

Distributional Impact of University-Led Revitalization on the Neighborhood Economy: A Computable General Equilibrium Model of a Small Urban Area

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Abstract

This paper assesses the economic impact of Cornell University on Tompkins County, New York, focusing on the impact of the investment on the new mixed-used development in Collegetown revitalization project. This study is one of the first attempts to study the economic impact of a university using a Computable General Equilibrium (CGE) model, which is an extension of an input-output model. In general, Social Accounting Matrix (SAM) multiplier analysis—a method widely-used in an economic impact study—assumes exogenous prices, excess production capacity, and no substitution parameters or feed-back effects. Thus, the economic impacts from SAM are likely to be overestimated and always positive. In addition, the assumption of increasing-returns-to-scale is incorporated into the framework of a small-area CGE model. This extension of the model allows for a more realistic representation of the imperfect competition in the economic simulation, which can be used as one of planning support tools.

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Key words: Economic impacts, College town revitalization, CGE

1. Introduction

Universities and large institutions can create considerable economic impacts not only on local but also on state economies where they reside. In Tompkins County and New York State, Cornell University has been the generator of economic activities and a cultural center for its community for almost 150 years. As an employer, purchaser of goods and services, investor, and researcher, Cornell University plays a key role in local and state economies. Cornell employed 12,461 workers, accounting for 23.18% of total employment in Tompkins County in 2007. The economic impact from the university on New York State in 2007 was estimated at \$3.3 billion, of which \$1.7 billion was the impact on central New York (Cornell University, 2007).

Due to its increase and expansion of academic programs and research activities, Cornell has expanded its residential, academic, and research buildings and facilities, thereby affecting the real estate market in the local economy. According to the 2009 Cornell Economic Impact Report, since 2002 its construction investment has increased steadily to \$179 million in 2007 (Cornell University, 2009). Because of the locally labor-intensive nature of construction activities, the construction investment is believed to generate income directly to local residents and stimulate the local economy.

Although Cornell has long played a key role in the local economy, Cornell's tax-exempt status has resulted in animosity between the university and the city of Ithaca. Tension simmers as local residents accuse Cornell of draining limited public resources without paying compensation. In addition, a lack of collaboration between the municipality and Cornell has raised questions about the contribution of Cornell to local communities. As one response to such concerns, the city of Ithaca and Cornell have proposed a revitalization plan of which the centerpiece is Cornell's role in the development of Collegetown, the university's nearest neighborhood.

In fact, Cornell has expressed its intention to contribute to local communities. The 2008 Cornell University comprehensive master plan states that "the plan will be driven by academic priorities and support the goals and aspirations of the university as it guides the campus's physical development over the next 10 to 25 years... While we have a remarkable campus, we want to make it better -- for our students, our faculty, our staff and our neighbors." This statement shows that Cornell is not only concerned with its academic community but also its local neighborhoods.

Both Ithaca downtown and Collegetown are considered as "opportunity areas" for greater Cornell presence (Cornell University, 2008). In fact, the university has already established its development at the Ithaca Commons in the downtown area. The addition of a sizeable workforce from Cornell to the downtown area has greatly benefited local businesses. As for Collegetown, its proximity and status as the urban edge of Cornell campus, the city and the university have a mutual interest to improve the Collegetown neighborhood.

The Collegetown Vision Statement, proposed by the Collegetown Vision Implementation Committee, aims to create new urban design guidelines in order "to create a diverse, commercially viable, mixed-use community." The motivation to engage actively in the local community is compelling since businesses in Collegetown have recently struggled economically (Collegetown Vision Implementation Committee, 2008). However, little attention has been paid to the economic impact of this revitalization plan. The concern is that only property owners may benefit disproportionately from such construction expenditures, which can lead to widening disparities.

1.1 Economic Impacts of Universities on Local Economies

Economic impacts of universities on their local communities have been a focus of many recent studies. In particular, various analytical methodologies have been employed to examine a university's impact on the local economy, since different analysis frameworks could lead to very different conclusions. According to Florax (1992), the economic effects of universities can be analyzed from three perspectives: through the university's input; through the university's output; or through a model that combines the input-output effects.

