

Michigan Center for Innovation and Prosperity

Michigan in the Pharmaceutical Industry

An Industry Review of Michigan's role in the global pharmaceutical industry

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The Journey of a New Drug

The general value chain of the pharmaceutical industry consists of six parts: drug discovery and development, clinical trials in humans, manufacturing, wholesale/distribution, pharmacy and consumer.

Drug discovery and development is mainly carried out by pharmaceutical companies, universities, and government research agencies, although there are increasing activities by the start-up and smaller companies that specialize in particular fields of research (Ng 5). It consists of the entity's research into new compounds that can be used for medical benefits and the refinement of those compounds into drugs that can be used by humans or animals. The annual payroll of an employee involved in the research and development services in the pharmaceutical industry averages \$71,173 and the receipts total about \$26.3 million over 6,119 establishments--an average of \$4,300,834 per establishment (U.S. Census Bureau)¹.

After a drug is fully developed, it moves to preclinical and clinical trials. In preclinical trials, the drug is tested in the lab and on animals for possibly adverse side effects. Only about five of the 250 compounds that enter preclinical testing make it to clinical testing. In Phase I, the medicine is tested in a small group of about 20 to 100 healthy volunteers to determine its safety, including the safe dose range. Then, in Phase II, about 100 to 500 volunteer patients participate in controlled trials to determine whether the medicine effectively treats the disease and to determine optimal dose strength and schedule (how often the drug is taken). Once the drug passes this stage, the drug moves into Phase III, where 1,000 to 5,000 volunteer patients take the potential new drug (or, for comparison purposes, a placebo or an existing treatment). Researchers closely

¹ For further statistics, see Appendix A

monitor patients to confirm that the drug is effective and identify any side effects. Even after all the years of studies leading up to Phase III trials, about half of the drugs that reach this point fail (Pharmaceutical Manufacturers of America).

If a drug manages to pass all of these stages and is approved by the FDA to be sold to the public, the drug then has to move into the manufacturing stage. At this point, the challenge of the production process is to construct or reconfigure the manufacturing facilities to meet FDA standards for Good Manufacturing Practice (Pharmaceutical Manufacturers of America). The company must also be sure that the drug that they could manufacture in small amounts is replicable in commercial amounts. Approximately 248,947 Americans work in the manufacturing sector of the pharmaceutical industry at an average payroll of \$55,386 per year in 1,829 establishments across the country (U.S. Census Bureau).²

Traditionally, the drug is then manufactured and sold to wholesalers and distributors. They in turn sell the drug to pharmacies and hospitals that in turn sell or prescribe the drugs to consumers. Increasingly, however, manufacturers have been attempting to sell directly to consumers, an issue that will be discussed in more detail later.

Innovative Trends within the Industry

The pharmaceutical industry has, for many years, been a cornerstone in Michigan's economy. However, the closure of two large Pfizer plants in Ann Arbor and Kalamazoo reflect the changing environment both for pharmaceutical companies and its clients.

Throughout the pharmaceutical industry, we see general trends that companies and consumers alike have been following.

² For more information, please refer to Appendix B

The Centralization of Pharmaceutical Production

First of all, pharmaceutical companies have been, in general, attempting to centralize more and more of the production process within large conglomerates. Usually this centralization involves companies buying up the companies that manufacture the biotechnology used in turn to manufacture its drugs (Lerer and Piper 46). The growing trend of pharmaceutical companies today is to seek to license products from smaller companies or buy such companies, to the extent that the acquisitions of biotech companies are at an all-time high and the prices they are fetching are on the rise (Pollack, “Pfizer, Hurt by Rival Generic Drugs, Will Lay Off 7,800). The main reason for these acquisitions is that most companies cannot find enough qualified individuals to create biotechnology, and because the core business of a pharmaceutical company remains drug, not software, development (Lerer and Piper 46).

However, pharmaceutical companies are finding increasingly innovative ways to bring more and more parts of the production process under their own roof. Some have even created multi-disciplinary bioinformatics groups that create and develop technology used to create and develop drugs, creating a “convergence of advanced technologies in information technology, engineering, and biological sciences” (Clapp 1).

Furthermore, the centralization process can be seen in the distribution process. Pharmaceutical manufacturers seeking to streamline the value chain have increasingly appealed directly to the consumer to sell their product, rather than using a wholesaler or distributor. This process is aided by the use of digital technology such as the internet and television to reach consumers directly. Direct-to-consumer (DTC) advertising brings FDA-approved information about prescription medicines to patients and families

(Pharmaceutical Manufacturers of America). In 2000, Johnson & Johnson, GE Medical Systems, Baxter International, Abbott Labs, Siemens, Medtronic and a range of partners formed the Global Healthcare Exchange (GHX), which allows hospitals and other healthcare providers to buy directly from a single website (Lerer and Piper 89).

The tendency to bring more and more of the tools into the company stems from the difficulty of trying to integrate hundreds of vendors, combined with varying standards and platforms. Many companies try to sway their partners to build tools according to Pfizer's standards, but integrating the systems is still a major task (Lerer and Piper 46).

By bypassing the wholesaler, these companies move to obtain more control of the sale of their products and eliminate distribution costs, even at the cost of their comparative advantage (Lerer and Piper 89-90). Furthermore, these companies have seen the centralization of their production process increase their sales. Research has shown that DTC messages educate consumers about conditions and symptoms that prompt many to visit their physicians. According to a recent survey, 43 percent of patients who visited their physician after seeing a DTC ad received a new diagnosis (Pharmaceutical Manufacturers of America). By centralizing their operations, pharmaceutical companies reap the benefits of economies of scale in operations and allow for the facilitation of internal communication channels. Centralization also allows companies to protect their research by providing a buffer to prevent leakages, thereby reducing the likelihood that a rival company will duplicate their work and isolating key techniques (Chacar 305). It produces widespread opportunities for the development and growth of companies engaged in drug development, medical implants and devices, agriculture and food

processing technologies, biosecurity, biofuels, and many other bioscience and bio-related applications. Says Donna Clapp, author of the article “Biotech Fuels Economic Success”:

Clusters of existing and emerging science-based technologies are crucial factors in shaping the economic winners and losers of the first half of the 21st century. To create international comparative advantage in a knowledge-based economy, clustering innovative activity is imperative (1).

The Personalization of Medical Treatment

Increasingly, pharmaceutical companies have also been moving towards creating products targeted to particular consumer groups. Because it has become easier and easier to duplicate high-profile ‘blockbuster’ drugs, pharmaceutical companies are beginning to find a greater incentive to develop many profitable products for individual segments that are harder to duplicate (Lerer and Piper 36). Furthermore, advances in medicine demand more personalized drugs. Researchers are now able to pinpoint a patient’s susceptibility to disease based on their genetic makeup, making it more and more likely that doctors will prescribe different drugs to different patients depending on their biological makeup and their medical history. Segmented medicine will result in more effective and safer (but more expensive) treatments for high-value patient segments (Lerer and Piper 36).

The personalization of medicine is characterized by three different approaches. One approach the pharmaceutical companies and biogeneticists use are pharmacogenomic tests, which predict the safety and efficacy of certain drug in any given individual. The trend to find ‘the right drug from the right person at the right dose’, as described by George Poste, SmithKlineBeecham’s retired chief science and technology officer, has been driving the “new paradigm in healthcare”. Also, the pharmaceutical industry is seeing the rise of pharmacogenics, which allows researchers to tailor drugs

more precisely to the genetic profile of patients being treated. Finally, disease-specific genetic tests and genetic databases are gaining increasing attention. Within decades, this storehouse could lead to a better understanding of how genes affect not only diseases, but also the medicines that treat them (Lerer and Piper 49).

The personalization of medicine holds many benefits for pharmaceutical companies. "Nonresponders" and patients who might experience ill effects might be excluded in advance by testing for specific biomarkers. Focus groups also make a drug benefit easier to spot. Because there would be less noise in data from the trial, it might also give an earlier readout on therapeutic failures, allowing company managers to kill a drug before the costs of late-stage clinical trials pile up. "You'll be able to weed out compounds early ... and quickly reduce clinical costs," says Frank Douglas, chief scientist at Aventis in Bridgewater, New Jersey (Service 1799). Furthermore, clinical trials offer options for building relationships, in areas ranging from cancer treatment to more lifestyle-oriented drugs. The result is a very different and certainly more cost-effective market research paradigm, where focused interactions with target customers will replace expensive generalized surveys (Lerer and Piper 63). In order to keep up with the trend, companies will have to produce smaller batches of highly customized products tailored to each patient's needs (Lerer and Piper, 80).

The Increasing Costs of Research and Development

The research and development of pharmaceutical products has been characterized by its inefficient and costly nature. The Pharmaceutical Manufacturers of America estimated that it costs about \$800 million to develop just one new medicine. Furthermore, it estimates that the total amount of money spent in biopharmaceutical research and

development topped \$51.3 billion in 2005. Much of this money is spent weeding out the ineffective or dangerous drugs: of 5000 compounds that show initial promise, 5 will go into human clinical trials, and only one will become an approved drug (Ng, 5).

There are many reasons why R&D costs are increasing. First of all, there has been an increase in the percentage of drug projects that fail in clinical trials. There has also been a trend toward bigger and lengthier clinical trials as well as a possible rise in the number of trials that firms are conducting (including trials for marketing purposes, such as to differentiate a product from its competitors). Furthermore, companies have shifted towards working on drugs intended to treat chronic and degenerative diseases. There have also been advances in research technology and in the scientific opportunities facing the pharmaceutical industry. In addition, the increased commercialization of basic research have contributed to research and development costs, as firms more often pay for access to basic research findings that in earlier years might have been freely available. Finally, there has been a lengthening of the average time that drugs spend in preclinical research (Congressional Budget Office).

The Explosion of Generics

Pharmaceutical companies have to combat the increasing availability of generic drugs. The Drug Price Competition and Patent Term Restoration Act of 1984, also called the Hatch-Waxman Act, opened the doors for generic-drug companies by eliminating the need to duplicate original research and development expenses. Under the system used today, the so-called innovator develops the original formula for a new drug. If approved by the FDA, the original patent holder gets a time period of exclusivity to sell the drug, up to 20 years. To cut health care costs, the FDA allows generic drug makers to make

drugs that are bioequivalent to the original brand-name drugs once the patent expires. That means the active ingredient in the generic works in the same way and with the same amount as the brand name drug. FDA mandates dictate that the generic also follow the same quality manufacturing standards and have similar labeling.

