VOL: 5, ISSUE: 2
February/2019
https://ijbassnet.com/
E-ISSN: 2469-6501

The Impact of a Potential Public/Private Initiative on a Defined Region of the South Suburban Chicago Metropolitan Area

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Abstract

The university is considered one of the engines of growth in a local economy or its market area, since its direct contributions consist of 1) employment of faculty and staff, 2) services to students, and supply chain links vendors, all of which define the University's Market area. Indirect contributions consist of those agents associated with the university in terms of community and civic events. Each of these activities represent economic benefits to their host communities and can be classified as the economic impact a university has on its local economy and whose spatial market area includes each of the above agents. In addition are the critical links to the University, which can be considered part of its Demand and Supply chain.

This paper contributes to the field of Public/Private Impact Analysis, which is used to substantiate the social and economic benefits of cooperating for economic resources. We use Census data on Output of Goods and Services, Labor Income on Salaries, Wages and Benefits, Indirect State and Local Taxes, Property Tax Revenue, Population, and Inter-Industry to measure economic impact (Implan, 2016).

Keywords: Regional Economic Analysis, Economic Development, Input-Output Modelling

JEL: R, O, C

1. Introduction

The contribution of colleges and universities has recently received a great deal of research attention due primarily to their critical input into local economies in terms of their benefits and costs. On the cost side, state-funded universities are being challenged to provide more of their funding due to the current state of economic affairs relative to state governments. According to Finney and Kelly (2004) and Okunade (2004), there is a strong link between the economic performance of state and federal economies to university funding. Between 1990 and 2004, the ability of state governments to sustain colleges and universities increased substantially. However, state and national business cycles have become a major threat to funding of colleges and universities, now having to consider additional revenue sources to increase their sustainability.

Consequently, colleges and universities have produced generating research to demonstrate their impact as economic drivers in the local market area. The presence of several universities in linked market areas is not a negative factor but one which strengthens the area by providing higher job and wage contracts to residents of these areas. Although these universities may compete in terms of students, there are substantial differences in cost structures and program differentiation among spatially close competitors. Thus, it is imperative that colleges and universities demonstrate their social and economic contributions to their local economies and measure these impacts in a qualitative and quantitative fashion.

Linked to the performance of the academy to local economies is the link between the private sector and the academy, especially in the areas where new technologies are introduced. Private sector innovation linked with

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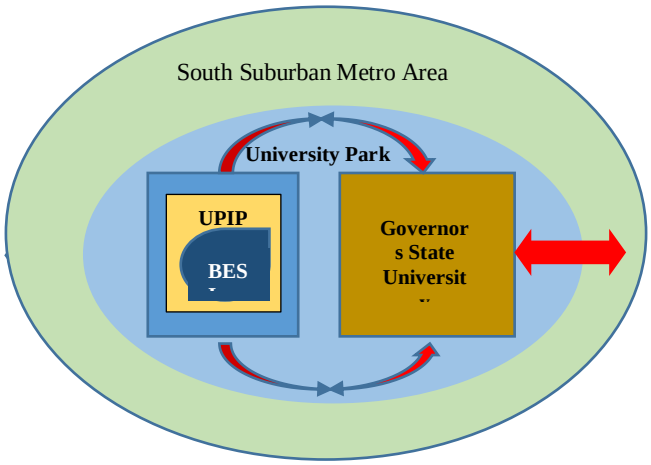
https://ijbassnet.com/
E-ISSN: 2469-6501

colleges and universities has demonstrated unique synergies resulting in a three-way benefit process. Increasingly, as federal and state funding is declining, it is becoming increasingly important how each of these sectors can support each other. For example, the private sector can provide opportunities in the areas of funding, training opportunities, and research opportunities.Universities can offer degree and certificate opportunities, access to faculty for specialized research, and venues for on-campus and online teleconferencing. These triad and co-joint relationships generate spatial economic agglomerative activities that positively impact local economies.

The purpose of this research is to measure the contribution of BESI to its local economy and to demonstrate that its contributions also extend into national and international economic environments. Figure 1.1 below shows impact linkages for Governors State University (GSU), University Park (UP), University Park Industrial Park, (UPIP) Biomass Engineering Systems Inc.(BES), University Park (UPIP), and the South Suburban-Metro Area (SSMA)economic and market areas.

Figure 1.1



The above configuration provides a pictorial representation of households, firms, governmental, and non-governmental agencies, which form concentrations and, largely connected localization economies, clusters, and agglomeration economies. Localization economies are companies that experience substantial costs savings for input sharing, labor pooling, and information spillovers (O'Sullivan, 2003, p. 53).Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, and firms in related industries and associated institutions (e.g., universities, trade associations, and standards agencies) that compete but also cooperate (Porter, 1996, p.197). In other words, clusters are geographic proximate groups of companies and associated institutions in a field, linked by commonalities and complementarities (p.199). Finally, agglomeration economies explain why some regions develop large clusters, especially those in large cities or metropolitan areas or some nodal concentrations within them (Stinson et al., 2002, p. 23). Understanding the composition of a community's agglomerative activities provides the basis for planning and enhancing existing cluster activities, which provides the basis for developing linkages or creating core elements necessary for new agglomerative sectors.

