Fraunhofer-Gesellschaft & Economic Policy
The Implementation & Possible Effects On U.S. Local Economies

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# Table of Contents

Abstract .................................................................................................................................................. 3

Section 1. Introduction.......................................................................................................................... 4

Section 2. Background of the Fraunhofer Model.................................................................................. 7

Section 3. Impacts of Research & Development.................................................................................. 11

Section 4. Logistics of Applying Fraunhofer to U.S. Municipalities..................................................... 14

Section 5. Applying Fraunhofer to U.S. Municipalities....................................................................... 18

  Subsection A. Chicago, Illinois.............................................................................................................. 20

  Subsection B. Austin, Texas.................................................................................................................... 23

  Subsection C. San Francisco, California............................................................................................... 27

Section 6. Recommendations................................................................................................................ 31

Section 7. Foreseen Challenges & Their Solutions............................................................................... 35

Section 8. Conclusion............................................................................................................................ 37

Appendix: Works Cited......................................................................................................................... 40
Abstract

The United States serves as an economic powerhouse in the world in many fashions. Following the economic collapse of 2008, in which the dollar deflated and our banking industry took a major economic hit, much of the world experienced, at the very least, an economic stall. Meanwhile, other countries experienced similar economic recessions. In 2008, Germany’s gross domestic product fell 6.6 percentage points over five quarters. However, Germany’s recovery was strong. According to the Konrad Adenauer Stiftung, the Germany GDP grew by a total of 6.2 percentage points between 2006 and 2010, more than other representative European nations, aside from the Netherlands, which remained more or less immune to the financial collapse. Other nations, such as Greece, Portugal, and Spain, experienced negative growth, as bad as -12.23 percentage points.¹

Economists credit Germany’s success to many factors, ranging from their mittelstand, or small/medium-sized businesses, to their reliance on manufacturing. German Chancellor Angela Merkel once responded to British Prime Minister Tony Blair that the Germany economy was a success because “we still make things.”² Another shining star in the Germany economy, however, is the Fraunhofer-Gesellschaft model, which emphasizes targeted research and development with private-public partnerships. This research will focus on theoretically applying the Fraunhofer-Gesellschaft model to various municipalities in the United States.

Introduction

Following the financial crisis of 2008, in which the United States’ housing market collapsed from the result of sub-prime mortgages, many feared that the U.S. would again slip into an economic depression. Investment banks, insurance companies, mortgage lenders, and commercial banks began to collapse, threatening to throw the United States off of a financial cliff from which it may not have recovered. The stock market also took a significant hit, with the Dow Jones Industrial Average losing 33.8 percent of its value in 2008 alone. The resulting value crash of the dollar led to a nearly worldwide economic slip, if not a recession, that threatened to halt much economic activity across the globe.³

In order to combat the recession, President Barack Obama, who took office in 2009, proposed the American Recovery and Reinvestment Act (ARRA), commonly referred to as the “Stimulus.” The ARRA focused on three areas – tax benefits, contracts/grants/loans, and entitlements. Altogether, expenditures from the ARRA totaled $816.3 billion, with the intent of inflating the marketplace artificially and “jump-starting” the dying economy.⁴ Republicans saw a different path to saving the economy. In their alternative Senate proposal to the ARRA, Republicans proposed a $713 billion bill, $430 billion of which was in the form of tax cuts, as opposed to $290.7 billion in tax cuts from the ARRA.⁵ While President Obama’s proposal ultimately passed the Democratic Congress and was signed into law, the United

⁴ http://www.recovery.gov/arra/Pages/default.aspx
States has experienced below average economic growth since the economic recession took place (see Figure 1).\textsuperscript{6}

\textbf{Figure 1.}

Meanwhile, the Germany economy has grown significantly quickly following the economic crisis of 2008. The German GDP took 12 quarters to fully recover, but, when compared to countries such as France, which took 20 full quarters, it appears Germany has experienced a relatively quick recovery. Additionally, in 2013, the Eurozone’s unemployment rose to 12.1 percent, while Germany’s unemployment rate declined to 5.3 percent. Germany’s recovery is illustrated in Figure 2, where the GDP recovery of Germany was compared against Italy, France, Spain, and the

\textsuperscript{6} http://www.cbo.gov/sites/default/files/43707-SlowRecovery.pdf
Eurozone as a whole.

*Note:* The index of real GDP for 2008Q1 = 100.

*Source:* Quarterly real GDP data are from the Eurostat Database.

*Figure 2.*

Many attribute Germany’s success to their *mittelstand*, otherwise known as SMEs, or Small/Medium Enterprises. While SMEs are an important leg in the Germany economic model, it is important to note what helps make SMEs successful in the eyes of many economists – Fraunhofer-Gesellschaft, or the Fraunhofer Society. The Fraunhofer Society, an independent research institution, has a reputation for producing well-structured, efficient, and intelligent research that helps German SMEs stay ahead of the competition.
Section 2: Background of the Fraunhofer Model

The ASME, or the American Society of Mechanical Engineers (ASME), has had a vested interested in the Fraunhofer Model for many years now. Since the German economy is extremely strong in the field of manufacturing, the ASME has had its eye on the Fraunhofer Model for potential implementation in the U.S. According to the ASME, more than 1,130 German SMEs “held either the number one or two position in the world market for their products, or the number one position in the European market.” This is due, largely in part, to the superior quality and performance of German products. Additionally, the United States has lost many SMEs during the 2008 recession and in competition with China and other Asian nations.