Generics appeal to consumers primarily because of its superior cost. Because entrepreneurs in the generic drug field do not have to pay the cost of research and development, and therefore do not pass those costs onto consumers, generic drugs end up costing about one-third the cost of brand-name drugs, according to the FDA(Dietderich, “The right prescription”). For this reason, many insurance companies and HMO plans will only cover generic medication as well, unless the physician prescribing the drug can give a concrete reason for why they prescribed the brand-name drug over the generic (personal interview, 23 February 2007).

Michigan’s Role in the Pharmaceutical Industry

The Industry’s Profile

Despite a business-friendly environment and strong growth across the life sciences sector, the Michigan pharmaceutical industry faces some unique challenges. With the loss of three major pharmaceutical R&D facilities and over 2,000 jobs, the news paints a grim picture of the industry. Retaining those highly skilled workers, creating new enterprise in the gap left by Pfizer, and strengthening linkages between educational institutions, private corporations, and state government will be important for future economic growth of the industry.

Michigan remains a leader in the life sciences industry, having a sound technology infrastructure, a large high technology workforce, and a pro-business

environment. With over \$2 billion invested in R&D annually, and close to 100 new companies in the past six years, Michigan has one of the fastest growing life science sectors in the country. It is also has the second most business-friendly climate, according to Site Selection Magazine (“Life Sciences Corridor”). The life science industry is comprised of over 542 companies that employ over 30,000 people. Michigan has led the nation in percentage growth of new companies, becoming the #2 state for overall R&D expenditures. The pharmaceutical industry itself employs 17,000 workers (Smith 27). For a comparison, the U.S. as a whole spent \$51.3 billion in R&D in 2005, and employs over 400,000 people around the country (PhRMA 2).

Key Companies

The Michigan pharmaceutical industry is comprised of both brand-name corporations, like Pfizer, and generic firms, like Caraco Pharmaceutical Laboratories, Ltd. Pfizer, the world’s largest pharmaceutical company, dominated Michigan’s industry since a merger with Pharmacia in 2003. Pfizer has several large R&D facilities in both Ann Arbor and Kalamazoo, as well as its largest manufacturing plant in Portage. Despite cuts of three facilities in Ann Arbor and Kalamazoo, Michigan will remain one of Pfizer’s largest locations. In addition to the manufacturing plant, their Veterinary Medicine Research and Development center will remain in Kalamazoo. The pharmaceutical industry is also represented by other, smaller companies performing R&D, clinical trials, manufacturing, and sales throughout the state.

Of the companies listed in Michigan, there are 21 pharmaceutical preparation manufacturing companies, 43 pharmaceutical and medical manufacturing companies, and 138 drug wholesalers, which include sales, distribution, and legal services (US Census

Bureau 68). A breakdown of companies by county indicates that there is clustering in several counties in south Michigan.³ Similarly, when one looks at member companies of MichBio, a non-profit organization that promotes the life science industry in Michigan, one also sees a clustering effect. MichBio lists 79 companies in Michigan, and categorizes them as either drug delivery, drug development, drug development tools, or general pharmaceutical firms.⁴ This agglomeration of pharmaceutical companies in only a few counties could be due to a number of factors. Biotechnology and pharmaceutical firms make location decisions based on proximity to universities, availability of a highly educated workforce, and a high quality of living. It has also been suggested that the regions in which pharmaceutical companies can thrive possess the following qualities: “the presence of major pharmaceutical companies, a rich talent pool, research infrastructure, a strong investment community, entrepreneurial support and available, suitable real estate” (Byrnes 1).

Research and Development

a. Industry Challenges

The Pfizer consolidation is representative of larger changes within the global pharmaceutical industry that are affecting Michigan. Drug development is a costly and time-intensive process, with companies investing more in R&D for a roughly linear amount of FDA approvals for the market each year. Additionally, companies need to recoup costs for the 5000 drugs they research for every one that makes it to the market. Big pharmaceutical companies, therefore, have relied on “blockbuster drugs”, or drugs that generate over \$1 billion of revenue annually, which account for one third of the

³ For a complete breakdown of pharmaceutical companies by country, see Appendix C.

⁴ For a visualization of the agglomeration effects in Michigan, see Appendix D.

current market. Pfizer is poised to lose \$14 billion in revenue when patents expire on two of its key drugs, Norvasc and Zyrtec, at the end of the year, and up to 41% of sales by 2012 (Kosmetatos 1), when it loses patent protection on Lipitor, the #1 blockbuster drug. When Pfizer halted development of torcetrapib, which was expected to replace sales of Lipitor, and no new breakthroughs in sight, the Ann Arbor facility, the one that developed Lipitor, was set to close (Kosmetatos 1). Pfizer's downsizing is an attempt to focus its efforts in a few key health areas. New advances in genomics and more personalized medicine will likely fragment the pharmaceutical industry even further in the coming years.

b. University Linkages

Since the pharmaceutical industry relies so heavily on innovative research, having a highly skilled workforce and research facilities are valuable resources. Not only does Michigan have a high-technology workforce, but Michigan "has become increasingly efficient at finding out what sorts of skills the area's life-science employers want in prospective employees, and then delivering them" (Smaglik) by forming linkages between private corporations and universities. Meetings between university administrators and company recruiters have been used to shape programs like Wayne State's MA in biotechnology. The program involves a year of coursework, a year of lab courses, and a summer placement in a local company (Smaglik). The program remains small, however, for though there are several hundred applicants, the program only accepts 18 students at a time. The program is beneficial both for students "who want to go into biotech [and] may need graduate training, but not necessarily a PhD and...

companies that need skilled people to perform research [who] will not necessarily need a cadre of PhDs” (Smaglik).

In addition to providing a highly-educated workforce, universities often provide the researchers, laboratories, and innovations that spawn new pharmaceutical companies. Professor Rawle Hollingsworth of the Department of Biochemistry and Molecular Biology at Michigan State University, used his campus research to create AFID Therapeutics, which is engineering chemical compounds as seed money for a pharmaceutical industry (Rook 1). MSU has helped launch over 40 high-tech companies in the past quarter-century, and there is evidence that the local industry is gaining more momentum (Rook 1). Over half of the new firms created have been developed in the past five years. Professor Milton Smith, of the Department of Chemistry at MSU, has developed a chemical compound that makes drug synthesis, like that of Lipitor, more efficient and less costly. Smith was awarded a \$1.38 million dollar grant to support increased production of the compound by his fledgling company BioPharm, which may have cross-over applications to other technology industries (MSU Newsroom). The 21st Century Jobs Fund Awards were established to promote this kind of research in order to diversify the state’s economy (MSU Newsroom). Programs like the 21st Century Jobs Fund are important to provide the start up capital to make commercialization of such innovations possible.

c. Research Park Linkages

There are 11 SmartZones and 7 Business Accelerators in Michigan to assist pharmaceutical companies develop and commercialize products by offering laboratory space, equipment, and funding to startup companies. The Core Technology Alliance

allows institutions to share resources and expertise to provide firms in agglomerated areas with competitive advantages in research and development. The Michigan Biosciences Industry Association also supports growing companies through meetings, networking, education, and career opportunities. The Biosciences Research and Commercialization Center at Western Michigan University has provided \$1.9 million for 9 new biotechnology firms, for example, and the Center for Applied Research and Technology at Central Michigan University is developing programs in nanotechnology to improve drug delivery and gene therapy.

The Michigan Life Sciences Corridor, created in 1999, provides similar funding in the range of \$1 billion annually toward developing Michigan's life sciences research and commercialization capabilities (Kerppola 1109). A commercialization grant for ApoLife helped the Detroit-based company into the recombinant-protein business. Of 22 high-tech companies started in Michigan that year, most received help from the corridor (Smaglik). The Corridor also funds SmartZones, a network of technology research parks located near universities, services for entrepreneurs like recruiting assistance, and six funds investing in early-state life science ventures (Kerppola 1109). The Van Andel Research Institute, supported by a \$60 million dollar endowment, has attracted investigators and researchers to Grand Rapids, an area with little scientific activity before the facility was erected (Smaglik). Targeted practices like these are essential to an R&D intensive industry like the pharmaceutical industry because of the high costs involved at start-up, and the long timeframe before products are developed.

These kinds of university linkages, research facilities, and funding opportunities have empirically had success in bolstering Michigan's pharmaceutical industry. When

Pharmacia merged with Pfizer in 2003, there were thousands of job cuts in the Kalamazoo area. The city “launched an aggressive campaign to retain laid-off scientists, with impressive results” (Menendez 1). The community raised \$64 million to create an innovative campus for Western Michigan University that would house not only the school, but the Southwest Michigan Innovation Center, a high-tech/lab business incubator, and the Biosciences Research and Commercialization Center, a center for commercialization expertise and research support ventures (Menendez 1). Over fifteen companies were developed within half a year, most of them located inside the park.

If Michigan is to retain the scientists recently laid off, it must provide incentives for them to stay in Michigan, as opposed to leaving for other Pfizer locations. The scientists have the technical skills to develop new products, but may need assistance with the business end of research. Programs like the Michigan Small Business and Technology Development network can provide the kinds of services that individuals would need for an emerging company, including IP protection, financing, management team planning, and commercialization strategies.

d. Linkages to Other Industries

The pharmaceutical industry is becoming increasingly linked to other industries, such as the biotechnology industry. Large U.S. firms like Johnson & Johnson have expanded the scope of their products from pharmaceuticals to incorporate medical devices into some of their divisions, for example, to take advantage of areas of intersecting research. Smaller companies, too, are forming the same kinds of collaborations. AureoGen, a company formed out of the Pharmacia-Pfizer merger in Michigan, is involved in the genetic engineering of antibiotics, and has formed a

partnership with Takara Bio Inc, a Japanese biotech company that focuses on genetic engineering research (“AureoGen Biosciences”). This linkage allows both companies access into international markets, access to technology transfers, and access to a broader range of information that allows each to take advantage of economies of scale. Cross-cutting collaborations are not limited to the private sector, however. Stemming from an agreement between the U.S. and Japan for increased cooperation in science, Michigan State University worked with several Japanese biotech firms on the environmental applications of biotechnology. Interactions between corporate laboratories and universities have fostered research exchange and technology transfers (Committee on Japan 36). Other signs of the convergence of the pharmaceutical and biotechnology industries include commercial meetings like the “Life Science/Biotech: Why Here, Why Now?” Conference held at the Ann Arbor IT Zone. The event included speakers like the vice president for Medical Affairs at the University of Michigan and the executive director at Pfizer in Ann Arbor. “We're fortunate to have these world-class research scientists so close at hand and willing to share their insights and perspectives on the growing commercialization of biotechnology,” said Claudia Rast, chair of the 2002 IT Forum events for the IT Zone. “The event and the sponsors represent a real convergence between the technological and life science communities,” she added (Erickson 1).