In addition, Drucker and Goldstien (2007) reviews four major approaches used to examine the impact of universities on regional economic development: (1) impact studies of individual universities, (2) surveys, (3) production-function estimation, and (4) cross-sectional and quasiexperimental designs. Even though the empirical results obtained from each method may vary in terms of the magnitude and levels of confidence, they all suggest substantial positive effects of universities on the regional economic development. Among these four approaches, impact studies of individual universities haven been widely conducted. For example, Carroll and Smith (2006) examine the economic impact of Bowling Green State University on Ohio State using the IMPLAN® (IMpact analysis for PLANning) economic impact

modeling system, developed by MIG Inc. They find that the university returns an estimate of 8 dollars for every dollar received from state support in economic activities to the state economy.

Cornell University has studied its economic impact on New York State and published reports in 2007 and 2009. These studies were based on a Social Accounting Matrix (SAM) model capturing “multiplier effects” which include direct, indirect, and induced effects. However, SAM multipliers may not give realistic impacts because prices are treated exogenously, and excess production capacity is assumed in SAM. Moreover, there are no substitution parameters and feed-back effects in the SAM analysis. Thus, the economic impacts from SAM are likely to be overestimated and always positive.

A more realistic representation of the economy with price endogeneity, limited production capacity, substitution parameters, and feed-back effects can be studied in the framework of a Computable General Equilibrium (CGE) model. CGE models employ a SAM as a data system to capture interactions between agents in the economy due to changes in policy, technologies, or other external factors.

Most CGE models are used in analyses at the macroeconomic level to represent the economy of an entire country. These macro-level CGE models, however, may not be appropriate to analyze economic impacts in a smaller region because of the difference in economic structure. In particular, the assumption of constant-returns-to-scale (CRTS) in production technology in a standard CGE model may not be suitable for a small-area economy where the presence of imperfect competition may exist. Nonetheless, there have been a few attempts to address local economic impacts with this modeling methodology. For example, Holland, Stodick, and Devadoss (2004) develop a CGE model, which is adapted from the standard CGE model developed by Löfgren (2000), for regional economic analysis of Idaho and Washington states. In addition, Sue Wing and Anderson (2007) study the framework of CGE analysis on small-area economy in the US.

Using a CGE model to quantify the economic impact of Cornell’s activities in the Collegetown Neighborhood, this study addresses two main questions. First, the paper examines whether university spending on local revitalization promotes a more egalitarian distribution of income. Second, it analyzes the implication of Cornell’s eminent presence in Tompkins County’s labor market on growth

and income distribution. In addition to the standard CGE model, novel approaches for impact analysis of revitalization in a small urban area will be introduced. Particularly, the assumption of increasing-returns-to-scale (IRTS) in production technology is incorporated in the CGE model. Simulation results under alternative scenarios are presented, and policy implications are discussed in the end.

2. Literature review

2.1 Social Accounting Matrix (SAM)

A social accounting matrix has long been used to estimate economic impacts of many development plans and projects. A SAM model, which is based on an input-output analysis (I-O), can be used as both a data system and a conceptual framework (Azis & Mansury, 2003). The SAM analysis can capture inter-industry transactions of purchasing of final and intermediate goods and provide useful information as inter-sectoral linkage measures. It can also capture transfers among production sectors, factors of productions, and institutions such as households, firms, and the government in an economic system (Azis, Anantsuksomsri & Tontisirin, 2008) A SAM analysis is useful for policy analysis since it is comprehensive and disaggregated, consistent in equal outlay, and complete in all identified buyer-seller transactions (Thorbecke, 1998).

The existence of excess capacity and unemployed or underemployed labor resources is an underlying assumption of SAM analysis. As long as excess capacity and abundant labor supply prevail, any exogenous shocks in demand can be satisfied through a corresponding increase in output without any effects on prices. Thus, prices are treated exogenously in a SAM analytical framework. In an economic development plan, SAM can be used as a tool to analyze the effects from the plan or exogenous shocks such as changes in demand of a certain production sector or government expenditure.