The Fraunhofer-Gesellschaft is an independent, nongovernmental organization that focuses on providing SMEs with fast-paced, efficient, applicable research to improve their products/processes. This is particularly important since SMEs generally are not large enough in scale to be able to afford their own research and development. What this implies is that, while the U.S. may provide limited, competitive grants to our own SMEs to do research, the Fraunhofer Model gives their SMEs a competitive edge by providing more efficient, short-term research, which provides for a faster implementation time and, thus, a “jump” on their competitors, so to speak. Indeed, Figure 3 shows that economic growth in areas hosting a Fraunhofer Institute is higher than typical development or stimulus funds.7

7 https://www.asme.org/engineering-topics/articles/manufacturing-processing/how-does-germany-do-it
The Fraunhofer Model is also large in scale. The organization itself has an annual budget of roughly $2.45 billion U.S. dollars. To put that into perspective, that's roughly the same amount the U.S. spent on international economic development in 2014.\(^8\) This budget is generated from governmental grants and independent contracts, although contracts make up a large majority of income, about two-thirds, for Fraunhofer Institutes. Because of this, the Fraunhofer Society is also able to take on large quantities of projects at once, usually between 6,000 and 8,000. And since the institutes are connected to a university, those projects move quickly, usually getting completed in a two-year time span.

Another benefit of working with universities is that Fraunhofer acquires well-trained, well-educated staff members on a rolling basis, ensuring the freshest

\(^8\) http://www.npr.org/sections/goatsandsoda/2015/02/10/383875581/guess-how-much-of-uncle-sams-money-goes-to-foreign-aid-guess-again
talent comes in every few years. Fraunhofer-Gesellschaft employs part time graduate and doctoral students who work for Fraunhofer in order to gain more experience before moving on to work in other sectors.

Since the mittelstand consists of small to medium-sized businesses, Fraunhofer is crucial to their development. In 2008, roughly one-third of research & development projects by Fraunhofer were on behalf of firms with less than 250 employees. 43 percent of projects were for firms with less than 1,000 employees. Fraunhofer serves as a pivotal player for those organizations that cannot afford to put forward the resources necessary to conduct those studies, such as manpower or funding.  

As a partial result from the Fraunhofer Model, manufacturing in Germany has been growing exponentially. From 2000 to 2011, the U.S. manufacturing sector shrunk in terms of Compound Annual Growth Rate and merchandise exports. The U.S. specifically shrunk from about 8 percent to 3 percent, and from 80 percent to 60 percent, respectively. Meanwhile, the German manufacturing sector grew from 1 percent to 4 percent and remained steady at 80 percent, respectively. However, Germany’s manufacturing sector grew from $459.2 billion to $1,226.3 billion in just 11 years. Comparatively, the U.S. grew from $644.6 billion to $952 billion in the same time frame. This data is shown in Figures 4 & 5.

9 https://www.asme.org/engineering-topics/articles/manufacturing-processing/how-does-germany-do-it

Since most SMEs in Germany are focused on manufacturing, it is logical to assume that there is a causal link between the Fraunhofer Model, the success of German SMEs, and the overall success of the German manufacturing sector, and, thus, economy.

Figure 4.
Section 3: Impacts of Research & Development

Fraunhofer-Gesellschaft is a unique player in the research & development (R&D) field because it combines public investment and private investment into one vessel. Additionally, the research & development conducted by Fraunhofer is not merely for academic purposes. In other words “the Fraunhofer Institutes focus is on applied research, with the goal of providing solutions that have a commercial value.”\textsuperscript{11} In a study conducted by Frontier Economics for the government of the United Kingdom, they broke down various forms of research & development and their impacts on the economy and their return on investment. This study compiled 55 other studies on research & development and examined their findings while summarizing both the theoretical and applicable knowledge gained. It is important to note that this study focused not only on the United Kingdom, but all of Europe.

In their study, Frontier specifically used the microeconomic approach to determine the return on investment that R&D efforts yield. In other words, Frontier

\textsuperscript{11} Seven Secrets of Germany
looked at the links between inputs and outputs and measured how important different links between the two were. According to the compiled studies, the estimated “private rates of return to R&D investments of around 30% (mean) or 20 to 25% (median).”\textsuperscript{12} Additionally, public investments had returns averaging between 30 and 40%, although Frontier admitted that these returns may be understated due to the models used, which modeled the impact public R&D investment had on the productivity of the private sector. Additionally, public R&D investment contributes returns in ways different than that of private investment, namely in societal benefits, such as education, public health, and national security. These averages can be safely considered adequate and reasonably accurate due to the large sample size of over 100 average estimates drawn from an even larger dataset.

A study by Marian Beise and Harald Stahl conducted in 1999 compiled survey responses from 2,300 firms in Germany. These responses were collected between 1993 and 1995 with the questions focusing on innovation and public funded research. They found that roughly 10 percent of new products and processes developed and used by these firms could not have been created without public research investment.\textsuperscript{13} Kris Aerts and Tobias Schmidt ran another study, this one on Belgian and German research & development between 1998 and 2004. In terms of public investment in/subsidization of R&D, they found it increased expenditures on

\textsuperscript{13} ftp://ftp.zew.de/pub/zew-docs/dp/dp3798.pdf
R&D in the private sector by around 65 percent. Another study, conducted by Wesley Cohen, focused on U.S. manufacturing firms. Cohen’s study concluded that roughly 30 percent of R&D projects are created using some amount of public research. From this we can draw that public investment in research & development has an even larger impact on private innovation in the United States than in Germany, which many economists herald as the standard-bearer for R&D. Additionally, these investments by the public don’t crowd out private investments, but rather attract them in larger quantities.