The purpose of this document is to identify linkages of competitive and cooperative localization and cluster economies that provide the basis for increasing competitive growth areas of three economic and market divisions: communities, production facilities, and institutions. Figure 1.1 provided a schematic view of these linkages and the following sections will provide add a spatial-techno-economic and marketing context for University Park and the South Suburban metropolitan areas.

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2. Materials and Methods: The Spatial Configuration of University Park

The Village of University Park is located 31 miles south of Chicago, along the old Illinois Central Rail line in Cook and will counties (see Figure 2.1). The Village's major economic drivers are its 1) two Industrial Parks, 2) Governors State University, and 3) its local government institutions.

Figure 2.1[1]

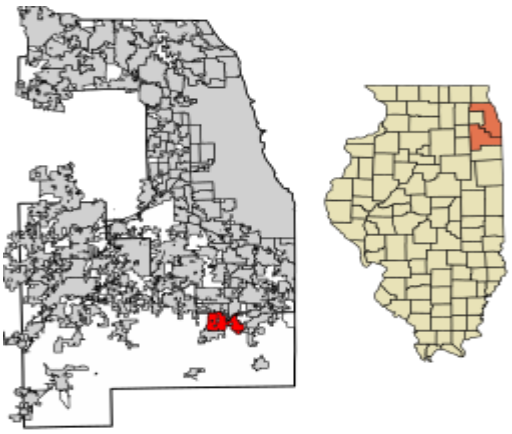
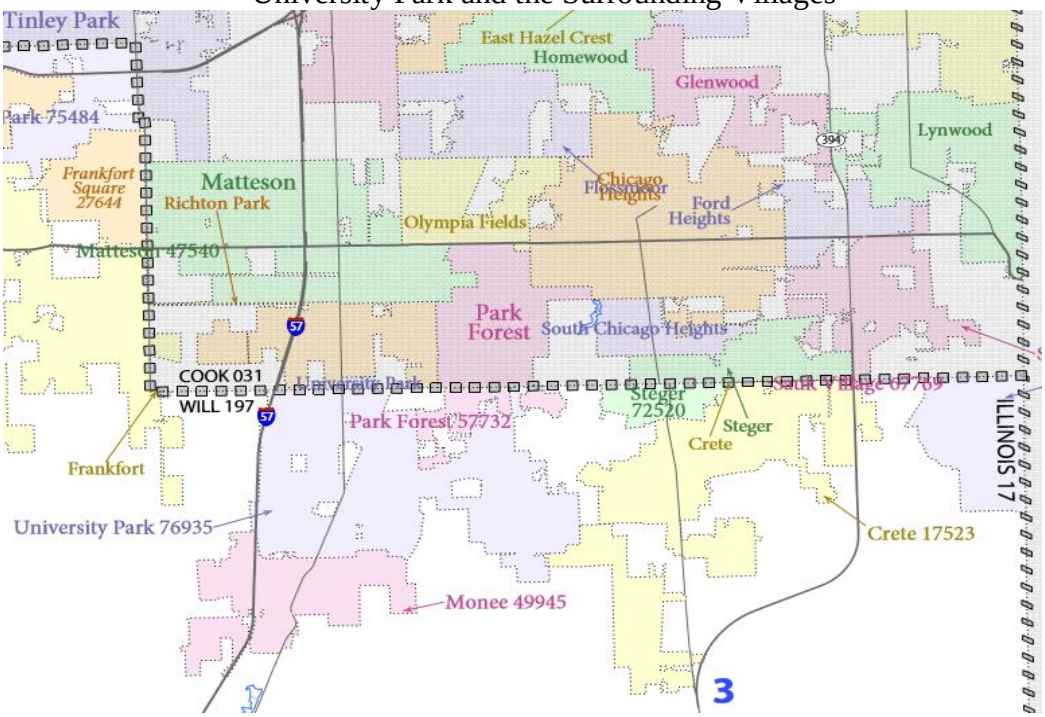


Figure 2.2:
University Park and the Surrounding Villages



Source: https://www2.census.gov/geo/maps/dc10map/tract/st17_il/c17197_will/DC10CT_C17197_000.pdf

[1] Source: https://www.google.com/imgres?imgurl=https://upload.wikimedia.org/wikipedia/en/thumb/5/59/Cook_County_Illinois_Incorporated_and_Unincorporated_areas_University_Park_Highlighted.svg/260px-Cook_County_Illinois_Incorporated_and_Unincorporated_areas_University_Park_Highlighted.svg.png&imgrefurl=https://en.wikipedia.org/wiki/University_Park,_Illinois&h=255&w=260&tbnid=66TZvKWJQYjXGM:&tbnh=160&tbnw=163&usg=__uld2pZcsyvuVzBoV5k3GVCWsFXs=&vet=10ahUKEwiAiNr5353WAhVK4iYKHa4KD0IQ9QEIKjAA..i&docid=Zr3S3veP0jWQ2M&sa=X&ved=0ahUKEwiAiNr5353WAhVK4iYKHa4KD0IQ9QEIKjAA

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E-ISSN: 2469-6501

University Parke is census placed in Cook and Will counties. The key business sector statistics for the Village are presented in Table 2.1.