Sales

Despite a positive business environment in life sciences, the pharmaceutical industry has been targeted by lawmakers in Michigan by government officials who favor lower drug costs for Michigan consumers. Representative John Dingell, one of the industry’s critics, is a key player in shaping healthcare legislation. He is lined up to chair

the Energy and Commerce committee, which oversees most healthcare issues, and is “already mapping plans for aggressive oversight of the FDA and the Part D drug benefit, [on] which he is strongly opposed” (Wechsler). Senator Debbie Stabenow has long been a proponent of lower brand-name drug costs, lobbying against the pharmaceutical industry and even organizing bus trips to Canada to purchase drugs. Both her and Senator Carl Levin were instrumental in helping the Senate to pass a measure to allow people to buy prescription drugs from Canada. This has allowed both internet pharmacies and drug re-importation to burgeon into multi-billion dollar industries.

Canadian drugs are less expensive because Canada has a single buyer system, as opposed to the U.S. multi-buyer system. In this system, the government is the sole purchaser of drugs. The Canadian government also pressures pharmaceutical companies to offer rebates on drugs to keep costs down. This system may be beneficial for consumers in the U.S. because it allows them to purchase drugs at a lower cost. Additionally, it may benefit state governments who cover Medicaid prescription drug costs if they can import drugs at a lower cost. Drug re-importation, however, has a detrimental impact on the Michigan pharmaceutical industry. It is estimated that the total effect on the industry produced 2,000 pharmacy and manufacturing job losses and lost sales of up to \$450 million (Parloff 1). While U.S. pharmacy losses are offset by Canadian pharmacies, manufacturers losses are not. The \$987 million in lost payroll revenue in 2005 also has spillover effects (Parloff 1). It discourages companies from investing in R&D because they will have less revenue to do so. It is approximated that for every pharmaceutical job created or lost, 6 additional spinoff jobs result. A downturn in the pharmaceutical industry can have widespread implications for other sectors.

New Jersey as a Competitor

New Jersey is traditionally viewed as the “medicine cabinet” of the U.S., due to the concentration of pharmaceutical companies located within its borders. It is not just the size of the industry, however, that has made the state a dominant force, but a strong infrastructure on multiple fronts. New Jersey possesses a highly educated workforce and the educational institutions to support continued development of labor and promote research. The pharmaceutical industry is becoming more vertically integrated as companies are centralizing all stages in production, as well as forming linkages with other key industries in the state, such as biotechnology and agriculture. The government also continues to place a strong emphasis on bolstering the industry with specialized initiatives, programs, and incentives for economic growth.

Sales from pharmaceuticals produce \$700 billion in revenue each year, 20% of which is then reinvested into research and development. That research investment, half of the total U.S. investment, produces about half of the drugs approved by the FDA each year (Khan 1). For New Jersey, that creates revenue for capital investments, charitable donations, clinical trials, and more research ventures. New Jersey is the largest biotechnology center in the U.S., harboring the headquarters of 15 out of the 25 largest drug companies in the world, both domestic and foreign (Khan 1). In addition to 15 of the top companies, 75% of the world’s other leading pharmaceutical companies have regional offices, research and development facilities, product development centers, or manufacturing plants located there (Quinn 1).

Key Companies

The New Jersey pharmaceutical industry is dominated by large companies. Of the top 11 companies, according to a healthcare review in 2005, all but #8, AstraZeneca, a UK-based company, have facilities in New Jersey. GlaxoSmithKline, the #3 company, has a major manufacturing site for consumer products in Clifton, NJ. Sanofi-Aventis, the #4 company, has a Bridgewater, NJ site that covers all aspects of its U.S. research and development. Pfizer, the #1 company, built a new research and development complex there in 2005 with the aid of state incentives. The state gave Pfizer tax exemptions under its Business Retention and Relocation Grant program when it approached Pfizer to bid for their expansion project (Smothers 6). Despite downsizing occurring throughout the industry, these companies have retained their New Jersey locations. A representative from Johnson & Johnson, the #2 company, said that "over the long term, New Jersey is a state in which we're strongly committed. You're probably going to see our commitment to New Jersey as a state grow over time." (Warner 1).

R&D Linkages

The size and commitment of the New Jersey industry can be attributed to a variety of positive factors, including easy access to major transportation arteries, a high quality of life, and a highly-educated, well-trained workforce (Levy 1). In 2002, the average salary of a pharmaceutical worker was \$80,439, higher than any other sector of the economy, which suggests that the workforce is highly valued. Additionally, while pharmaceutical companies need infrastructure, facilities, and a positive business climate, "biotech runs on brilliance...that reliance on brain power is embedded in every aspect of their corporate culture" (McCandless 2003). At every step of the value chain, the industry

requires people with advanced degrees and specialized skills. The pharmaceutical industry employs over sixty-two thousand people at 115 facilities in the New Jersey. A profile of these employees reveals that they are mostly scientists, administrators, manufacturers, and sales and marketing supervisory staff.

New Jersey has more scientists per capita than any other state, and ranks 8th for educational achievement of individuals 25 years of age and older. “Much of that educational attainment can be credited to New Jersey’s network of educational institutions” (McCandless 2003). New Jersey’s universities produce 3000 graduate engineers and 8000 graduate science students each year, some of which come from specialized programs like pharmaceutical management at Rutgers University and pharmaceutical sales at the College of New Jersey. The state government has put more emphasis on developing university resources in recent years, providing money through its Technology Workforce Program and the Commission on Jobs Growth and Economic Development, which is dedicated to maximizing job opportunities in research-based and high-technology industries. Ten research centers are located in the major universities, providing not only potential employees, but opportunities for research and development collaborations.

The pharmaceutical industry depends on innovation, and to support new developments, strategic alliances with manufacturers, academic institutions, and other organizations play a key role. Approximately 24% of the \$7.5 billion in research and development is tied to strategic alliances in New Jersey institutions. Of the 900 listed current clinical trials, 30% are sponsored by the National Institute of Health, and 10% by universities, the Center for Disease Control, or the Department of Defense. To increase

awareness of novel therapies, the state also allocated funds to the Cancer Institute of New Jersey for a clinical trial matching service for New Jersey cancer patients (Brice 24). This trend is expected to grow as companies set the stage for further growth.

Linkages with Other Industries

The New Jersey pharmaceutical industry is also poised for growth across other industries. The pharmaceutical industry alone is the largest manufacturing employer in the state, and for every job created within the industry, six additional spin-off jobs are added in other sectors. The industry is also branching out. Mark Lapping developed a food infrastructure program for nutraceuticals, or drugs derived from food, at Rutgers University. Since New Jersey is such a huge center for chemical and pharmaceutical research, which includes agrichemicals, researchers “began to consider how to develop R&D opportunities to help the pharmaceutical industry use more of the food [they] grew in New Jersey” (Terrerri 1). These new technologies also have uses in the food and beverage industry. Companies developing odor modulation technologies are applying biotechnology principles to consumer oriented markets for new products (Gilbert 1044).

State Initiatives

New Jersey has a difficult time recruiting businesses because, according to the New Jersey Business and Industry Association, over 90% of firms surveyed said that New Jersey has higher taxes, health-care costs, and government spending, which discourages new enterprise (Mansnerus 1). To counteract these factors, the state has created a number of programs that target high technology industries, like the pharmaceutical industry. The Business Employment Incentive program lowers the threshold for job eligibility for biotechnology firms, enhances workforce training and

development, and provides over \$16 billion in private capital investment to pharmaceutical companies (Building a Better New Jersey 1). Under the New Jersey Economic Development Authority, one company, Tris Pharma, is using \$2.9 million in bond financing to increase research space and add jobs. The program allows them to control their manufacturing and better protect their technology interests (Building a Better New Jersey 1). Business Retention and Relocation Assistance Grants have allowed 3 of the largest companies to invest over \$650 million in constructing new research and development, PILOT manufacturing, and headquarters facilities (McCandless 1). Together these programs have aided in retaining more than 12,000 jobs and generating \$1.1 billion in private investments (McCandless 1).

Dealing with Competition

Pharmaceutical companies are expanding abroad to find less expensive ways to do early drug research and development and to enter new markets. Of the companies located in New Jersey, at least 20 have other facilities in Asia. In Singapore, those facilities either do R&D or clinical trials because those activities are more secure and less costly. To avoid losing businesses to overseas competitors, Governor Corzine is promoting “research that can be done in universities in New Jersey and Singapore in conjunction- particularly stem-cell research and other advances in biotechnology” (Khanna 1). Gov. Corzine visited places like the Agency for Science Technology and Research (A*Star) to investigate areas where synergies between the two locations are possible. To avoid losing drug development processes to offshore competitors, New Jersey is also strengthening its workforce to be able to continue to compete globally.

Despite a wide-reaching educational network, New Jersey faces domestic competition as well. States like California are experiencing rapid growth in biotechnology sectors, mostly in small and midsize companies. New Jersey, on the other hand, has not been able to attract smaller pharmaceutical companies. Richard Goldberg, of the New Jersey Science and Technology Commission, believes it is because the state has underinvested in university facilities (Mansnerus 1). Even when New Jersey was the first to commit \$5 million in grants to stem cell research for 17 teams at research institutions across the state and establish the New Jersey Stem Cell Institute, California adopted a similar initiative, although it has yet to spend the money (Clapp 1). In addition, while New Jersey ranks third in private investments, it lags behind other states in NIH and public funding. California, alternatively, has been aggressively bringing small companies to the state. New Jersey has since founded the Commercialization Center for Innovative Technologies, which provides cost-efficient laboratory spaces for young companies in life sciences. This center is part of a larger project to promote scientific achievement to keep New Jersey at the forefront of the life sciences field (Hallock 1).

New Jersey's pharmaceutical industry faces many new challenges as the industry is evolving: increased time, cost, and difficulty in the R&D stages, the increased use of specialized medicines to treat and prevent diseases, an increased focus on access and affordability of medicines, and the protection of intellectual property. But New Jersey's unique combination of pharmaceutical infrastructure, educational research facilities and expertise, ties to other industries, and political support will advance the industry into the future.