The study by Frontier also indicated that links to academia are crucial for successful R&D investments, stating, “being able to draw on academic skills and new ideas is critical to longer-term innovation.” This concurs with Fraunhofer’s model of working alongside research institutions, drawing in the best and brightest graduates to conduct research. Reports cited in Frontier’s study indicated that that private sector innovation, and thus output, relies heavily on public funding of academic research. This is why the Fraunhofer Model is ingenious within itself – it combines public R&D funding, private R&D funding, and academia/higher education to create the “perfect storm” for innovation and returns on investment.

Section 4: Logistics of Applying Fraunhofer to U.S. Municipalities

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It is important to note that the process by which we will go about projecting the impacts of the Fraunhofer Model onto U.S. municipalities is simplified. There are numerous factors, including spillover benefits, knowledge gains, and broader societal implications, that accompany R&D investment that we do not have the ability to measure. Instead of looking at these mix of variables, we will concentrate on simplest measurement of success for any investment – the return gained on the capital put down. To do this, we must make a few basic assumptions:

1. The Fraunhofer Model is going to be sponsored across the nation on a federal level.

2. The funding levels will be determined on a per capita basis. In other words, we will extrapolate the spending levels in the U.S. based on the difference in population between Germany and the United States.

3. The funding will be dispersed across the four regions of the United States on a per capita basis – the West, Mid-West, South, and Northeast.\(^{16}\)

4. The three Fraunhofer Institutes projected in this thesis are the only Institutes in their respective regions\(^ {17}\).

First, we must determine the per capita spending by Fraunhofer in Germany. In 2013, Fraunhofer had a budget of around $2.45 billion, while the German population

\(^{16}\) We determined that we would not model a Fraunhofer Institute in the Northeast region of the United States due to the high concentration in this region already. We advise that an Institute located there also be brought up to the same funding levels, adjusted for all necessary computational changes.

\(^{17}\) There are currently seven Fraunhofer Institutes in the United States, but they do not follow the same public-private partnership model that their counterparts in Europe do.
was 80,565,861. The equation to calculate the per capita spending is exceedingly simple:

$$\text{Per Capita Spending} = \frac{\text{National Spending}}{\text{Total Population}}$$

Thus, our equation is:

$$X = \frac{2,450,000,000}{80,565,861}$$

$$X = 30.40990278$$

After rounding, we see that Fraunhofer spends an average of $30.41 USD per person on research & development.

In order to project this per capita spending average onto the United States, we simply need to multiply the per capita spending in Germany by the population of the United States. In order to remain consistent, we will use the estimated population of the United States on July 2nd, 2013, which is considered the middle of the year from an annual calendar perspective. According to the U.S. Census Bureau’s estimations, the population on this date was 316,434,677.\(^{18}\) From this, we have a simple equation:

$$\text{Projected U.S. Spending} = (\text{German Per Capital Average})(\text{U.S. Population})$$

Thus, our equation is:

$$\text{Projected U.S. Spending} = (30.41)(316,434,677)$$

$$\text{Projected U.S. Spending} = 9,622,778,528$$

\(^{18}\) http://www.census.gov/popclock/
We can see that our projected total U.S. spending on a Fraunhofer project would be a little over $9.6 billion USD. While this may sound like a significant sum of money, in reality it makes up a rather miniscule percentage of spending. If we look at Figure 6, we can see that the amount of money spent by the United States on research & development was significantly more than the amount spent by Germany. This is to be expected, however, due to the vast size of the United States government and economy. We can see through Figure 7 that the amount of spending by the United States is actually a smaller percentage of our national GDP compared to Germany. The Gross Domestic Product for the United States in 2013 was around $16.77 trillion, while our spending on R&D in 2013 was $456,903,847,000, meaning we spent around 2.742% of our GDP on research & development efforts. In order to project how much of our GDP we

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19 2013 is the last year where data is available for how much the United States spent on research & Development. Thus, our projections for this increase in federal funding will be for 2013. We will use 2013’s Gross Domestic Product and other indicators for our analysis.
would theoretically spend in 2014 after adding in our spending on Fraunhofer, reaching the following equation:

2013 Theoretical U.S. R&D Spending = 2013 Spending + Projected Fraunhofer Spending

\[ X = \$456,903,847,000 + \$9,622,778,528 \]
\[ X = \$466,526,625,528 \]

2013 Projected GDP Percentage Spent on R&D = \( \frac{X}{2013 \text{ GDP}} \)

\[ Y = \frac{466,526,625,528}{16,663,160,000,000} \]
\[ Y = .02799 \]
\[ Y = 2.799\% \]

When we add in our projected U.S. Fraunhofer spending to our existing R&D spending levels for 2013, we raise the percentage of our GDP we spend on R&D in the US to 2.799\%, up from 2.742\% recorded by the Organisation for Economic Cooperation and Development (OECD). This still does not reach Germany's level of spending, which was 2.826\% of their GDP, but it gets us closer to their level. This indicates that the increased spending on Fraunhofer would not be unreasonable, as we would still be spending less of our GDP than Germany and the difference makes up 0.057\% of our total GDP. Additionally, in actual implementation, this increase does not solely consist of public spending – an ideal situation would split this between the public and private sectors. However, we are proposing the simplest situation imaginable – we will ignore the origin of the funding and instead focus on the total amount as it stands. From these data points we will be able to extrapolate investment returns.
Section 5: Applying Fraunhofer to U.S. Municipalities