Table 2.1
Sector Statistics - 2017

Sector	$	Share
Health and Social Assistance	NA	
Wholesale	853,563,000	65.52%
Manufacturing	416,127,000	31.94%
Retail	30,574,000	2.35%
Accommodations and Food Services	2,515,000	0.19%
	1,302,779,000	**100.00%**

Source: US Census: University Park

The predominant sector for which data is available is in Wholesale Trade, establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing and generally considered an intermediate step in the distribution of merchandise. Thus, approximately 66 percent of production is in this sector.

Manufacturing is the second largest sector at approximately 32 percent, followed by Retail at 2.4 percent and Accommodations and Food at 2 tenths of one percent. While the retails and accommodations and food services sectors seem small, University Park is located in an area where major sectors in these two areas are located north in the Villages of Matteson and Richton Park, with other key markets including retail, located to the west, in Orland Park. The dominant retail sector has been moving west since the late 1980s, as population shifts have moved in that direction and movement from the northeast from the O'Hare airport area, converging in locational areas around I-80, I-55, I-90, and I-294. These convergences provide University Park with a competitive advantage in locational distribution.

2.1 University Park Industrial Parks

The University Park Industrial Park (UPIP) and Governors Gateway Industrial Park (GGIP) are primary distribution facilities along the I-80, I-57, I-90, and I-294 Corridors. Firms in both parks along with Governors State University, comprise the major employment and production companies in University Park. These sectors exist in a south suburban region with other competitive communities where University Park accounts for 16.16% of the areas regional distribution of firm activity (Table 2.2).

Both firm production structures can be defined by specific production, as shown below in Table 2.3, where the major employment sector is in machinery manufacturing and the sales leader in the Chemical manufacturing sector. University Park's location is in two counties (primarily Will),

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Table 2.2:
Distribution by City of Production

Tabulation of CITY
Date: 04/15/17 Time: 21:21
Sample: 1 1182
Included observations: 1182
Number of categories: 10

Value	Count	Percent	Cumulative Count	Cumulative Percent
Beecher	10	0.85	10	0.85
Crete	580	49.07	590	49.92
Frankfort	1	0.08	591	50.00
Mokena	1	0.08	592	50.08
Monee	304	25.72	896	75.80
Park Forest	61	5.16	957	80.96
Richton Park	2	0.17	959	81.13
Saint Paul	1	0.08	960	81.22
Steger	31	2.62	991	83.84
University Park	**191**	**16.16**	**1182**	**100.00**

Table 2.3:
University Park Industrial Structure in Will County
($000) *

NAICS	Meaning of 2007 NAICS code	Firms	Sales*	Payroll*	Employees	Non-Employer Firms	Non-Employer Sales*
311	Food manufacturing	31	964,030	87,976	2,312	33	370
322	Paper manufacturing	16	421,436	D	914	6	60
323	Printing and related support activities	63	D	D	967	78	2,446
324	Petroleum and coal products manufacturing	8	D	D	f	7	483
325	Chemical manufacturing	37	2,412,456	136,469	2,126	21	1,051
326	Plastics and rubber products manufacturing	33	791,155	96,085	2,225	10	734
327	Nonmetallic mineral product manufacturing	40	D	51,531	1,168	D	D
332	Fabricated metal product manufacturing	124	592,795	118,941	2,675	74	4,818
333	Machinery manufacturing	84	1,154,410	207,018	3,498	27	773
334	Computer and electronic product manufacturing	27	698,210	65,367	1,298	9	578
336	Transportation equipment manufacturing	18	D	D	867	14	667
337	Furniture and related product manufacturing	40	D	42,466	1,022	15	711
339	Miscellaneous manufacturing	53	D	22,843	639	91	4,274
31-33	Manufacturing	12	387,460	62,334	1,227	N	N
334	Computer and electronic product manufacturing	1	D	D	f	N	N

Source: US Census, American Factfinder

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Table 2.3:
Industry Composition by Number of Firms
University Park, IL

Graphic area name	NAICS	Meaning of 2007 NAICS code	Firms	%
Will County, Illinois	332	Fabricated metal product manufacturing	124	21.12%
Will County, Illinois	333	Machinery manufacturing	84	14.31%
Will County, Illinois	323	Printing and related support activities	63	10.73%
Will County, Illinois	339	Miscellaneous manufacturing	53	9.03%
Will County, Illinois	327	Nonmetallic mineral product manufacturing	40	6.81%
Will County, Illinois	337	Furniture and related product manufacturing	40	6.81%
Will County, Illinois	325	Chemical manufacturing	37	6.30%
Will County, Illinois	326	Plastics and rubber products manufacturing	33	5.62%
Will County, Illinois	311	Food manufacturing	31	5.28%
Will County, Illinois	334	Computer and electronic product manufacturing	27	4.60%
Will County, Illinois	336	Transportation equipment manufacturing	18	3.07%
Will County, Illinois	322	Paper manufacturing	16	2.73%
Cook County (part), University Park village, Illinois	31-33	Manufacturing	12	2.04%
Will County, Illinois	324	Petroleum and coal products manufacturing	8	1.36%
Cook County (part), University Park village, Illinois	334	Computer and electronic product manufacturing	1	0.17%