A SAM multiplier, which captures direct, indirect, and induced effects, can be interpreted as the economy-wide impact from an increase in demand of a particular sector. Under the SAM framework, the effects are transmitted through the interdependent SAM system, namely direct, indirect, and induced effects, which are estimated through a multiplier process. From the standard SAM framework,

$$y_a = A_n y_n + x = (I - A_n)^{-1} x (-1) \quad x = M_a x$$

where x denotes exogenous demand,
 y_n denotes endogenous total income,
 A_n denotes average expenditure coefficients, and
 M_a denotes accounting multiplier or SAM multiplier.

2.2 Structural Path Analysis (SPA)

The SAM multiplier analysis alone, however, cannot reveal the structural or behavioral mechanism responsible for the effects or paths that exogenous demand shocks pass through. Therefore, Structural Path Analysis (SPA) can be employed as an extension of the SAM multiplier analysis to identify various paths along which the exogenous shocks pass (Defourny & Thorbecke, 1984; Azis, Anantsuksomsri & Tontisirin, 2008).

SPA decomposes the SAM multiplier and identifies a network of paths through which the “effect” is transmitted in the economic system. In order to understand how SPA works, consider an effect travelling from an origin pole i to a destination pole j . Under the SAM framework, this effect can be considered as an average expenditure propensity “ a_{ji} ” or marginal expenditure propensity “ c_{ji} ”. The link between pole i and j is denoted by “arc(i,j)”. Let “path” denotes a sequence of consecutive arc; “elementary path” denotes a path that does not pass the same pole more than once; “circuit” denotes a path, which the origin pole is the same as the destination.

SPA breaks down influence into three types of effects: 1) direct effect (DE), 2) total effect (TE), and 3) global effect (GE). Direct effect $DE_{(i \rightarrow j)}$ can be measured as average expenditure propensity a_{ji} that passes through an elementary path from i to j . $DE_{(i \rightarrow j)} = a_{ji}$

The direct effect $DE_{(i \rightarrow j)}$ can also travel to multiple poles along the path(i, \dots, j). If it is the case, the magnitude of the direct effect is the product of average expenditure propensity of arcs connecting the path. As shown in Figure 1, the direct effect that passes through path(i, x, y, j) equals

$a_{xi} \cdot a_{yx} \cdot a_{jy}$. As shown in Figure 2, the total effect $TE_{(i \rightarrow j)}$ captures all direct effects that pass from pole i to pole j .

The global effect $GE_{(i \rightarrow j)}$ measures the total effects on income or output of pole j as a consequence of a shock from pole i . Unlike the direct effect, the global effect captures all direct, indirect, and induced resulting from circuits along path(i, \dots, j) and can be computed by summing all $TE_{(i \rightarrow j)}$ (see Figure 3). Practically by construction, the global effect is an element in SAM multiplier M_a .

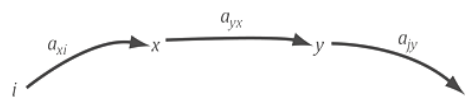


Figure 1. A Direct Effect $DE_{(i \rightarrow j)}$ in the Structural Path Analysis.

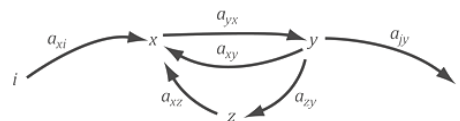


Figure 2. A Total Effect $TE_{(i \rightarrow j)}$ in the Structural Path Analysis.

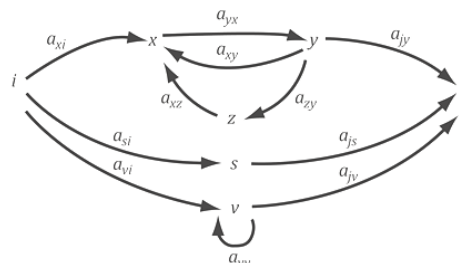


Figure 3. A Global Effect $GE_{(i \rightarrow j)}$ in the Structural Path Analysis.