It is a given that different places in the world want to succeed and thrive economically. Without the desire to better your own economic circumstances, there would be no Silicon Valley, manufacturing clusters, or a drive to remain competitive on the global stage. The study of the economies of various places has been one that has confounded many economists over the years as they try to figure out why economic policies better some places and not others. For example, in his book “Everything in Its Place: Entrepreneurship and the Strategic Management of Cities, Regions, and States,” Dr. David Audretsch of Indiana University and the Centre for Economic Policy Research says that many economists wrongly believe that economic policies will better all places equally. So to speak, a rising tide will raise all boats. However, Audretsch says, “just because San Francisco surges, it does not mean that Gary, Indiana will follow.”20

It is important to note that the Obama Administration has recently been launching an initiative focusing on regional manufacturing innovation hubs. Much like the Fraunhofer Model, the regional manufacturing innovation hubs, housed under the Advanced Manufacturing National Program Office, or the AMNPO, used government and contractually obligated funding to attempt to find innovation in the field of manufacturing. However, that is where the similarities generally end. According to Dr. Erik Lehmann

While the AMNPO is too specific and unimaginative to be a replacement for the Fraunhofer Model, the Obama Administration’s choice of locations for the hubs

20 Book
themselves is particularly helpful. While they may have chosen areas specifically for their connection to the manufacturing sector, the areas in question are also rich in SMEs, in various industries, and in appropriate infrastructure for advanced research. Currently, there are five manufacturing hubs housed under the AMNPO and they are located in Knoxville, Tennessee, Chicago, Illinois, Detroit, Michigan, Raleigh, North Carolina, and Youngstown, Ohio.²¹

When applying the Fraunhofer Model to municipalities in the United States, as we will examine later in this research, we tried to choose three representative areas in the United States from which we could look at and draw basic conclusions about the United States as a whole. We attempted to draw municipalities that came from different regions of the United States, had one or more major research universities within the city or relatively close to it, and had a variety of sectors nearby, such as technology, biomedical, manufacturing, or agricultural. We also attempted to locate clusters of SMEs and chose locations that were located within or near these clusters. The location of the manufacturing hubs under the AMNPO was also taken into consideration, but was not a deciding factor for a majority of the chosen municipalities, as the AMNPO solely focuses on manufacturing and we wanted to analyze a variety of sectors. As a result, we ended up analyzing Chicago, Illinois, Austin, Texas, and San Francisco, California. While these places obviously do not make up a majority of the U.S., nor are they fully representative of such, they will provide, in our opinion, a stable model from which to draw from in the future when

looking at the Fraunhofer Model and its possible implementation in the United States.

**Subsection A: Chicago, Illinois**

Since it’s inception, Chicago, Illinois has been a pivotal harbor for growth and business. It’s relative proximity to the steel and ironworks industries, Northwest Indiana, and Lake Michigan have made it an area of economic growth and expansion. After the financial crisis of 2008, like most of the U.S., Chicago lost footing economically, but has been steadily growing following the crisis. Chicago stands out as an exemplary candidate for a Fraunhofer Institute because of its proximity to various sectors, its continually growing economy (both in terms of corporations and SMEs), and the presence of over a dozen universities.

Chicago has been the home of various industries that have propped up the city’s economy for decades. As a centrally located, major city in the heart of the Midwest, Chicago has been a hub for travelers, for businessmen, and for investors since its inception. As such, Chicago is home to dozens upon dozens of businesses, ranging from the smallest of SMEs to the largest of corporations. According to World Business Chicago, over 405,000 people are employed in the manufacturing sector in Chicago alone. This figure does not even account for those employed in the biotech or InfoTech sectors, both of which are continually growing fields in today’s economy.²²

Additionally, Chicago’s economy is increasingly diverse. The largest market share taken by a single industry is 14 percent. This implies that Chicago is home to a

²² [http://www.worldbusinesschicago.com/key-industries/](http://www.worldbusinesschicago.com/key-industries/)
large variety of sectors, making it an ideal position to sustain a Fraunhofer Institute.

The sheer size of Chicago’s economy has also been an attractive selling point for those considering settling down in the city. With a $576 billion economy, Chicago’s economy is larger than Belgium and Poland, for example, which come in at $525 billion and $526 billion, respectively. Because of these factors, Chicago was ranked the number one “Top Metro for New & Expanding Companies” by Site Selection magazine.23 Chicago is also home to 273 digital startups per year, on average, and is home to 1,800 foreign-based companies.24

Educationally speaking, Chicago is one of the best locations for a Fraunhofer Institute. The city is home to two top business schools, the Booth School of Business and the Kellogg School of Management.25 It is also the city where acclaimed research institutions, such as the University of Chicago, Northwestern University, Loyola University Chicago, DePaul University, and the University of Illinois at Chicago reside. A Fraunhofer Institute would have multiple partners from which to choose. Perhaps, even, the Institute could partner with different universities depending upon the project itself. With a plethora of options for partnerships, a Fraunhofer Institute would have an ideal position to produce quality research & development.