Canada as a Competitor

The pharmaceutical industry is one of the most innovative and profitable industries in Canada. Innovation in the pharmaceutical industry is highly valued because of its highly skilled workforce, university and hospital linkages, philanthropic donations, and reduction of costs to the national health care system. Supportive government policies and major biosciences clusters have the industry poised to grow relative to the global industry as the fourth fastest growing market.

Industry Profile

Canada has 2% of the world market in pharmaceuticals, which make it the 8th largest country in terms of sales, and 4th fastest growing market at 10.7% each year, behind China, the U.S., and Spain (Rosborough). This market represents almost \$10 billion in sales annually. As compared to other domestic industries, it is the fifth largest of high knowledge industries. Canadian pharmaceutical companies accounted for 10% of new drug discoveries in 2001, despite only having 2% of the of the world market (Rosborough). The industry employs over 31,000 workers: 20,000 in the brand-name companies, 7,000 in bio-pharmaceutical firms, and 4,500 by generic manufacturers (Rosborough). These workers are both highly skilled and highly paid.

Key Companies

The Canadian pharmaceutical industry is comprised of brand-name multinational corporations, Canadian bio-pharmaceutical firms, and both foreign and domestic generic companies. The industry is dominated by brand-name corporations, who represent 85% of the industry, and generic companies represent the other 15%. Although none of the top 50 pharmaceutical companies have their global headquarters in Canada, the top 10

multinational firms comprise 60% of drug purchases in the Canadian market. The top 5 companies account for 40% of the market, of which Pfizer, the largest company, has increased its sales lead (Rosborough). There are two firms that dominate the generic market: Apotex, which is Canadian-owned, and Novopharm, part of an Israeli company. They comprise 5% and 2% of the world market, respectively (Chetan). Other leading companies also have research and development facilities mainly located in Montreal and Toronto, due to major bioscience clusters and supportive government policies. AstraZeneca, the #8 company according to a 2005 healthcare review, and GlaxoSmithKline, the #3 company, have increased funding to support asthma research at the St. Joseph's Healthcare/McMaster University's Firestone Institute, for example (Chetan).

Research and Development

The pharmaceutical company is one of the most R&D intensive industries in Canada. Creating an innovative drug for market can take between 10-12 years and \$200-\$300 million (Chetan). Generic drugs take between 2-3 years for R&D and cost \$1-\$3 million. The total spending for R&D increased to \$1.43 billion in 2003 (Chetan). Thirty-one pharmaceutical companies are listed in Research Infosource's Top 100 R&D spenders in 2003. Apotex, 13th on the list, spent \$153 million, and Pfizer Canada, ranked 14th, spend \$152 million on R&D. Despite these increases, the Canadian pharmaceutical industry lags in R&D performance, since the ratio of research to sales has remained level over the past decade. In other industrialized countries, the level of R&D has dramatically increased relative to innovative drugs on the market.

Pharmaceutical companies are localized in Ontario and Quebec because of biosciences clusters and favorable provincial policies. Quebec's government is working to foster linkages between universities, teaching hospitals, clinical research networks, and the private sector to create North America's largest hospital facilities involving three hospitals in Montreal. Quebec also has low labor costs and high tax credits for R&D firms, which make Montreal one of the most competitive cities in the country. Twenty-seven pharmaceutical companies are located in Ontario due to similar linkages and benefits. AstraZeneca, for example, works with the Northern Ontario School of Medicine with assistance from the Northern Ontario Heritage Fund Corporation, creating research opportunities for students and for the company (Chetan).

Manufacturing

Canadian pharmaceutical manufacturers' sales revenue has increased 11.5% over the past 4 years (Rosborough). Patent protection in Canada is comparable to other industrialized nations, at 20 years, with about 8-10 years left on the patent by the time the drug comes to market. 1993 legislation was enacted to extend patent protection to big pharmaceutical companies in exchange for a pledge to boost R&D spending in Canada. This has come into effect only in the last several years as generic drugs from Canadian pharmaceutical companies were "grandfathered" in, and companies had to wait until they came up with new innovations for them to be protected ("Apotex investment welcome"). Even though New Jersey is recognized as the pharmaceutical capital of the world, GTA is now recognized as a kind of second-tier capital of drug research and manufacturing, as it hosts the headquarters for homegrown companies Apotex and Biovail, and branch plants for GlaxoSmithKline, Bayer, and AstraZeneca ("Apotex investment welcome").

Sales

Likewise, drug export revenues have doubled in the past decade, with 85% of exports being sent to the United States. Despite the rise in exports, however, Canada has a growing trade deficit in pharmaceuticals. Both the rise in sales and importation may be explained by two developing trends in pharmaceutical sales. While Canadian drug prices are comparable to other industrialized countries, the price of patented drugs is lower than in the U.S. Internet pharmacies have become popular with U.S. residents for this reason, with sales rising to \$600 million in 2003 (Parloff 1). This development is a key concern to brand-name companies in both markets who are losing revenue due to the price differential. Additionally, many individuals, especially on border states, go to Canadian pharmacies for drugs for their personal use, and then “reimport” them to the U.S. Pharmaceutical companies claim that while the cost of manufacturing additional drugs is insubstantial, R&D expenditures are no longer covered. While beneficial for U.S. consumers, pharmacies and manufacturers are losing out on revenue.

China as a Competitor

Though the opinions about China as a friend or a foe to the United States are diverse, one opinion seems to be agreed upon by everyone who talks about China—it has become one of the most formidable contenders in the global economy today. China’s intimidating presence stands firm in the pharmaceutical industry, mainly in the field of generics. An estimated 97% of the drugs (excluding traditional Chinese medicines) produced by local companies are generics or counterfeit (“Investing in China’s Pharmaceutical Industry” PricewaterhouseCoopers).

Manufacturing

This focus on generics has created a number of problems for the US pharmaceutical industry. First, American pharmaceutical companies are quickly realizing that the local competition far outstrips them—they are able to make the same drugs at a fraction of the cost that the multinationals produce the drug. Though the drug's effectiveness is slightly less potent, the market shows that a patient's choice of drugs is driven by affordability and access, including whether the drugs are included on the reimbursement lists which the government uses to regulate drug pricing (“Investing in China's Pharmaceutical Industry” PricewaterhouseCoopers), not necessarily the potency or the safety of the drug. So, the Chinese generics have exactly what the patients are looking for—low cost. Chinese drug makers do not share the development costs, liability costs and quality assurance costs of global players because the drug approval system in China is both less intensive and less pervasive in China (“Investing in China's Pharmaceutical Industry” PricewaterhouseCoopers).

Part of the problem lies on the Chinese industry's reliance on counterfeit pharmaceuticals. However, since China acceded to the WTO in 2001, it has agreed to uphold the Trade-Related Aspects of Intellectual Property rights (TRIPS) Accord and strengthen its protection of intellectual property rights (“Investing in China's Pharmaceutical Industry” PricewaterhouseCoopers).. And it seems to be upholding its end of the bargain--in 2004, 2,550 patent litigation cases were filed in China, and courts found in favor of more than 80% of the foreign patent holders that filed, experts say (Seewald).

But, the Chinese government's new strategy seems to move more towards cheaper goods than to uphold intellectual property rights. China is in process of convening a number of meetings to develop what China's State Intellectual Property Office (SIPO) refers to as an "IPR strategy". The IPR strategy is a radical approach to IPR, which seeks to develop or appropriate formulas, know-how, and trade secrets—not to create IP value, but to make manufactured goods cheaper ("Investing in China's Pharmaceutical Industry" PricewaterhouseCoopers).

Despite this competitive detraction, however, multinationals still cannot resist the call of China's growing consumer market. As of 2006, multinationals have over 600 active joint ventures in China and most global industry giants have a China presence: Johnson & Johnson, Roche, Novartis, GlaxoSmithKline and Pfizer are some of the largest players in the industry ("Investing in China's Pharmaceutical Industry" PricewaterhouseCoopers). For the most part, these ventures occur in the manufacturing end of the value chain. More than 3,700 manufacturers are certified in Chinese Good Manufacturing Practice (GMP) standards and provide 90% of the country's total drug revenues (Agres). Furthermore, to date, these companies are still only devoting a part of its production process to China. Western companies still develop their manufacturing process in the West and then transfer bulk API manufacture to China or India, BridgeNet says (Seewald). However, it's not for a lack of cost-cutting benefit--outsourcing non-cCMP steps to a key intermediate in Asia can reduce total cost of drug manufacture by more than 40%, Joyce says (Seewald).

Today, China is home to more than 400 biogeneric manufacturers, which mainly develop and manufacture generic biopharmaceuticals for the domestic population

(Langer and Zhou). However, as the industry grows, it will begin to export its goods. In 2005, China exported \$478 million of biopharmaceuticals to foreign countries, a 54% growth over the previous year. Tonghua Dongbao Group, the domestic recombinant human insulin manufacturer in China, has been exporting insulin to Germany, Italy, Egypt, Mexico, Russia, and other countries, and has generated \$30 million in foreign income since 2001. Though this is not a significant figure by Western standards, but it shows that Chinese biotherapeutics can be sold internationally (Langer and Zhou). So, manufacturing in China is a beast to contend with.

Research and Development

Though China has found its strength in the production of cheaper products, it is still weak on the research and development. An integrated environment that favors enterprise innovation has not completely formed in terms of new drug approval, drug price management, taxation policies, and biopharmaceutical contract manufacturing.

However, recognizing its weakness, the Chinese biopharmaceutical industry is beginning to establish itself as a “research-driven, domestic, market-oriented industry”. The government is increasing investment in the biotechnology sector through a number of policy shifts that focus government funds on research and development. The Chinese government has been building biotechnology parks and funding research projects. China's "863 Program," a government program aimed at supporting early-stage technology projects, has been successful in funding promising R&D projects (Langer and Zhou). The 863 program was first formulated in 1986 and approved by the famed architect of China's move to the free market, Deng Xiaoping. Since then, it has been continuously re-approved in successive five-year plans, the latest being in the 10th Five-Year Plan in April

of 2001. It aims, in the coming years, to develop key pharmaceutical technologies to improve the welfare of the Chinese people and master key new materials and advanced manufacturing technologies to boost industrial competitiveness (“S&T Programmes”). Beyond the 863 Program, the Chinese government has also been fighting to keep its scientists in its borders to promote greater scientific innovation. For example, according to the United States-China Economic and Security Review Commission, established by Congress, the Chinese government offers "incentives for talented Chinese students and researchers studying and working overseas to return to China" and transfer the information and technology they've acquired. The total funding that the Chinese national government devoted to pharmaceutical research and development reached 270 million Euros (\$320 million) in 2004, said Wang Hongguang, director general of the China National Center for Biotechnology Development. All of these policies and initiatives suggest that the Chinese government is, now more than ever, increasingly refocusing its efforts to promote China’s pharmaceutical research and development. And this trend seems to see no end. Ted Agres, author of the article “Foundations for Chinese Pharma”, suggests that by 2010 China will be investing a higher proportion of its gross domestic product in research and development than will the European Union (EU). In 2003, China invested 1.31% of its gross domestic product in R&D, compared to 1.93% for Europe, 2.59% for the United States, and 3.15% for Japan. But since that time China's growth has been increasing by about 10% annually (Agres).