2.3 Computable General Equilibrium (CGE)

The Computable General Equilibrium is sometimes known as the Applied General Equilibrium (AGE), initially developed by Scarf (1967) and Scarf and Hansen (1973). A CGE model is based on the general equilibrium theory of the competitive market economy. In the model, a representative household determines its consumption bundles to maximize its utility subject to a budget constraint while a firm maximizes its profits by managing its inputs and outputs subject to its production technology. The model involves optimizing behaviors of economic agents under given resource and technology constraints, and under indicators from market prices. The CGE framework is usually based on a Social Accounting Matrix (SAM). The structure of a SAM of Tompkins County is shown in Figure 4.

The structure of the CGE model in this study is based on the standard CGE model developed by Hosoe, Gasawa, and Hashimoto (2010) and is illustrated in Figure 5. The nested structure represents the connection between production and good markets. The overview of the interrelation of goods and production factors in the model can be explained as following (from the bottom to the top):

1. The intermediate goods ($X_{i,j}$) and the value-added of production or composite factor (Y_j), which consists of Labor (FLAB, j), and capital (FCAP, j), are used to produce the output (Z_j).
2. Some outputs (Z_j) are exported (E_i) and the rest are sold domestically (D_i). The proportion of exported and domestic goods is controlled by the function of Constant Elasticity of Transformation (CET).
3. The domestic goods (D_i) and imported goods (M_i) are used to produce composite goods (Q_i) to serve domestic demands. The proportion of imported and domestic goods is controlled by the function of Constant Elasticity of Substitution (CES).
4. The composite goods (Q_i) will be distributed among private consumption (X_p), government consumption (X_g), investment (X_v), and intermediate uses by production sectors based on the Cobb-Douglas utility function.
5. Utility subject to a budget constraint (UU) is derived by maximizing private consumption.

The income of private institutions (Y_p) consists of factors of production (FF) and institutional transfers. Government revenues (Y_g) are from direct taxes (T_d), production taxes (T_z), import tariff (T_m), and institutional transfers.

In the case of Tompkins County, import activities within New York State and the rest of the US have no import tariff. Based on the marginal propensity to consume, the revenues of each institution will be allocated to savings and consumptions. The net export is denoted as a foreign saving (S_f). Again, in the case of Tompkins County, foreign sectors include the rest of the US and the rest of the world. The total savings consist of private saving (S_p), government saving (S_g), and foreign saving (S_f). The consumption and investment behaviors of private institutions (X_p) and government (X_g), based on the Cobb-Douglas utility function, are determined by prices of goods and disposable incomes. In this economy, the assumption about the balance of total saving and total investment must hold.

Figure 4. Structure of Tompkins 2009 SAM and its variables.

		PROD(j)		FACTOR(h)		IDT	TRF	INSTITUTE				
		LAB	CAP	LAB	CAP			PRIV	GOV	INV	EXT	
PROD(i)		X_{ij}						X_{pi}	X_{gi}	X_{vi}	E_i	
FACTOR(h)	LAB	F_{hj}										ETran
	CAP											
IDT		T_{zj}				D_i						
TRF		T_{mj}										
INSTITUTE	PRIV					FF_{h}						
	GOV					FG_{ov}		ΣT_{zj}	ΣT_{mi}	T_d		
	INV					Fl_{nv}				S_p	S_g	
	EXT					Remit						S_f
												Z_j

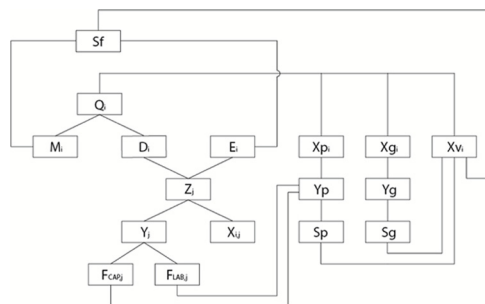


Figure 5. The structure of standard CGE model.

