to examine the nature of and reasons for such shortfalls (Center for Urban Policy and the Environment 2000; Nunn 2001).

Similarly, in the context of public policy decisions, various kinds of infrastructure investments (e.g., transport, communications, education) are critical to future economic growth and innovation within the state, and deserve much more attention, both from an analytical and a fiscal perspective. How do these infrastructures influence where and how innovative activity can occur? How do Indiana infrastructure investments compare to other regions with successful track records of innovation and patent activity? What regions in the state need additional infrastructure investment, and of what type? Providing answers to these and other questions potentially can offer a strategic perspective on the future of innovation in Indiana.

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