According to economic reports, Illinois as a whole has also been improving economically in terms of exports. According to the Chicago Tribune, “since 2009, goods exports have increased 58.8 percent, from $41.6 billion that year to $66.1 billion in 2013; this growth outpaced the national average of 49.6 percent over the

23 http://www.worldbusinesschicago.com/economy/
24 http://www.worldbusinesschicago.com/business-climate/
25 http://www.worldbusinesschicago.com/workforce-education/
same period.” Indeed, Illinois’ Compound Annual Growth Rate (CAGR) grew for all high-tech sectors between 2009-2013 except basic chemicals, aerospace products, oil & gas, and software. Conversely, Illinois outpaced the United States in terms of CAGR in precision instruments, pharmaceuticals, communications equipment, semiconductors, computer equipment, resins, commercial and service industry machinery, and magnetic/optical media. Of those, precision instruments, pharmaceuticals, communications equipment, and magnetic/optical media set record values for Illinois. In 2013, Illinois exported $13.4 billion in high-tech goods, making it the number six state for high-tech exports. Illinois also does well in agricultural commodities and heavy machinery – in fact, the non-high-tech industry in Illinois exported $52.7 billion worth of goods in 2013.

In terms of SMEs, Illinois is below average. SMEs in Illinois only produced 90 percent of the states exports, while the national average was 98 percent. As a result, however, local and state agencies have created programs, such as the Illinois State Trade and Export Promotion (ISTEP) program to help SMEs make trade deals so that they could grow.26 Thus, Illinois has shown it has a vested interest in improving the standing of SMEs within its borders. A Fraunhofer Institute, then, would be working alongside the current of the system itself – working with governments and SMEs to improve the system. Thus, it can be theorized that research & development would be sorely needed and appreciated at this time, meaning Fraunhofer would have an open market and welcoming clients.

In its totality, Chicago, Illinois is an ideal market for a Fraunhofer Institute due to its growing economy, the governments desire to help grow SMEs within the state, the location being a hub for business and for universities, and an economy that eclipses some nations. Chicago, Illinois not only is high-tech, but also is a place where people from all sectors come together to buy, sell, and trade goods. With industries ranging from steelwork to agriculture to pharmaceuticals, Chicago, and Illinois as a whole, are booming. Thus, it is our determination that Chicago ought to be one of the three municipalities we use to model the impact of a Fraunhofer Institute.

**Subsection B: Austin, Texas**

As the only southern city on our list of chosen municipalities, Austin, Texas is in a unique position to bring economic change to the South. Indeed, Austin has proven itself as a valid economic powerhouse. Following the financial crisis of 2008, Austin has fared better than other U.S. cities, ranking as the #1 economy in the United States by *The Business Journal*.\(^{27}\) Indeed, Austin, due to a variety of factors, has proven itself as a worthy economic competitor against other areas of the country. As a city with an exceptional economy, a growing workforce, and access to high quality education, Austin will prove itself to be an economy worthy of a Fraunhofer Institute.

As a city with over 1 million residents as of 2013, no one is calling Austin a small town by any means. To the contrary, Austin has been growing at a nearly

alarming rate, far outpacing the rest of the United States. In fact, between 2003 and 2013, the United States experienced a population growth of 8.9 percent, compared to Austin’s incredible 36.8 percent increase. As a city, Austin is not only growing in size, but it is rather booming. Not only is it booming in size, but Austin’s population is also better off educationally than the rest of the United States, on average. In fact, 41.5 percent of those living in Austin, Texas have a bachelor’s degree or higher, while only 29.6 percent of the United States can say the same. Meanwhile, 14.3 percent of Austin residents have a graduate degree, compared to 11.2 percent of United States citizens. This may be due to the fact that a campus of the University of Texas, a major research institution, calls Austin home.

Indeed, Austin, Texas is a growing municipality that rivals the United States in terms of both growth and educational attainment, both of which are important factors when considering the placement of a Fraunhofer Institute. Texas as a whole has also been growing economically in terms of globalization. According to Anil Kumar, a Senior Economist at the Federal Reserve Bank of Dallas, Austin is in the top 25 U.S. cities in terms of globalization, due largely in part to their partnership with Mexico. The Brookings Institute also ranks Austin highly in terms of economic growth. In 2014, Austin’s economy grew by 1.9 percent and job growth

29 http://repositories.lib.utexas.edu/bitstream/handle/2152/14681/tbr-2009.06.pdf?sequence=2
reached 3.6 percent. This outpaces the U.S. averages of 1.3 percent and 1.5 percent, respectively.30

Austin, Texas is home to various industries that will help provide diversity and growth for a Fraunhofer Institute. For example, Austin is the headquarters for Samsung’s largest domestic semiconductor production center. Other high-tech companies that have firms or centers within Austin are IBM, Dell, Apple, Altera, and 3M, to name a few. Austin is also home to over a dozen “general” manufacturing companies. A 2012 report by the National Science Foundation ranked Austin in the top 10 cities for research & development, while the region itself ranked 9th in per capita activity and patents awarded. Truly, Austin is proving to be a global economy for innovation and research. As of 2012, Austin was home to 306 high tech manufacturing firms that employed 29,700 people.31 However, the high-tech field of manufacturing does not account for more traditional forms of manufacturing, such as steel/iron works. It also does not include clean energy/power technology. The Austin-region is home to ten clean energy/power companies that focus on everything from water purification to solar panel design.32

In addition to having a plethora of existing businesses, Austin is constantly evolving as one of the best places in the United States to start a business. As the second-fastest growing metro in the United States, Austin is no stranger to accelerated expansion. In fact, Entrepreneur Magazine rates Austin as the number

32 http://www.austinchamber.com/site-selection/key-industries/clean-energy-power.php
one “hottest startup scene in the US,” making Austin a prime location for new businesses to be born and to grow. The Chamber of Commerce in Austin has started an “Innovation Ecosystem,” targeted towards attracting and sustaining new businesses. The Innovation Ecosystem has 4,744 high-tech companies and has created 46 co-working spaces designed to help accelerate business growth.\textsuperscript{33}

Generally speaking, Austin has proven itself as a city with an economy that is sustainable, growing, and innovative. With both high-tech and general manufacturing sectors, new research into sustainable businesses, and high quality educational opportunities close by, Austin is a hotbed for economic growth. Additionally, the efforts by the Chamber of Commerce and local governments shows that Austin is making an effort to grow small businesses and startups. By being able to probe local research institutions and work with both larger corporations and SMEs, a Fraunhofer Institute would greatly benefit the city of Austin and vice-versa. Thus, it is our determination that Austin ought to be one of the three municipalities we use to model the impact of a Fraunhofer Institute.