Source: Table 1

TOTAL 587 1.0000

able 2.4:
University Park Manufacturing Sector Firm Sales
2007 ($000)

NAICS	Meaning of 2007 NAICS code	Firms	Sales*	Non-Employer Sales*	Total Sales*
327	Nonmetallic mineral product manufacturing	40	D	D	
334	Computer and electronic product manufacturing	1	D	N	
325	Chemical manufacturing	37	2,412,456	1,051	**2,413,507**
333	Machinery manufacturing	84	1,154,410	773	**1,155,183**
311	Food manufacturing	31	964,030	370	**964,400**
326	Plastics and rubber products manufacturing	33	791,155	734	**791,889**
334	Computer and electronic product manufacturing	27	698,210	578	**698,788**
332	**Fabricated metal product manufacturing**	**124**	**592,795**	**4,818**	**597,613**
322	Paper manufacturing	16	421,436	60	421,496
31-33	Manufacturing	12	387,460	N	**387,460**
339	Miscellaneous manufacturing	53	D	4,274	**4,274**
323	Printing and related support activities	63	D	2,446	**2,446**
337	Furniture and related product manufacturing	40	D	711	**711**
336	Transportation equipment manufacturing	18	D	667	**667**
324	Petroleum and coal products manufacturing	8	D	483	**483**
				TOTAL	**7,438,917**

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The major employment sector is in machinery manufacturing and the sales leaders are the Chemical manufacturing sector. However, logistic transportation information is not currently available.

Table 2.5:
Distribution by City of Production

Tabulation of CITY
Sample: 1 1182
Included observations: 1182
Number of categories: 10

Value	Count	Percent	Cumulative Count	Cumulative Percent
Beecher	10	0.85	10	0.85
Crete	580	49.07	590	49.92
Frankfort	1	0.08	591	50.00
Mokena	1	0.08	592	50.08
Monee	304	25.72	896	75.80
Park Forest	61	5.16	957	80.96
Richton Park	2	0.17	959	81.13
Saint Paul	1	0.08	960	81.22
Steger	31	2.62	991	83.84
University Park	**191**	**16.16**	**1182**	**100.00**
Total	1182	100.00	1182	100.00

Source: Database USA

Table 2.6
Distribution of Production by County

Tabulation of COUNTY
Date: 04/15/17 Time: 21:28
Sample: 1 1182
Included observations: 1182
Number of categories: 3

Value	Count	Percent	Cumulative Count	Cumulative Percent
Cook	13	1.10	13	1.10
Decatur	1	0.08	14	1.18
Will	**1168**	**98.82**	**1182**	**100.00**
Total	1182	100.00	1182	100.00

Source: Database USA

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Table 2.7
Distribution of Employment by Firm Size

Tabulation of EMPCOD3 and EMP_CODE

Sample (adjusted): 1 1150
Included observations: 1150 after adjustments

Tabulation Summary

Variable	Categories
EMPCOD3	8
EMP_CODE	8
Product of Categories	64

Count		A	B	C	D	E	F	G	H
	1 to 4	**538**	**0**	0	0	0	0	0	0
	10 to 19	0	0	205	0	0	0	0	0
	100 to 200	0	0	0	0	0	17	0	0
EMPCOD3	20 to 49	0	0	0	87	0	0	0	0
	200 to 500	0	0	0	0	0	0	10	0
	5 to 9	**0**	**243**	0	0	0	0	0	0
	50 to 99	0	0	0	0	46	0	0	0
	501 to 900	0	0	0	0	0	0	0	4

Source: Database USA

Table 2.8
Distribution of Sales

Tabulation of SALESCDE2
Included observations: 1085 after adjustments
Number of categories: 7

Value US$	Count	Percent	Cumulative Count	Cumulative Percent
1,000,000 - 2,495,999	217	20.00	217	20.00
10,000,001 - 50,000,000	65	5.99	282	25.99
100,000,001 - 750,000	9	0.83	291	26.82
2,500,000 - 4,999,999	105	9.68	396	36.50
25,000 - 499,999	402	37.05	798	73.55
5,000,000 - 10,000,000	75	6.91	873	80.46
500,000 - 999,999	212	19.54	1085	100.00
Total	1085	100.00	1085	100.00

Roughly 57% of firms in the target area are with firms

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Table 2.9
Distribution of Sales by 2-Digit SIC

Tabulation of NAICS_3
Number of categories: 25

Value	Count	Percent	Cumulative Count	Cumulative Percent
11	16	1.35	16	1.35
21	3	0.25	19	1.61
22	3	0.25	22	1.86
23	146	12.35	168	14.21
31	5	0.42	173	14.64
32	15	1.27	188	15.91
33	39	3.30	227	19.20
42	57	4.82	284	24.03
44	78	6.60	362	30.63
45	36	3.05	398	33.67
48	50	4.23	448	37.90
49	15	1.27	463	39.17
51	15	1.27	478	40.44
52	41	3.47	519	43.91
53	63	5.33	582	49.24
54	81	6.85	663	56.09
55	1	0.08	664	56.18
56	76	6.43	740	62.61
61	32	2.71	772	65.31
62	96	8.12	868	73.43
71	35	2.96	903	76.40
72	68	5.75	971	82.15
81	136	11.51	1107	93.65
92	28	2.37	1135	96.02
99	47	3.98	1182	100.00
Total	1182	100.00	1182	100.00