All of its focus on research and development seems to be paying off. Chinese companies have developed and commercialized 30 biotech drugs to date (Langer and Zhou), including an approved gene therapy treatment (Agres). Furthermore, 150 more

biopharmaceutical products are in clinical trials. Over the next five years, 40 new, never-before-seen-in-the world biopharmaceuticals are expected to complete clinical trials and enter the market (Langer and Zhou). So, though China is still weak in the research and development area, it is moving to correct its weakness and become a formidable competitor.

Wholesale/Distribution

China's wholesale and distribution sector of the pharmaceutical industry is characterized by the difficulty of being able to track where products are going and how they get there. Up to 80% of all Western-style drugs are thought to be distributed through hospitals and clinics, though the broader the distribution base, the more difficult it becomes to track goods. The remainder is sold through pharmacies. Hospitals in China depend on drug sales for more than 80% of their revenues ("Investing in China's Pharmaceutical Industry" PricewaterhouseCoopers). Because hospital revenue is so dependent on drug sales, the hospitals favor locally-produced generics, which tend to be cheaper. To be able to sell to the hospitals, drug makers are obliged to offer a significant margin to middlemen and distribution companies or provide incentives for hospital officials and doctors to prescribe their drugs. This complicates the distribution process for multinationals by forcing them to participate in corruption in order to sell their product ("Investing in China's Pharmaceutical Industry" PricewaterhouseCoopers).

Furthermore, some multinationals have little idea where as much as half of their product is actually being sold outside the hospital chain. China's vast geography has made it difficult to build and maintain an efficient transportation infrastructure. At the same time, the traditional state-owned distribution system, which emphasized provincial

and local networks with few links to other regional markets, has hampered the creation of a truly national distribution system (“Investing in China’s Pharmaceutical Industry” PricewaterhouseCoopers).

However, moves are being made to streamline and de-corrupt the distribution of pharmaceuticals. The central government is encouraging the development of retail pharmacies in a bid to separate the functions of prescribing and dispensing—and so to limit over-prescription of drugs (notably antibiotics) and the often exorbitant mark-ups on drug prices by hospitals. PricewaterhouseCoopers, an internationally recognized consulting firm based in New York, predicts that the pharmaceutical sector will see the emergence of specialist distributors and third-party logistics providers, or (3PLs). They predict that local and international 3PLs will be able to help multinational drug makers streamline supply-chain management in China as they have done in other countries, enabling them to identify and address inefficiencies in the distribution chain (“Investing in China’s Pharmaceutical Industry” PricewaterhouseCoopers).

Consumers

Obviously, as a large country, China is a significant market for pharmaceutical companies. China's economy is growing at an annual rate of 8.8%. However, it has an immature medical insurance system: two-thirds of Chinese citizens are not yet covered by any kind of medical insurance. The Chinese spent less than \$20 per capita on medications in 2003, compared with American per capita spending of \$700 in the same year. Therefore, the Chinese market is, in an intractable way, more likely to buy inexpensive generic drugs. However, the Chinese consumers' ability to afford more expensive biopharmaceuticals, especially novel biopharmaceuticals, is also increasing. Its middle

class is expanding and is now about the size of the population of the UK or France (Langer and Zhou). So, as China's population grows, it will become an even more important market for both the makers of generics and for those pharmaceutical companies looking at producing innovative medication.

In many ways, China faces some of the same problems as Michigan. Like Michigan, China has an economy that relies heavily on manufacturing. To increase its research and development, Michigan could learn from some of the policies that China has enacted, particularly China's incentives program to students who stay in China and China's 863 program, which has a particular focus on the pharmaceutical industry. By focusing on its two biggest goals, brain retention and business creation, China stands to become one of the biggest research and development centers for pharmaceuticals in the world. Michigan stands to gain some of the same benefits by enacting an incentives program for its students, especially since Michigan houses some of the top universities in the country.

Pharmaceutical Industry Regulations and Incentives: Michigan

Within Michigan, there are many organizations that are involved in the facilitation of entrepreneurship and of economic development, especially in the life sciences sector. Though each organization has a particular geographical area of strength (except the MEDC, who is spread out throughout the state), all of the organizations are trying to be the one-stop shop within their region.

One of the most prominent economic development organizations in Michigan and the one that purports the most to be a one stop shop is the Michigan Economic Development Corporation. The MEDC was first formed in 1999 through an alliance

between the State of Michigan and several local communities. It represents a more evolved form of its predecessor, the Michigan Jobs Commission, which was the state's original economic development department (Medc.org). They claim to be a one-stop resource for both emerging businesses and established companies that are considering relocating to Michigan, and its website provides many resources for the business world. Of particular interest to those in the pharmaceutical industry is its state license search, which provides a list of licenses needed for pharmacies, pharmacists, medical equipment and medical products to establish themselves in Michigan. Furthermore, it places a particular focus on the life sciences industry, listing the strengths of the life sciences industry in Michigan and providing a list of resources available to those involved in the industry.

Though the MEDC's website provides a lot of useful information to pharmaceutical companies through its website, it does not provide a lot of in-person consulting specifically for start-up pharmaceutical companies. Instead, it relies on the SmartZones to provide personal service to those who are thinking of starting pharmaceutical companies in Michigan. The SmartZones consist of collaborations between universities, industry, research organizations, government and other community institutions. It intends to stimulate the growth of technology-based businesses and jobs by aiding in the creation of recognized clusters of new and emerging businesses. In particular, they focus on commercializing ideas, patents and other opportunities surrounding corporate, university or private research institute R&D efforts in order to stimulate entrepreneurship ("Michigan SmartZones").

However, each of these SmartZones tends to focus their efforts on their own regions—they do not actively seek to help entrepreneurs outside of their region. Though some SmartZones work together, more often they tend to compete between each other to attract businesses to their area. The MEDC could fill the gap that the SmartZones create in their race to be competitive by helping the regions that have been perpetually left behind in the fight to create Michigan business (like the Mid-Michigan and the Upper Peninsula) but as of yet there has been no push to do so. MEDC says that it serves all of Michigan, but because it has relied on the SmartZones to provide on-site business aid, regions without a strong SmartZone have been left behind. This has been especially true for the pharmaceutical industry, which, as described earlier, highly benefits from agglomeration economics and tends to centralize in Western and Southeast Michigan, thanks in part to the strong SmartZones in Kalamazoo and Ann Arbor.

Western Michigan's Business Technology and Research Park, based in Kalamazoo, boasts the most comprehensive program for those seeking to enter the pharmaceutical industry in Michigan. The park houses two important resources for start-up pharmaceutical companies: the Southwest Michigan Innovation Center and the Biosciences Research and Commercialization Center ("About the Park"). Together, these two resources have proven to be some of the most powerful forces in creating pharmaceutical companies in Michigan.

The Southwest Michigan Innovation Center is a high tech business and wet lab incubator geared specifically towards the pharmaceutical industry. It allows pharmaceutical start-ups to rent office and wet lab space in their facility at reduced rates, giving new companies the time to develop before they enter the 'real world' of business

competition. It also gives these companies access to equipment that is usually too expensive for a new company to purchase, either as part of their rent or for a small fee.

The Biosciences Research and Commercialization Center was established in 2003 when Governor Granholm presented Western Michigan with a \$10 million check. The Center was conceived by the governor as a way to keep Pfizer employees in Michigan after it merged with Pharmacia, and promote a pharmaceutical heritage for the state (Newspaper). It applies its “pharmaceutical expertise” to provide development assistance and facilities to emerging life science industries. It also provides a database of Michigan consultants and companies involved in the life sciences industry, including pharmaceutical and medical technology companies. Its executive director, Dr. Jack R. Luderer, is a physician by trade and has spent more than 20 years in pharmaceutical research (<http://www.brcc.wmich.edu/>). Since its inception in 1999, nearly \$100 million has been granted to 63 life sciences projects at Michigan-based universities, research institutions and businesses. More than 500 proposals for more than \$600 million have been received for this competitive grant program. The BRCC’s competitive grant program makes it a considerable asset to Michigan’s pharmaceutical industry.

The Ann Arbor/Ypsilanti SmartZone, in partnership with Ann Arbor SPARK, has had a particular role in the pharmaceutical industry after Pfizer shut down its 177 acre campus in the area. It has rounded up its resources to encourage those laid off or who may be relocated by Pfizer to start their own business in Michigan instead, including access to its business accelerator, a pre-seed capital fund, the Michigan Innovation Equipment Depot, career events, job postings, career change boot camps, a Wet Lab incubator and business attraction and retention services. It has also partnered with

Governor Granholm, MEDC, University of Michigan, Michigan Works!/ETCS, Michigan Venture Capital Association, MichBio, and local, county and state units of government, chambers of commerce and convention and visitors bureaus to create Pfizer Strategic Working Action Teams (SWAT). The SWAT teams intend to aid displaced workers from Pfizer Inc.'s Ann Arbor campus.

Michael Finney, the president of Ann Arbor SPARK, has stated in a podcast that over 25% of Pfizer colleagues have contacted them about staying in Ann Arbor. The SPARK blog, as of March 2, 2007, had stated that it had been able to connect with over 30% of those affected by the Pfizer lay-offs, and that it has collected 500 resumes from Pfizer colleagues who want to stay in the area and are seeking job opportunities that would permit them to do so. 19 employees in small employee groups (in groups of five or less) have contacted SPARK were interested in forming companies. As far as the 177 acre campus, Finney mentions that he would like to see the facility distributed to a mix of small, medium and large businesses, as well as many start-ups. He also mentions that he would like to see part of Pfizer property to use as a long-term incubator with University of Michigan and with other universities. Because the facility is essentially as large as Downtown Ann Arbor, there are infinite opportunities for the facility to become as densely developed as the city as well.