**Subsection C: San Francisco, California**

Home to the Golden Gate Bridge, San Francisco has been an iconic city for generations. Home to 1,832,800 in the metro area, San Francisco is more than just an icon – it’s a booming metropolis rich with sustainable economic growth and prosperity. Indeed, according to Forbes, the median household income is $81,135, while the metro area produces around $159.8 billion in Gross Metro Product. The metro area is also growing in terms of size – roughly 2,700 people migrate to the

\textsuperscript{33} http://innovation.austinchamber.com/
city each year. As a city gifted with steady economic growth and a population rich in education and employment, San Francisco has proven itself, in our minds, worthy of a Fraunhofer Institute.

According to the San Francisco Center for Economic Development, it is possible to separate the city’s industries into six key sectors. These sectors are IT & Software, Social & Digital Media, Life Sciences & Biotechnology, Environmental & Clean Technology, Professional Services, and International Business. While all these sectors are important for San Francisco’s economic success, we are going to focus on IT & Software, Life Sciences & Biotechnology, and Environmental & Clean Technology. In the IT & Software Sector, San Francisco is quite literally booming, as it is the home to 6,706 IT firms with the sector growing by over 18 percent between 2010 and 2014. Going even further, San Francisco’s high-tech job base has grown by 51 percent, as illustrated by Figure 6.

Figure 6.

2010 and 2014. Going even further, San Francisco’s high-tech job base has grown by 51 percent, as illustrated by Figure 6.

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34 http://www.forbes.com/places/ca/san-francisco/
In the Life Sciences & Biotechnology sector, San Francisco is managing to hold its own. The city is home to top-tier biotechnology programs at Stanford, UC Berkeley, US San Francisco, and the University of San Francisco. As a result, the Bay Area has the highest concentration of biotechnology companies in the world, with over 1,662 life science companies, generating nearly $4 billion in economic activity for the city. For the metro area as a whole, Life Sciences & Biotechnology produced $95 billion in economic activity. As a city known as the birthplace of biotechnology, San Francisco is living up to that name.\(^{36}\)

As for the Environmental & Clean Technology sector, San Francisco is maintaining a lead over other U.S. cities. With over 635 Clean Technology companies in the Bay Area, with 225 in San Francisco alone, the industry is booming in the San Francisco Metro Area. The city itself has been recognized for this progress, being named the number one city in various categories, from being most sustainable to being the greenest city in North America. It also received an award for being the number one city for Clean Technology job activist. The city itself is also dedicated to being sustainable, which has proven beneficial to these businesses. The city has invested in solar panels, clean air vehicles, and various greenhouse gas elimination practices over the years. As a whole, San Francisco has ranked number one in Clean Technology out of all other U.S. cities, providing a booming market for this increasingly relevant sector.\(^{37}\)

\(^{35}\) http://sfced.org/case-for-business/sectors/information-technology/
Educationally speaking, San Francisco is also a thriving municipality. With 7,051 college degrees per square mile, San Francisco is the number one city in the U.S. for Educational Attainment Density.\(^3^8\) And with nearly 20 percent of San Francisco residents having a graduate/professional degree, the city is thriving in terms of continuing education.\(^3^9\) With the University of California, San Francisco, the University of California, Berkeley, and San Francisco University, residents near San Francisco have world-renowned universities at their disposal. Indeed, the potential for research & development at these universities is fairly high. Once you factor in the high density of growing sectors in the region as well, a Fraunhofer Institute would have no shortage of projects.

Public officials in San Francisco are also scrambling to help build up their small-medium enterprises, realizing that small business is “the key to supporting economic growth... and creating new jobs,” according to San Francisco Mayor Edwin M. Lee. In January of 2012, Mayor Lee announced $1.5 million would be made available to small businesses in San Francisco to try and boost their economic growth and standing within the city. Indeed, in 2014, the Milken Institute ranked San Francisco the number one “Best Performing City”. According to their 2014 report, the Milken Institute stated that San Francisco raised in the rankings because of it’s technology-based job growth and wage growth. Between 2008 and 2013, for example, the scientific and technical services sector grew by 25,500 jobs, or 45 percent of total job growth. In terms of wage growth, those in the technology field

\(^{38}\) http://content.usatoday.com/communities/ondeadline/post/2010/06/new-measure-ranks-san-francisco-the-smartest-us-city/1#.VWbZy1meDGc
\(^{39}\) http://sfced.org/case-for-business/facts-figures/workforce-education/
in San Francisco make around $91,400 annually, compared to the national average of $70,900. This increasingly quick job/wage growth is attracting young, talented individuals, making San Francisco a booming area for a creative class. According the Milken Institute, the San Francisco Bay Area has two main assets – “a leading entrepreneurial ecosystem with innovation strengths in both the creative and scientific economy” and “high education attainment and the ability to attract talent from around the world.”