Source: Database USA

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Table 2.10
University Park Industrial Park by NAICS Code and Specialization

NAICS	# Firms	Share	Top 4	HHI	UPIP Specialization
23	146	0.1256			Construction
81	136	0.1170			Repair and Maintenance
62	92	0.0792			Health Care and Social Assistance
54	81	0.0697	0.3916	1533	Professional, Scientific, and Technical
44	78	0.0671			Retail Trade
56	76	0.0654			Admn Support & Waste Management
72	68	0.0585			Accommodation and Food Services
53	63	0.0542	0.6368	4056	Real Estate, Rental, and Leasing
42	57	0.0491			
48	50	0.0430			
99	47	0.0404			
52	41	0.0353			
33	39	0.0336			
45	36	0.0310			
71	35	0.0301			
61	32	0.0275			
92	28	0.0241			
11	16	0.0138			
32	15	0.0129			
49	15	0.0129			
51	15	0.0129			
31	5	0.0043			
21	3	0.0026			
22	3	0.0026			
55	1	0.0009			
Total	1182	1182			

Source: Database USA

Table 2.11
University Park Industrial Park by Employees and Annual Payroll

Year	Firms	Employees		Annual Payroll
			Firms per worker	Annual Payroll USD (000)
2015	109	1,247	11.44	95,954
2014	101	1,360	13	99,151
2013	106	1,239	12	97,889
2012	59	864	14.64	77,30

Source: US Census, County Business Patterns

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Table 2:11
Industrial Parks by Firms, Employees and Enumeration

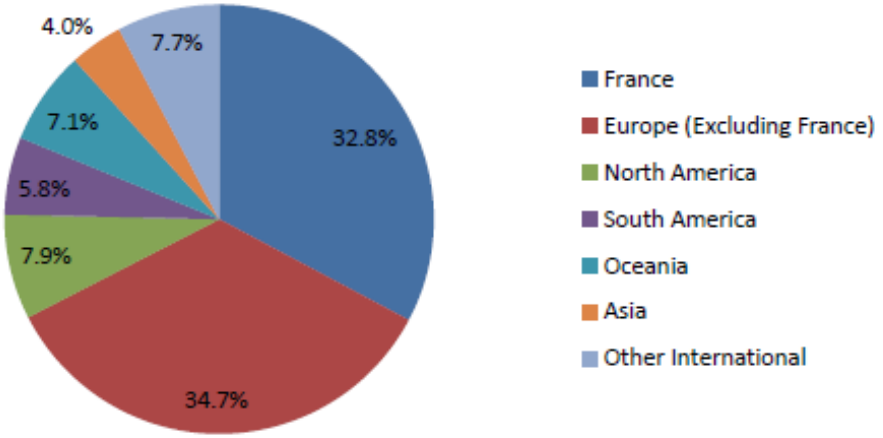
Year	Firms	Employees	Firms per Worker	Annual Payroll USD (000)	Hourly $ Rate	Wage Index
2015	109	1,247	11,44	95,954	37.00	86
2014	101	1,360	13.47	99,151	35.00	81
2013	106	1,239	11.69	97,889	38.00	88
2012	59	864	14.64	77,302	43.01	100

Source: US Census, County Business Patterns

3. Results: The Biomass Energy Sector and Biomass Energy Systems, Incorporated (BESI)

The Biomass Energy Sector's Global use of bio energy is expected to more than double by 2035, with heat and power being the largest consumers. (Davis and Pierce, 2014). Vision gain, an energy consulting firm, forecasts the "Global waste-to-energy market [is] set to grow by UD$ 12.9 billion in 2017" In addition, they report the international market share, as shown in Table 3.1. As presented, Europe accounts for 34.7% of the W2E market, while North America accounts for only 7.9% of the international market. Thus, the North American W2E market, using the above data, could possibly be approximately valued at about US$ 1 bn.