Detroit's SmartZone, known as TechTown, also has remarkable resources for pharmaceutical companies and start-ups. In particular, they boast of their affordable office, wet lab and dry lab space, business and technical resources, Internet 2 capability, access to investors, custom designed work environments and a supportive community of entrepreneurs. Of particular interest to pharmaceutical companies is its close proximity to

major research institutions, including Wayne State University, Henry Ford Health System and Karmanos Cancer Institute. Asterand, the leading supplier of high quality human tissue samples for medical research, was TechTown's first and is its largest tenant. 21st Century Therapeutics, which is a drug discovery company that develops and commercializes experimental anti-cancer drugs targeted against human solid tumors, is also located in TechTown. Other tenants involved in the pharmaceutical industry include EXT Life Sciences, Neocutis, and the Perinatology Research Branch of the National Institutes of Health.

The Michigan Life Sciences Corridor is an organization aimed at developing the life sciences industry in Michigan as well. It was originally formed through a Public Act in 1999 signed by former Governor John Engler. The Act appropriated about \$50 million dollars towards the initiative, which was at the time meant to focus on aging issues. A steering committee meant to control the fund consists of 14 members, including the CEO of the MEDC, members from Michigan State University, University of Michigan, Wayne State University, the VanAndel Institute, and two members from the private sector. They distribute funds on a competitive basis to research on health-related issues and support collaborative peer-reviewed grants. In 2003, the MLSC was expanded to include the Technology Tri-Corridor. The Tri-Corridor incorporates research on the emerging homeland security and critical advanced automotive technology sectors (Kurz "Bailey named to Technology Tri-Corridor Committee").

Finally, the Michigan Economic Growth authority was first created in 1995 to promote economic growth in Michigan (Michigan Economic Growth Authority Act). It was designed to be a Single Business Tax and Income Tax credit program targeted at

large-scale investment and job creation, as well as attraction of technology-intensive business concerns (Survey of Economic Development Programs in Michigan). Since then, the Act has awarded grants to many companies. However, only one since May of 2000 is involved in the pharmaceutical industry—Solvay, which is involved with chemical processing. In fact, it is the only company that is even remotely related to the life sciences industry since 2000 to receive a MEGA grant. The other companies are all involved in a facet of the automotive industry or in office equipment sales, with the exception of Walden Books, a retail store bookseller (Citizens Research Council of Michigan 21). One could hardly argue that the MEGA has put much, if any, focus on any high-tech entrepreneurs since its inception, including pharmaceutical companies. Possibly in response to this bias, the legislation that enacted the Authority was amended in 2000 in response to Pfizer's announcement of its acquisition of Pharmacia and its subsequent cut of several hundred jobs in Kalamazoo. The amendment lowered the amount of jobs that high-tech entrepreneurs were required to create in order to qualify for a grant (Citizens Research Council of Michigan 20). However, there is little news on whether or not the amendment has provided more grants to high-tech companies, or if any of the companies that have been given grants since 2000 are pharmaceutical companies.

Legislation

One of the biggest issues concerning the legislature right now is the elimination of the SBT. Because businesses and legislators alike are unsure about what the new tax code will bring, many businesses are choosing to hold off on coming to Michigan, or are deterred from starting a new business. The pharmaceutical companies are no exception. The old Single Business Tax gives a tax credit for 6.5% of increased qualified research

related to an eligible taxpayer's pharmaceutical based business activity ("Outline of the Michigan Tax System"). However, the proposed systems vying to replace the SBT take different approaches to facilitating entrepreneurship in Michigan.

Governor Granholm recently proposed a way to replace the SBT through something called the Michigan Business Tax. The MBT includes, among other things, includes a provision for tax relief for small businesses with annual gross receipts under \$350,000 (mainly zero-stage companies). It also retains credits for created or retained jobs and the funding of research and development. The MBT retains the current MEGA compensation credit, which provides a credit equal to up to 100% of compensation for created or retained jobs for up to 20 years. The MBT also creates a new MEGA credit for established Michigan business to help fund R&D. It also honors commitments made before the end of 2007 for the brown- field and historic preservation tax credits. Business activity occurring in Renaissance Zones will continue to receive tax exemptions (Anderson Economic Group). All of these factors make it less expensive for zero-stage companies to start their businesses in Michigan.

However, the MBT also adds a tax for small businesses with gross receipts between \$350,000 and \$700,000. Because the tax applies to gross receipts and not gross revenue, the tax does not take into account the amount of expenses that a burgeoning company must pay, especially in the pharmaceutical industry. A pharmaceutical company may sell a shipment for \$500,000, but it costs them so much to produce the product they're selling that a tax liability on those sales may make it prohibitively expensive for pharmaceutical companies to grow in Michigan. One could argue that since all taxes are passed on to consumers, this tax may make prescription drugs even more expensive for

Michiganders. However, this affect is mitigated by the fact that the tax liability is limited to businesses with gross receipts between \$350,000 and \$700,000—most consumers buy their drugs from large companies like Pfizer, whose gross receipts far exceed the millions mark.

Arguably, the most controversial part of the MBT is its integration of a services tax. The service tax does have a benefit for pharmaceutical companies in its exemption of medical and diagnostic laboratories and, more significantly, in its exemption of scientific research and development, including (though not limited to) research done for “the creation of new or significantly improved products or processes”. By exempting scientific research and development, the plan avoids adding another tax burden to pharmaceutical companies, especially the entrepreneurial entities still in the development stage of their product, at the most costly stage of their production.

However, if the services tax creates liability for pharmacies, then that’s one more cost that the consumer must pay on prescription drugs. This extra liability will again make prescription drugs more expensive in Michigan, which has been a big problem for pharmaceutical industries that must compete with cheaper Canadian pharmaceuticals.

The next proposal up for debate is the Senate Republicans Fair Tax plan, embodied in Senate Bill 151. By design, it eliminates the Single Business Tax, the Personal Property Tax and Michigan Income Tax and replaces it with a single sales tax (“The Michigan Fair Tax Proposal”). By eliminating the Michigan Income Tax and shifting the entire tax burden to purchases, pharmaceutical industry will no longer have to worry about the large chunk of money that is taxed from their employees’ often high wages. The tax plan also has an advantage over Governor Granholm’s tax plan in its

simplicity. Companies just entering the business world would have an easier time complying with the tax code because fewer taxes would apply to them. Representative Fulton Sheen, who is a supporter of the Michigan Fair Tax Plan, has said in a public email that “Any plan that does not completely eliminate both [the Single Business Tax and the Personal Property Tax] is only dealing with half the problem.....Only the Fair Tax Plan completely eliminates both the SBT and the PPT”(Email). Charlie Owens, director of the National Federation of Independent Business-Michigan, said the NFIB's analysis indicates small businesses would probably fare best under the Senate plan because of the tax-payment choice it offers.

However, pharmaceutical companies may not benefit from an increased sales tax. Because sales taxes are shifted wholly to the consumer for the most part, pharmaceutical companies will face yet another increase in their prescription drug costs, pricing them at even more uncompetitive levels in comparison to Canadian pharmaceutical companies.

Because the tax code is still up in the air for Michigan, pharmaceutical companies have no real way to predict how well or badly their businesses will do in Michigan. From this uncertainty stems a reluctance to push forward entrepreneurially until, figuratively speaking, the dust settles on Michigan's tax environment. Until the SBT expires and is replaced with a new tax code at the end of the year, it's hard for anyone to say how businesses will respond to it.

Beyond legislation targeted specifically at economic growth, there are specific policies in place in Michigan that indirectly affect the ability of pharmaceutical companies to grow here. For example, Michigan had been the only state in the nation to prohibit product liability claims against manufacturers and sellers of drugs that are

approved by the federal Food and Drug Administration (FDA) and labeled in compliance with that approval. The state House of Representatives, however, voted 70-39 to repeal the law. Critics claimed it made it exceedingly difficult for citizens to sue pharmaceutical companies when drugs cause injury, but which business groups argue has helped Michigan's life sciences industry grow by providing protection from unreasonable lawsuits (Grand Rapids Press B3). The tort reform negatively impacts Michigan's business climate because companies, especially pharmaceutical companies, perceive it as targeting them for lawsuits, and because the legal climate is a consideration when businesses decide to locate or invest in a state. Business groups and pharmaceutical companies "argue that the repeal would...open the floodgates for lawsuits at a time when the state's economy can ill afford it" (Grand Rapids Press B3).

The 1995 Michigan House Legislative Analysis Section notes that the law was originally put in place because the tort system is "a hidden tax that stifles innovation, suppresses enterprise, restricts the availability of products and services, and reduces the ability of Michigan businesses to compete in the global economy" (Foley and Sveska). Since the law was passed, Michigan has attracted \$355 million in life sciences R&D, according to the Manhattan Institute's Center for Legal Policy. Life sciences research has been a target of Michigan's business plan since the inception of the law. For comparison, in 1994 Michigan was ranked 48th in the nation for product liability climate, whereas in 2006 the Pacific Research Institute ranked Michigan 5th in the nation for tort liability (Foley and Sveska).

Though Michigan has made attempts to support pharmaceutical research and development, political pressure has moved the legislative trend towards forcing

pharmaceutical companies to reduce their prices, especially for the most disadvantaged groups in the state. Representative John Dingell, one of the industry's critics, is a key player in shaping healthcare legislation. He is lined up to chair the Energy and Commerce committee, which oversees most healthcare issues, and is "already mapping plans for aggressive oversight of the FDA and the Part D drug benefit, [on] which he is strongly opposed" (Wechsler). Senator Debbie Stabenow has long been a proponent of lower brand-name drug costs, lobbying against the pharmaceutical industry and even organizing bus trips to Canada to purchase drugs. Both her and Senator Carl Levin were instrumental in helping the Senate to pass a measure to allow people to buy prescription drugs from Canada. This has allowed both internet pharmacies and drug re-importation to burgeon into multi-billion dollar industries.

In response to the growing concerns about the high cost of prescription drugs, Representatives Aldo Vagnozzi (the primary sponsor), Pam Byrnes, Mark Meadows, Lee Gonzales, Bob Constan, LaMar Lemmons, Steve Tobocman, Tim Melton, Terry Brown, Frank Accavitti, Matthew Gillard, Paul Condino, Fred Miller, Robert Dean, Alma Smith, Kathleen Law, George Cushingberry, and Coleman Young have introduced House Bill 4094 on January 23, 2007. The bill enters Michigan into "the Midwest pharmaceutical compact". The compact allows Medicaid recipients, publicly insured or uninsured health care recipients, and "any other persons who the commission deems eligible" to purchase pharmaceuticals through the compact, thereby benefitting from the compact's lower drug prices. These drugs would be distributed through health care professionals, public hospitals and clinics, nonprofit hospitals and clinics, organized emergency department or

free clinics within the states participating in the compact. The bill has been referred to the Committee on Health Policy (“House Bill No. 4094”).