In it’s entirety, San Francisco has proven to be a bastion for small-medium enterprises and start-ups. As the number one ranked city in the nation, San Francisco is a proven player in terms of growth and prosperity. Its growth in sectors ranging from clean technology to software, in addition to city investment in startups, makes San Francisco a booming economic paradise for high-tech startups and businesses in general. Indeed, San Francisco’s ability to attract young talent from around the world, paired with its high rate of educational attainment, makes it one of the better cities, in our opinion, to host a Fraunhofer Institute. In all actuality, it appears that San Francisco’s growth is not slowing down significantly any time soon. The presence of Fraunhofer in San Francisco, in our minds, would only increase the strength of small businesses and create an atmosphere that is only more attractive to entrepreneurs and new businesses.

Section 6: Recommendations

Based on our research and analysis provided above, we had a set of recommendations we would make to key stakeholders. These stakeholders would

include private industry, which would encompass venture capitalists, investment firms, manufacturing organizations, a variety of corporations, and small-medium sized enterprises in need to research & development. Additionally, both public and private universities would be involved in the conversation, as well as academics in relevant fields, such as biotechnology and mechanical engineering. Arguably, our largest task would be to engage governmental stakeholders, including Members of Congress, the Departments of Commerce/Homeland Security/Education/Labor (among others), and state/city officials in our chosen municipalities.

First, we would advocate that the federal government partner with Fraunhofer-Gesellschaft officially and with a substantial upfront investment as is done in Europe. Currently, Fraunhofer USA is lacking that long-term, constant investment from the U.S. federal government than that exists between Fraunhofer-Gesellschaft and the German government. Instead, the Fraunhofer USA Institutes that are in existence fight for contracts, grants, and projects on a regularly basis. This draws from some of the original research/capabilities that Fraunhofer-Gesellschaft has capitalized on in order to fund rapid growth and expansion. In Germany, the government provides a 30 percent base funding level to Fraunhofer, in order to allow for original, base research and administrative strategies that are necessary for expansion. As we have shown, the partnership between the government and Fraunhofer has the potential to spark economic development. Funding options could come in a variety of forms. Grants, built into the budget of a department (or multiple departments) as a line-item, or even strategies to shift the burden from the federal government to the states as the Institutes establish and
prove themselves. In reality, the form of the funding is not the most important stipulation – rather, the requirement that the funding be consistent in continuity and percentage of operating budget to the funding provided to Fraunhofer-Gesellschaft is of the most importance.

Of course, our next recommendation is for the federal, state, and local governments to work together to lobby Fraunhofer for the implementation of an Institute in Chicago, Illinois, Austin Texas, and San Francisco, California. As we have established above, these municipalities all have exhibited strong economic track records, with renowned universities and private industry located in or near the city. We would want the governmental stakeholders to have already worked to sponsor and support these Institutes, among others, at the previously identified ideal levels.

According to a study completed by the United State Conference of Mayors, the 10 largest U.S. metropolitan areas would rank as the world’s fourth largest economy, after the United States, Japan, and Germany. The 50 largest U.S. metropolitan areas would rank second only to the entire economy of the United States, producing $825 billion more than Japan. Within the United States, they found the gross product of our 10 largest metropolitan areas has a larger combined output than the 31 smallest states. 84 percent of Americans employed in 1998 were employed in metro areas – the bulk of U.S. economic growth and development occurs in these highly populated, urban areas41. As a result, it is crucial that Fraunhofer operate in these areas as well.

In order to help ensure the success and growth of these Fraunhofer Institutes, the U.S. Department of Commerce ought to assist in marketing these

Institutes to small-medium sized enterprises in neighboring communities/states. These is a recommendation for ours for two major reasons – the number of SME firms and the connections offered by the Department of Commerce. Firstly, when establishing stakeholder meetings, it is easy for Fraunhofer to identify the large corporations that may use their services. For example, U.S. Steel would be a fairly intuitive company for Fraunhofer to reach out to for a potential partnership in the future. Smaller businesses are inherently at a disadvantage in this model, as they may not have gained the name recognition needed to be on the radar of researchers, including Fraunhofer. The Department of Commerce could serve a crucial role in advocating Fraunhofer to these SMEs by providing a trusted “stamp of approval.”

Due to the connections the Department of Commerce has in a variety of sectors across our economy, this outreach program could be relatively swift. While the Department would not be charged with brokering deals or partnerships between Fraunhofer and the businesses themselves, they would provide informational materials on the new program sponsored – at least in part - by the U.S. Department of Commerce. This additional marketing and advocacy could heavily assist in notifying SMEs about this program which has the potential to exponentially help their business. As a result, we believe it is well worth the effort.

Our final recommendation focuses largely on the educational aspect of the Fraunhofer Model. Fraunhofer’s close relationship with universities brings forward opportunities for students studying applied sciences and who need experience working in a research-oriented position. Due to this invaluable, vastly beneficial partnership, the U.S. Department of Education should work with Fraunhofer to
create a benefit program that would subsidize or incentivize the continued hiring of graduates or advanced students in the applied sciences field. This program could potentially lead to an increase in the number of students/graduates that Fraunhofer could hire, leading to a net societal benefit in the form of gained knowledge, a higher employment rate amongst graduates, and the increase in skills held by our next generation of scientific researchers.