Figure 3.1:
The International Market Share of the W2E Market, 2016[2]



The year 2016 set a new record for annual renewable energy capacity additions, as the US added an enormous 22GW of renewable generating capacity while biomass, biogas and waste-to-energy added 132MW. While capital expenditures have been declining since 2010, the W2E segment of the sector accounts for the majority expenditures for the sector. (Visiongain)

Figure 3.2below provides capital expenditures in the US markets for Anaerobic, Biogas and Waste-to-Energy sectors. Between 2008, capital expenditures were increasing at an increasing and seem to lag the impact of The Great Recession by two (2) years, while a significant decline ensued in the sector afterwards. Competitive

[2] ttps://www.visiongain.com/Report/1971/Waste-to-Energy-(WtE)-Market-Outlook-2017-2027

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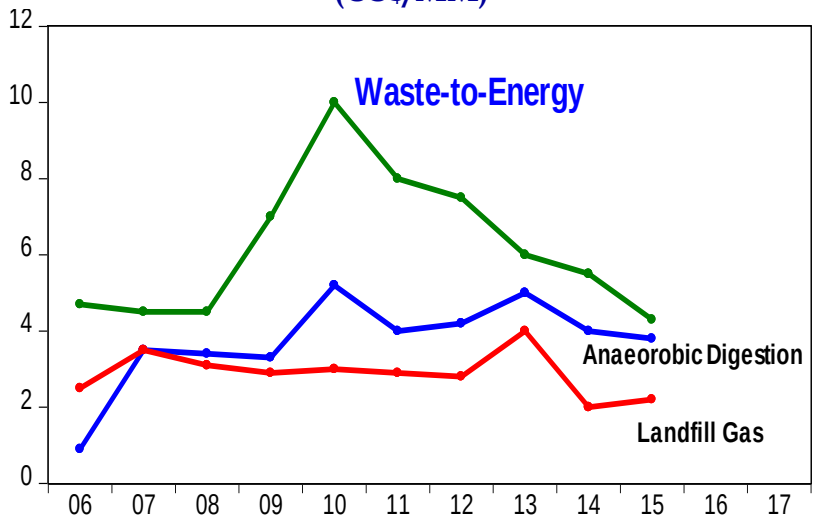
markets were rather flat, but W2E continued to dominate the sector, if only narrowly recently. However, the US growth prospects for the industry remain strong and, as the US economy continues to grow, we can expect capital expenditures in the sector to pick up. This inference is based on the fact; W2E represents a strong competitor to firms in the wasted management sector.

Figure 3.2:
Capital Expenditures for Biogas and Waste-to-Energy Projects (US$/MM)



Source: Bloomberg Energy Reports

BESI: The Company and its Growth Prospects

BESI (NAICS Code 221117) operates in Biomass Electric Power Generation industry which comprises establishments primarily engaged in operating biomass electric power generation facilities. These facilities use biomass (e.g., wood, waste, alcohol fuels) to produce electric energy. The electric energy produced in these establishments is provided to electric power transmission systems or to electric power distribution systems. The company is a waste-to-energy production facility, specializing in BESI's core capabilities include energy design engineering, specialty product development and implementation of innovative technologies, and training.

Critical economic data for the sector is presented in Figure 3.3, which show Unit Labor Costs, Labor Compensation, and Output per Worker for the national economy. Since there is only 12 years of annual data, we cannot comment on a long-term trend (more than 25 years). The next growth cycle will possible provide such trend information, from which we can view not only cycles, but also, the data's random components, which provide evidence of structural breaks, (Salvatore, 2015, p. 227).

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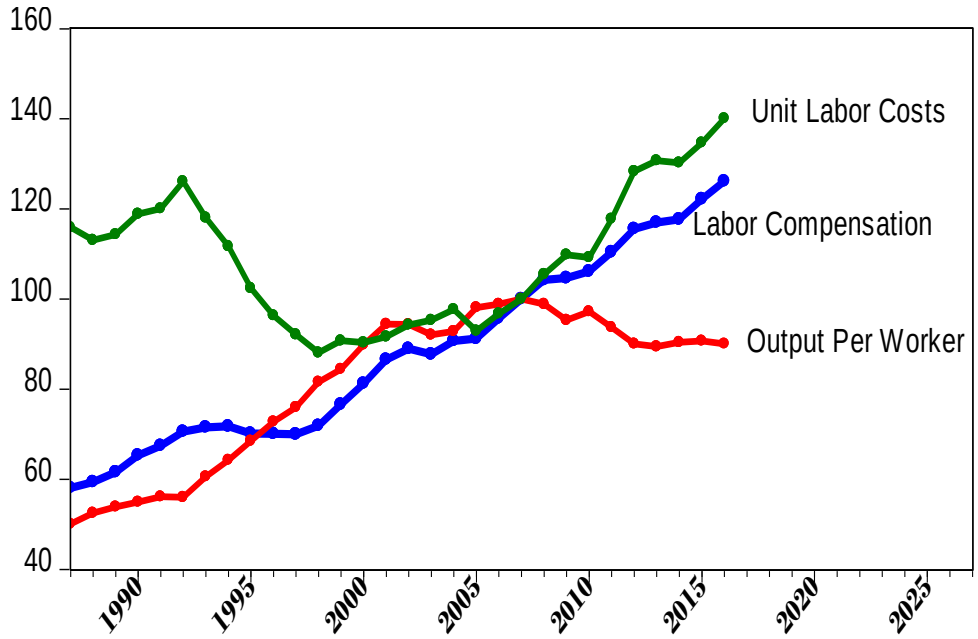
Figure 3.3
Industry 2211(Power Generation and Supply) of
Sector 221117 (Biomass Energy)