A similar proposal was submitted to the State Senate by Senators Roger Kahn, Wayne Kuipers, John Pappageorge, Jason Allen, Gerald Van Woerkom and Glenn Anderson introduced Senate Bill No. 293 on February 28, 2007. The bill amends the current public health code to allow the Department of Health to join a multistate prescription drug purchasing program. By entering a multistate cooperative on drug purchasing, the Senators hope to “use the collective purchasing power of the participating states and members to reduce the cost of prescription drugs for those participating states and members”. This bill has also been referred to the Committee on Health Policy (“Senate Bill No. 293”).

The “Michigan prescription drug fair pricing act” (House Bill 4115) is a much more aggressive attempt to force pharmaceutical companies to reduce the cost of prescription drugs. Introduced by Reps. Donigan, Polidori, Gonzales, Spade, Miller, Vagnozzi, Meisner, Tobocman, Accavitti, Constan, Bieda and Leland, the bill pressures certain prescription drug manufacturers and labelers to negotiate rebates with the Department of Community Health. It also pressures manufacturers to establish a discount prescription drug program (“House Bill No. 4115”). Furthermore, it makes public the names of companies that refuse to offer rebates, and require prior authorization before any drug made by a company that refused to agree to a rebate or discount could be dispensed to a recipient of Medicaid or other low income health program. The bill would also establish a state “Rx Card” program that would extend discounts to Medicaid clients and other people without health care or drug insurance coverage. The program would

require pharmacies that fill Medicaid-paid prescriptions to sell drugs to Rx cardholders at reduced price levels specified in the bill, and would reimburse the cost of the discounts from the rebates received from drug makers (Search Legislation—Michigan Votes).

The strategy of state drug purchasing has been highly successful for Canada, whose single-buyer system has often been cited for its significantly lower costs in prescription drugs. Furthermore, the strategy of coalition drug purchasing has been successful for businesses seeking to reduce the cost of drugs. A whopping 50% of those that used coalition drug purchasing called it highly successful, and 36% of those using data analysis gave this technique their highest praise, far above any of the other seven strategies asked about in a survey done by IOMA's 2006 Prescription **Drug** Cost Control Survey. By taking the successful component of Canada's drug policy, i.e. allowing Community Health departments to negotiate lower prescription drug costs for the most disadvantaged groups, Michigan stands to reap the same benefits that Canada has seen in terms of lower prescription drug prices and a more competitive pharmaceutical industry. One could argue that these trends will force pharmaceutical companies to cut costs in production to support the reduced price, inevitably in the most costly stage of drug production—research and development. However, Canada has not seen this cut in research and development. In fact, Canadian pharmaceutical companies accounted for 10% of new drug discoveries in 2001, despite only having 2% of the of the world market (Rosborough). However, one could argue that these policies, though they haven't cut research and development, have slowed the growth of research and development in Canada. The ratio of research to sales has remained level over the past decade in Canada,

while in other industrialized countries, the level of R&D has dramatically increased relative to innovative drugs on the market (Chetan).

Pharmaceutical Industry Regulations and Incentives: New Jersey

New Jersey, as one of the leading states in the pharmaceutical industry, has state-led incentives and regulations that promote growth in the industry. By forming authorities that concentrate on economic growth in key areas like the pharmaceutical industry, the state can determine which policies are most effective. The Commission on Jobs, Growth, and Economic Development formulates policies and programs to support R&D by enhancing government responsiveness to business needs (Quinn 3). The state government recognizes the need to partner with businesses and streamline bureaucratic processes to make New Jersey a more attractive place in which to do business. In 2004, the commission also decided to create new centers to spur collaboration between research universities and industries to strengthen public-private partnerships (Gaunt 1).

A more specific task force, the Commission on Science and Technology (CST), also promotes ties between universities and science industries to accelerate the commercialization of technology and foster research collaboration among universities (Preische 6). The CST also looks at key areas at the forefront of the pharmaceutical market for ways to drive growth. A recent report by the commission suggested that the market for nanotechnology products and services could reach \$1 trillion by 2015 and that “without significant investment, New Jersey will fall behind” (D’Errico).

After considering several specific areas of pharmaceutical research, the state invested in the New Jersey Nanotechnology Center. Under the Edison Innovation Fund, created by the CST, the state devoted \$500,000 to the creation of the center to provide

infrastructure, equipment, and expert support at Rutgers University (Preische 7). The center has also leveraged \$5 million in equipment from donations and federal grants. Additionally, the Stem Cell and Biomedical Research Facilities Initiative provides over \$300 million to several facilities across the state, including blood collection facilities, a cancer center, and other university sites (Preische 8). New Jersey is the first state to commit funding to stem cell research, and one of two states whose regulations encourage stem cell research.

According to the Tax Foundation, New Jersey's state tax burden is the 17th highest nationally, and New Jersey ranks 48th in the nation for its business tax climate. The New Jersey Business and Industry Association has similar findings, as over 90% of firms surveyed cited higher taxes, health-care costs, and government spending as items that discourage new enterprise in the state. New Jersey has, however, created a number of tax credits to compensate for the tax rates. There are investment tax credits, where 10% of the qualified investment amounts in 3 tax years can be carried forward for 15 years (Quinn 3). Employment Training Credits match grant dollars for on-the-job and classroom-based training for workers (Quinn 3). The Urban Enterprise Program provides investment credits for job creation in the state (Quinn 3). Targeting high-tech companies, the Technology Tax Certificate Transfer Program has already approved 166 applications for companies to raise money to finance growth by allowing them to sell tax losses or R&D tax credits to other businesses. The success of the program can be seen in the 41% growth of the program since its inception (Quinn 4).

New Jersey also has several incentive programs that target high technology companies to encourage innovation and location within the state. The New Jersey Seed

Capital Program enables early-state high technology companies to obtain loans of up to \$500,000 in order to bring new technology to the market (Quinn 3). With the New Jersey Technology Fund Program, the Economic Development Authority partners with banks to loan money to later-stage companies at a below-market rate (Quinn 3). Tris Pharma, a small pharmaceutical company, is using \$2.9 million in bond financing for increased jobs and research space. The Business Employment Incentive Program assists biotechnology companies in relocating to or expanding in New Jersey. Companies can receive a rebate of income taxes withheld from new employees for up to 10 years. It also provides over \$16 billion in private capital investment to pharmaceutical companies. The program has already resulted in the relocation of 125-employee LifeCell to Bristol-Myers Squibb's 96-acre New Brunswick facility, as one example (Quinn 4).

For all companies, not just start-up firms, there are other business development opportunities. The Entrepreneurial Training Institute hosts an 8-week program that covers topics like preparing a business plan, developing market strategies, and running a small business . A Business Mentoring Program offers recent graduates and loan recipients help with business operations and loan package preparations (Quinn 4). Business Retention and Relocation Assistance Grants have allowed 3 large companies to invest over \$650 million in constructing new facilities for research and development, PILOT manufacturing, and headquarters (McCandless 1). These kinds of programs have generated over \$1.1 billion in private investments and retained over 12,000 jobs (McCandless 1).

New Jersey and Michigan are both leading states in life science industries, but New Jersey's commitment to the pharmaceutical industry is what makes it the leading

competitor in the industry. There is a specific task force that promotes ties between universities and science industries which fosters research collaboration, technology transfers, and looks into new areas of research. Areas where the pharmaceutical industry is growing are areas that take advantage of and promote these linkages. Michigan is lacking those same ties and policies. The government has banned stem cell research, as opposed to New Jersey, which has supported a research center specifically for stem cell research. Taxes are not the major hurdle to growth, as New Jersey has a high tax burden. They do, however, compensate for that with specific tax incentives for high-tech businesses. Michigan has many similar resources for start up companies in its Smartzones, research parks, and other organizations that provide assistance and funding to new companies. New Jersey has, however, business development opportunities for all companies, not just start up firms. This is especially important in an industry like pharmaceuticals, which are so research intensive and where research takes a long time to come to fruition.

Pharmaceutical Industry Regulations and Incentives: Canada

The Canadian pharmaceutical industry regulatory framework resembles the U.S. system in several ways, largely due to a similar set of objectives. Both countries are concerned about the safety, efficacy, and pricing of pharmaceuticals, as well as consumers' access to medication. Additionally, both have shown strong commitments to providing a policy framework that supports the research and development of pharmaceuticals that meet the goals above.

Canada has an agency that mirrors the FDA: the Health Protection Branch (HPB). The Canadian federal government promotes drug safety through an HPB review process

that focuses on the therapeutic effects of a drug. The HPB was renamed the Therapeutic Products Programme (TPP) in 1997, and then divided into the Therapeutic Products Directorate (TPD) and the Biologics and Genetic Therapies Directorate (BGTD) in 2001. The agency and the pharmaceutical industry have a relationship of mutual dependence, as the agency is “limited in its ability to implement policy without assistance and information from companies” (Wiktorowicz), and the industry must abide by TPD regulations. Canada’s Research-Based Pharmaceutical Companies (Rx&D), which is an organization that represents 63 Canadian firms who control over 90% of drug sales, meets with the TPD in joint committees for regulatory changes, such as with product licensing frameworks. This consultation occurs because of the nature of regulations under the Food and Drug Act, where the only requirement for testing the safety of new drugs is that companies submit the details of the tests carried out to establish safety (Wiktorowicz). The vagueness of the act means that the TPD and the industry must work together to develop standards of practice.

Additionally, as a member of the WTO, Canada adheres to the Trade-Related Aspects of Intellectual Property (TRIPS) Agreement with regards to the protection of intellectual property, and changes in recent years have brought its patent laws more in line with U.S. laws. Until 1980, Canada maintained a policy of compulsory licensing, where the government could force pharmaceutical patent holders to grant the right to use the patent to other companies to produce the drug. This caused the generic drug industry to grow in Canada. In 1983, however, the Minister of Consumer and Corporate Affairs called for changes in the policy to generate growth of the innovative pharmaceutical industry. The resulting Bill C-22 lengthened the time a patent is in effect from 17 to 20

years, reduced compulsory licensing, and formed the Patented Medicine Prices Review Board (PMPRB), designed to curb excessive prices charged for pharmaceuticals (Smith). When Canada joined NAFTA, it also supported increased patent protection proposals introduced at the GATT, such as eliminating compulsory licensing, and stopping discrimination between Canadian and foreign-designed products (Smith).