All in all, our recommendations are simple on paper: invest in Fraunhofer, expand Fraunhofer, market Fraunhofer to SMEs, and help more students get involved with Fraunhofer. Implementation of these policies may prove more difficult than modeled here – it is impossible for our research to encompass all potential outcomes, models, predictions, or historical data related to these recommendations. We focus on building a case for these recommendations, specifically on the implementation of Fraunhofer in Chicago, Austin, and San Francisco, not necessarily “flushing them out” in their entirety. While this would be a worthwhile topic for ongoing research in this field, this is simply outside of our scope and ability at this point in time. As the United States moves forward with its relationship with Fraunhofer, we ought to continue asking and researching these questions. We believe this is an important field to explore and strengthen.

Section 7: Foreseen Challenges & Their Solutions

The largest challenge, faced both during the research completed in this thesis and the future implementation process of our recommendations, originated from the nature of this field itself. Firstly, there is no consensus on which is the appropriate way to measure return on investment as it relates to research &
development investments. In traditional calculations regarding return on investment, one would look at how much capital was gained due to the original investment. Research & development clouds this process because there are multiple other factors at play. For example, in addition to the gained capital, there is also spillover benefits, societal benefits, and knowledge benefits. These benefits are generally broad in scope and require a significant amount of data and analysis to compute. Bronwyn Hall, Jacques Mairesse, and Pierre Mohnen concluded their report “Measuring the Returns to R&D” by saying “…because of the difficulties uncovered in constructing an R&D capital and choosing the appropriate... model... further work on the best way to model the R&D input would be extremely desirable.”

Until an appropriate model is designed, and report on this matter could potentially be under or overstating benefits of R&D investment. Without this data, even our most basic research is prone to criticism, as we are making recommendations on the basis of correlation, not proven causation.

Likewise, the privacy of these organizations has shown to be a barrier in our research. Fraunhofer and many of their contracting organizations hold these partnerships, research investments, and scientific advancements in confidence. As a result, we cannot quantify the impact of Fraunhofer on the German economy. There are thousands upon thousands of factors that shape the economy – we simply cannot measure them all, especially considering the lack of information regarding Fraunhofers work. Many economists point towards Fraunhofer as being a major economic player – however, this cannot be concretely proven with hard numbers.

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due to Fraunhofer refusing to release many of these numbers. Aside from their total budget, we are uncertain about how much their research has sparked in additional investment, profits, societal gains, etc.

From a political standpoint, there may be some significant pushback against the United States investing a significant sum of money invested with a private research institution to benefit private industry. In the United States, certain conservative elected officials may oppose this plan on the basis of laissez faire economics. They may feel as though the government “subsidization” of private industry research leads to the government having an undue influence over private economic development and progress. Even liberal elected officials may oppose this plan, based on their continued opposition to many industries receiving tax-breaks or subsidies from the government. Funding an organization, such as Fraunhofer, which may complete research on the behalf of the fossil fuel industry may raise the ire of some more left-leaning bureaucrats or politicians.

Section 8: Conclusion

Fraunhofer-Gesellschaft has a wealth of benefits and opportunities to offer our communities, our industries, and our nation. Germany's continued success with developing SMEs, growing manufacturing sector, and high levels of education and employee satisfaction all lead to an outstanding economy, especially in the world we know today. Fraunhofer has continued to help the German and European people through their Institutes, which help develop applied research & development through contracts with both private industry and the government. This research has
helps benefit thousands of businesses over the years, producing millions upon millions in revenue for these private organizations.

While there are currently Fraunhofer Institutes placed throughout the United States, they lack the baseline funding that exists in the German model. Whereas Fraunhofer-Gesellschaft receives a baseline contribution of 30 percent of their operating budget from the Germany government, Fraunhofer USA receives no baseline funding. Individual institutes can compete for contracts, grants, or aid from the government on a case-by-case basis. These processes take up valuable time and energy that Fraunhofer could be focusing on expansion and research. As a result, the progress of Fraunhofer has been bogged down ultimately mitigated.

Our main goal in this thesis was to identify three potential future locations for Fraunhofer US Institutes. Due to the vast majority of economic growth in the United States originating from metropolitan areas, as well as a larger amount of data available in these same regions, we looked primarily towards large cities. Through our research, we identified three areas of economic strength and diversity suitable for a Fraunhofer Institute – Chicago Illinois; Austin, Texas; and San Francisco, California. If Fraunhofer were to invest and enter these markets, we believe there would undoubtedly be economic benefits to be gained, potentially resulting in increased profits, increased wages, and increased revenue for the government.

There are definitely issues with our analysis that we recognize and accept at this time. The lack of data available from Fraunhofer or their partners certainly serves as an impediment to continued, accurate research. Without knowing the return on investment for Fraunhofer/their partner, we can never quite measure the
economic impact derived from this research & development investment vessel. Additionally, the lack of consensus surrounding what constitutes an accurate, informed measure of return on investment for research & development clouds this field of study to some degree. However, we stand by our final recommendations. There is a reason why Fraunhofer Institutes have continued to expand in the United States and there is merit to their past successes as a vessel for research & development. By partnering with Fraunhofer, the United States will continue to push forward, inspiring new, high-tech projects and research, maintaining its position as an economic powerhouse and world superpower. Fraunhofer completes research for industry and government while giving students and recent graduates at research universities the opportunity to learn and work at the same time. In its entirety, Fraunhofer USA has the potential to serve as catalyst for growth and competition – it is important that further research is completed on this matter so that we may take advantage of this amazing opportunity. It is clear that Fraunhofer has a proven track record in Europe– let's work with them to prove it here.

https://www.asme.org/engineering-topics/articles/manufacturing-processing/how-does-germany-do-it

http://www.census.gov/popclock/