Source: Visiongain

As seen in the graph, unit labor costs, the ratio of Labor Compensation to output per worker, have been increasing in the national industry since 1997. This appears to be the result of declining output per worker, which could be explained by the transformation of the US economy from a manufacturing base to technological and serviced based. However, labor compensation is also increasing. The implication here is that the US W2E market is in its product development stage and mimics the S-Curve development process: where only early adopters and niche markets buy the product or invest in the company. Then, they experience rapid growth, and the product or business has a dominant position in the market. After the rapid growth, these businesses maintain a high-performance level, but with little growth, which often signals a mature market. According to Dranove and Marciano of the Kellogg Business School at North-western University, "almost all new technology follows a predictable pattern where early adaptors as customers, in this industry, look for cost advantages and complementarities to offset, in this case, their waste management costs. For instance, a brief telephone survey of villages in the south suburban Chicago metro area revealed substantial potential costs savings by adopting a W2E waste management process. The waste management process in the south suburban area is dominated by a few firms, evidencing an oligopolistic market structure, which indicates a product with limited substitutes and the ability to impose higher than average prices, where firms set prices rather than production requirements (Colton and Perloff, 2005, p. 174).

According to the Mergent Database of public companies for NAICS 221117, there are no publicly held US W2E companies and only one international firm listed. Given the cost structure of BESI, its location in a growing population metro and urban region, relative to the state and Northwest/North growth pole areas, the production location is one in which to take advantage of villages looking to lower cost waste management processes. BESI's strategy is to link with Governors State University in a public/partnership, to develop a customer, base by training village managers and personnel in the Biomass Energy processes, as a conduit to educating these same constituents,

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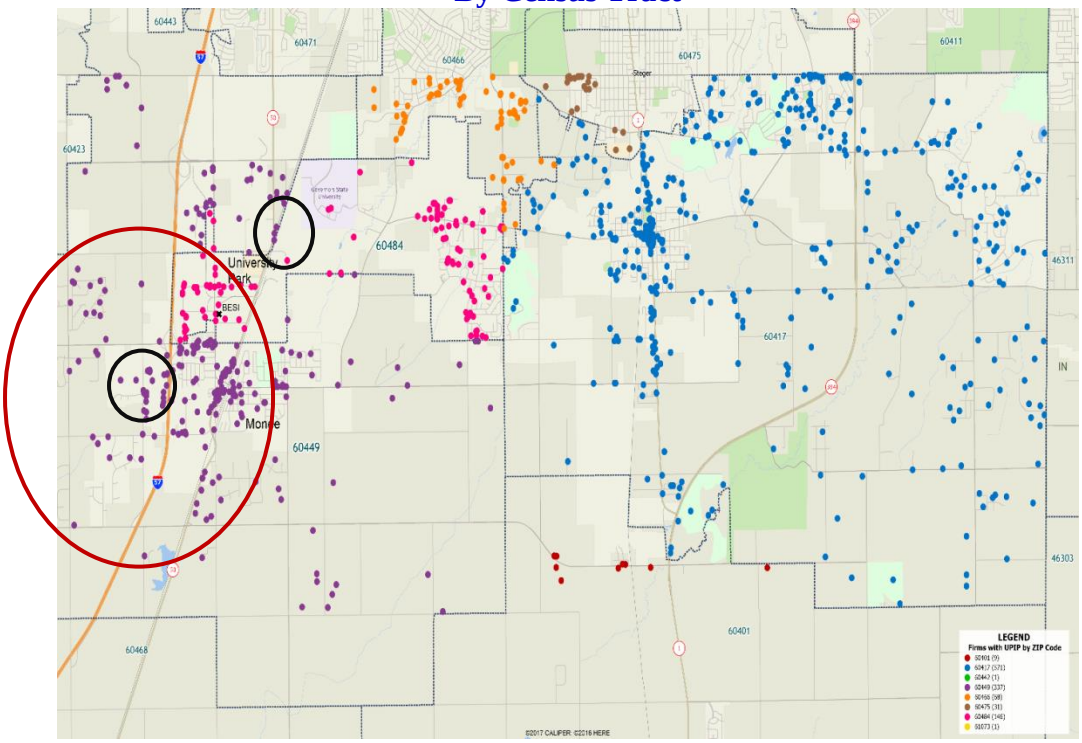
E-ISSN: 2469-6501

on the cost-effectiveness of the W2E process. The viability of BESI's technological advantages has demonstrated its efficiency in its present Hawaii facility and providing credible evidence of a strategy to influence the market environment by linking with GSU.

Technology companies' production processes, such as BESI, can be characterized by an "S-curve" production expansion process with a shallow start, and where only early adopters (customers) and niche markets buy the product or invest in the company. The next phase is one of rapid growth, where the business garners a significant position in the market. After the rapid growth, these businesses maintain high-performance levels but with continued growth, due to the highly technical nature of the firm and the continuous innovation taking place in the sector. Thus, the product and production process of the Biomass Energy sector holds significant promise for expansion, job creation, and educational training synergies in a region of the Chicago Metropolitan area that can significantly impact growth and employment opportunities for University Park. Figure 3.4 shows the larger industrial cluster of University Park's two industrial parks the inner circle the locational cluster around BESI. The 2nd circle is the location of Governs State University. Thus, the proximate location of the Industrial Parks and the University provide excellent intellectual and technological synergy linkages.