Despite these similarities in objectives and regulations, several differences in priorities and regulatory range have led to different policy outcomes in Canada and the U.S. While U.S. policy focuses on protecting intellectual property rights and incentives to spur innovation, Canada has tended to promote lower prices (Hollis and Ibbott). Canada's regulatory scope furthers that goal. It not only regulates drug safety and efficacy, as does the U.S., but also drug prices. The government is a consumer due to public drug benefit programs through its healthcare system. The government becomes the largest buyer of drugs, creating a situation where there is effectively one seller and a single buyer who negotiate prices in Canada's single buyer system. Canada also formally implemented price controls through the PMPRB, which ensures that prices for wholesalers, hospitals, and pharmacies are not "excessive". If the drug is comparable to a product already existing in Canada, that price can be no greater than that of the other product. If the drug is innovative, the price can be no greater than the median price in seven other industrialized countries: France, Germany, Italy, Sweden, Switzerland, the U.K., and the U.S. (Hollis and Ibbott). The board considers manufacturing and marketing costs in this estimate, but not the costs of research and development, despite that comprising the majority of the cost of producing a new drug. Price increases are limited to the rate of

inflation, and set to the Canadian consumer price index (CCPI). It is generally accepted that the PMPRB has been successful in maintaining low drug prices in Canada:

“While the rise in drug prices in Canada greatly exceeded the CCPI in the five year period prior to establishment of the PMPRB, drug price inflation has been below the CCPI in every year since it was established.” (Hollis and Ibbott)

Many drug manufacturers voluntarily comply with price reductions, as opposed to undergoing formal hearings (Stanton). Drug prices suggested by the PMPRB are put in place ninety days after a drug is introduced.

Due to price controls, prices of pharmaceuticals in the Canadian market are lower than in the U.S. Consumers in the U.S. see this difference, and there has been an increase both in the number of U.S. citizens who travel across the border to Canadian pharmacies to fill their prescriptions, or who have them filled by a Canadian internet pharmacy. At the National Governors Association 2004 Winter Meeting, governors from 15 states also supported importing low cost drugs from Canada (Hollis and Ibbott). The FDA does not condone purchasing drugs from Canada, as such drugs are not labeled according to FDA standards, and may therefore, the agency says, be unsafe. The FDA, however, estimates that three million U.S. prescriptions per year are filled in Canada (Outterson). Despite claims that the rise of drug importation from Canada will inevitably cause drug prices there to rise also, the Canadian market is not self-correcting given government price controls.

As Canada supports research and development, it has several incentive structures in place to promote innovation and growth in the pharmaceutical industry. While Canadian agencies have monitoring roles, they can also provide incentivized “carrots” to accompany the regulatory “sticks”. The PMPrB, for example, has sought to increase

R&D funding of the industry to promote innovation. It has met initial goals of increasing R&D investment to 10% of sales by 1991 (Stanton). The government also promotes innovation by directly funding pharmaceutical research through the Canadian Institutes of Health Research (CIHR), for example. The CIHR is the main agency responsible for funding health research in Canada, and supports over 10,000 researchers each year with the goal of improving the health of Canadians. CIHR invests \$580 million annually to health sciences through training initiatives, grant programs, collaborative research projects, and other programs. One example of a program they sponsor is the University-industry Partnership program which encourages academic researchers to pursue ideas that could prove useful in health science industries (What We Do). The Canada Foundation for Innovation (CFI) is a corporation endowed with \$3.65 billion by the federal government to fund research infrastructure. It was also designed to increase the capacity of universities, research hospitals, and other institutions that can form important linkages with the pharmaceutical industry.

Both Canada and Michigan have prioritized research and development in life sciences industries, as both have high levels of R&D investment. While Michigan's investment in R&D has outpaced Canada and has seen returns in life science industries, more could be done. Canada broadens the spectrum of their commitment by also working to build relationships between universities and the private sector to encourage the commercialization of technologies produced at the university level. Increasing linkages between pharmaceutical companies and universities could speed technology transfers at the university level, and also allow companies to benefit from human capital, research facilities, and other university resources. Canada has also been fostering a positive

relationship between industry regulators and industry representatives. Their oversight board has a consultation mechanism where they work with industry leaders to develop regulations and standards of practice. Michigan's government is currently viewed as anti-pharmaceuticals, with recent changes in tort legislation, drug re-importation practices, and statements made by different individuals. If the government could work closer with pharmaceutical industry leaders to develop practices, it could improve perceptions of pharmaceutical opportunities in the state.

Conclusion

It's widely known that Michigan cannot afford to give tax credits to firms. However, Michigan legislators can help attract pharmaceutical companies. The reason why pharmaceutical companies charge so much for drugs is not that they are trying to make a profit on the backs of consumers, but to support the heavy costs of research and development. So, instead of making Big Pharma the boogey-man, maybe Michigan state legislators will better serve their constituents by finding ways to help pharmaceutical companies lower the costs of research and development, thereby lowering the cost of the pharmaceuticals themselves.

How can government help lower the cost of research and development, without cutting tax revenue we can't afford to lose? Well, for starters, it can help subsidize building costs or negotiating lower wages. Or, it could help replace the jobs lost by Pfizer's layoffs by using the soon-to-be empty facility in Ann Arbor to build a campus modeling the Southwest Michigan Innovation Center or the Biosciences Research and Commercialization Center. Michigan's government should also work with both unions

and with businesses to come up with competitive and fair wages so that no more pharmaceutical companies have to resort to completely shutting down their facilities here.

New Jersey, Canada and China can provide important lessons for Michigan because of the efforts each has undertaken to promote the pharmaceutical industry. They have seen success in the pharmaceutical industry in part because the government works to foster linkages between universities, teaching hospitals, clinical research networks, and the private sector. Michigan stands to reap just as many, if not more benefits from the formation and strengthening of such linkages because we house some of the best universities in the country that produce top students. And with the world-class hospitals, universities and scientists residing right here, there is no reason why Michigan should have to miss out on the opportunities its competitors have long ago learned to embrace. Additionally, Michigan's competitors understand the benefits not only of targeting sectors like the life sciences industries, but of making all of the resources necessary for a starting business to succeed easily accessible. Michigan has demonstrated it has the resources available to make this happen, and now only needs to consolidate and promote such resources.

As long as Michigan's legislators continue to alienate the pharmaceutical industry, the industry will continue to see Michigan as an unfavorable business climate in which to build their research facilities and manufacturing sites. Lower drug costs might make a catchy campaign slogan, but they do not serve Michigan's future. We may love to hate the business world, but the business world can help Michigan craft a new, more prosperous future. And no one would vote against that.

Appendix A—
Research and Development in the Pharmaceutical Industry (NAICS code 5417102)

	Michigan	New Jersey	California	United States
Ranking in US by receipts in Research & development in the phys, engineering & life sciences	14	9	1	--
Establishment:	102	281	1,304	6,119
Receipts :	284,237,000	1,096,480,000	6,936,137,000	26,316,797,000
Receipts (% of US) for Research & development in the phys, engineering & life sciences	1.78%	3.24 %	23.53%	100
Annual Payroll:	992,982,000	1,167,216,000	4,382,400,000	17,418,708,000
Average Annual Pay per employee (derived by dividing the annual payroll by the number of paid employees)	73,576	75,739	81,664	71,173
Paid employees:	13,496	15,411	53,664	244,737

Source: Economic Census 2002, U.S. Census Bureau

**Appendix B—
Manufacturing in the Pharmaceutical Industry (NAICS code 3254)**

	Michigan	New Jersey	Pennsylvania	United States
Ranking (within the US, in value of shipments)	9	4	1	--
Establishment:	42	152	69	1,829
Value of Shipments (\$1,000):	4,047,605	14,246,827	21,966,111	140,557,276
Value of shipments (% of US):	2.88	10.14	15.63	100%
Annual Payroll(\$1,000):	334,278,000	2,028,917,000	1,043,150,000	13,788,405,000
Average Annual Pay per employee (derived by dividing the annual payroll by the number of paid employees)	46,916	59,069	66,072	55,386
Paid employees:	7,125	34,348	15,788	248,947

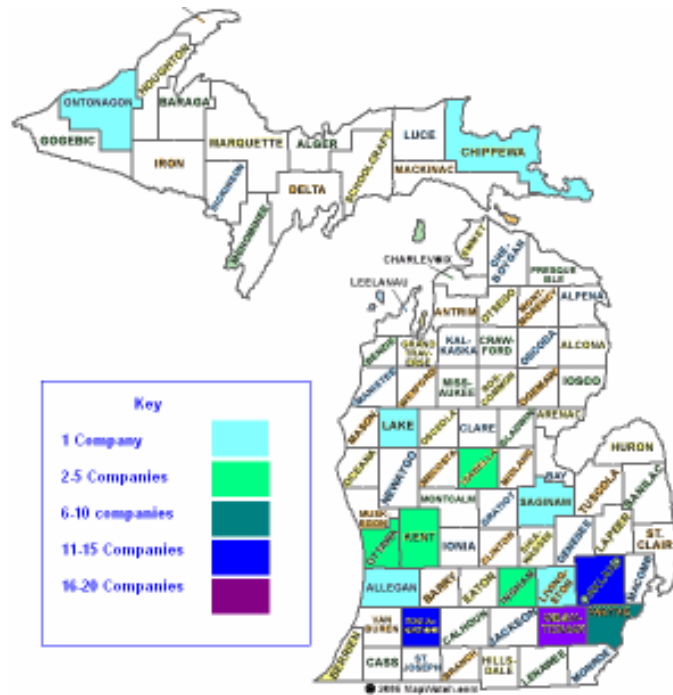
Source: Economic Census 2002, U.S. Census Bureau

Appendix C—
A Breakdown of the Location of Pharmaceutical Companies by Type and County

	Pharma/Med Manufacturing	Pharma Preparation Manufacturing	Drug Wholesalers/Distributors
Allegan	2	2	0
Ingham	2	0	3
Kalamazoo	2	1	7
Kent	0	0	11
Macomb	0	0	9
Oakland	9	3	44
Ottawa	5	4	0
Van Buren	1	0	0
Wayne	9	4	22

(Information from US Census Bureau)

Appendix D— A Visualization of the Location of Pharmaceutical Companies by County



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