Figure 3.4:
Firm Location of GSU and BESI Local Market Area
With Designate Areas of Firm Concentration
By Census Tract



Source: DevelopMetrics

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4. Conclusion: The Techno-Economic Analysis of BESI and its Strategic Production Location

A techno-economic analysis is one linking technical information of a production activity or firm, with that of socio-economic data at a particular location or region. The traditional methodology for modeling and analyzing economic performance is the Input-Output Model, which provides inter-industry linkages to evaluate the impact of changes (growth and decline) in one industry sector (Biomass Energy) on others (which include a larger regional sector and other interrelated sectors). The results of the analysis are to provide impact multipliers to evaluate the summed effects of cross-activity linkages in the region being examined. The region of analysis in this report will be that of BESI in University Park to the State of Illinois. A smaller regional model (BESI to University Park) is substantially more complicated, since the data requirements and the modelling approach is significantly more complicated. However, the relation of BESI production contribution to the state is a relevant contextual analysis. Miller and Robinson (1998) argue against using any modeling below analysis in developing regional impact analysis studies (Miller and Blair, 2009, p. 359).

The model used is an Input-Output (I-0) model developed by IMPLAN, a spatio-temporal company, which provides both the model and the data to allow users to input their own sector data. Implan has 15 years of panel data over 66 countries, state, county and sub-state areas, for 536 sectors at the 3-7 NAICS code levels.

The model is developed as follows: Let Z represent the complete table of interregional data of the input-coefficient matrix

$$Z = \begin{bmatrix} z^{rr} & z^{rs} \\ z^{sr} & z^{ss} \end{bmatrix} \tag{3.1}$$

Then we define the Leontief Matrix as

$$(I - A)Z = d \tag{3.2}$$

Where Z and d are the variable vector and final demand vectors and the inter-industry coefficients are derived along with the impact multipliers as:

$$Z^* = (I - A)^{-1} d \tag{3.3}$$

An important area of the application of I-O models is to measure the impact of expansion or contraction of an existing firm or industry and to predict the impact of an expansion on a particular location and/or region. (Stinson et al. 2002, p. 124) We use the IMPAN I-O software to measure the impact of BESI's production process on the state of Illinois. The analysis is for 2017 as indicated earlier, measurements below state level have resulted in over estimation of impacts. Table 4.1 provides BESI's input information for the model. While the firm is small, with only 8 employees, its entry into the University Park economy is within the last two years; however, its sales and labor income are significant; that is, for every dollar of labor income, the firms is generating $12 of sales.

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Table 4.1:
Impact Analysis Variables for BESI (2017 US$)

	$
Project Output (Value of Transactions or Sales):	**6,000,000.00**
Labor income (Salaries, Wages, and Benefits):	**500,000**
Output / Labor Income Ratio	**12**
Employment (number of employees):	**8**

Source: BESI

Additional data for running the model is provide in Table 4.2, for Value-Added and Final Demand, where value-added represents intermediate sales and final demand, the demand for external inputs,

Table 4.2:
State of Illinois Gross Regional Product

Value Added	
Indicator	**Value**
Employee Compensation	$429,379,809,277
Proprietor Income	$47,937,415,888
Other Property Type Income	$251,574,522,800
Tax on Production and Import	$49,536,874,974
Total Value Added	**$778,428,622,939**

Final Demand	
Indicator	**Value**
Households	$517,946,803,119
State/Local Government	$98,297,896,436
Federal Government	$24,281,473,221
Capital	$113,256,483,460
Exports	$453,355,946,790
Imports	($400,522,440,986)
Institutional Sales	($28,187,539,353)
Total Final Demand	**$778,428,622,686**

Source: IMPLAN Input-Output Model, 2017

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Inputting these data into the model generates our impact results, as shown in table 4.3/

Figure 4.3
The Total Impact Summary

Impact Type	Employment	Labor Income ($)	Value Added ($)	Output ($)
Direct Effect	8.00	1,215,247.43	2,748,290.93	6,000,000.00
Indirect Effect	20.66	1,121,401.66	1,684,702.12	3,014,095.78
Induced Effect	14.49	721,081.89	1,292,725.49	2,177,235.72
Total Effect	**43.15**	**3,057,731.00**	**5,725,719.00**	**11,191,332.00**

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https://ijbassnet.com/
E-ISSN: 2469-6501

Appendix 1:

National Composition of Biomass Energy Firms

Year	Firms	Employees		Annual Payroll
			Firms per worker	Annual Payroll USD (000)
2015	109	1,247	11,44	95,954
2014	101	1,360	13	99,151
2013	106	1,239	12	97,889
2012	59	864	14.64	77,30

Year	Firms	Employees	Firms per Worker	Annual Payroll USD (000)	Hourly $ Rate	Wage Index
2015	109	1,247	11,44	95,954	37.00	86
2014	101	1,360	13.47	99,151	35.00	81
2013	106	1,239	11.69	97,889	38.00	88
2012	59	864	14.64	77,302	43.01	100

Source: US Census, County Business Patterns