3. Data

In this study, the 2009 Social Accounting Matrix (SAM) of Tompkins County, New York is used as the major database for Structural Path Analysis (SPA) and Computable General Equilibrium (CGE) analysis. The SAM used in this study is produced by IMPLAN. The original SAM consists of 533 accounts of which 520 accounts are endogenous. Out of these endogenous accounts, 508 accounts are of production sectors; two accounts are of factors of production (i.e., capital and labor); ten private institutions consist of nine households groups by income levels and firm. State and federal governments and the rest of US and the rest of the world are exogenous accounts.

The production sectors in the original SAM of Tompkins County are aggregated into 24 major production sectors based on the 2007 North American Industry Classification System (NAICS) using IMPLAN software. In this SAM, Cornell University is recorded as a part of production sector number 392 (Junior colleges, colleges, universities, and professional schools), not as an institution. In Tompkins County, there are three major higher education institutes: Cornell University, Ithaca College, and Tompkins Cortland Community College. In order to analyze the role of Cornell University, sector 392 of Tompkins County is disaggregated into two sectors: Cornell University and other universities. The disaggregation is based on the financial data of Cornell: financial statement, data on purchase and procurement, payroll, and construction of Cornell University in 2007-2008 fiscal year.

The aggregation procedure is processed in Microsoft Excel software. After exporting the aggregated SAM of 2009 Tompkins County into an excel file format from IMPLAN software, 24-sector SAM are aggregated into 16 major production sectors, nine household groups are categorized into three income groups, and all state and federal government sectors are grouped into one government sector. Like the aggregation procedure, the disaggregation procedure of Cornell University sector from the university sector is managed in Microsoft Excel. The following steps constitute the disaggregation procedure:

- Categorize payment and receive items of Cornell's financial data according to the sectors of Tompkins County's SAM,
- Proportionally disaggregate all sectors in the column of university sector in the SAM based on the payments of Cornell and all sectors in the row of university sector based on the receives, respectively, and
- Balance corresponding cells of the Cornell sector and university sector to equate the sums of each row and column.

After aggregation and disaggregation procedures, the final SAM consists of 17 production sectors in the model (see [Appendix 1](#)) including Cornell University as a production sector, two types factors of production (labor and capital), three types of taxes (income tax, indirect tax, and tariff), saving-investment, and six institutes (three household groups, firm, government, and the rest of the world). The SAM used in this study is shown in [Appendix 2](#).

In this study, the solution of the CGE model is computed in the General Algebraic Modeling System (GAMS) developed by GAMS Development Corporation, Washington, DC, USA. The following are key properties of this CGE model:

- Cornell University is one of the production sectors.
- Labor and capital is assumed to be fully employed.
- Wage is set endogenously.

4. Methodology

In order to calculate a quantitative result of economic impact analysis, most of studies are usually employed under the framework of SAM, and IMPLAN is widely-known software used in the economic impact study. Many planners, however, argue that the simulation using IMPLAN is sometimes a "black box" approach since the underlining computational methodology is not explicit. In this study, computation of SAM multipliers and simulation are done in Microsoft Excel rather than in IMPLAN. Thus, all transmission mechanisms in the analysis can be traced. The SAM multiplier analysis of 2009 SAM is used to quantify economic impacts of Cornell University in Tompkins County, in particular the key roles of the university as employers. In addition to the SAM multiplier analysis, the Structural Path Analysis (SPA) is also employed to identify the origin and destination poles that the impacts from Cornell pass through.

The 2009 Tompkins County SAM is then used as the database to calibrate the small-area CGE model. The simulation model, based on the proposal of the Collegetown development plan, provides a quantitative result of economic impact to the local economy. The result will reveal, vis-à-vis the concern of this development plan, whether revitalization expenditure will benefit all members of the community or mainly property owners disproportionately. In addition, in order to analyze the implied effect of Cornell's eminent presence in Tompkins County's labor market on growth and income distribution, the assumption of increasing-returns-to-scale (IRTS) in production technology is incorporated in the CGE model extension based on the model developed by Hosoe et al (2010).

In this study, the specification to incorporate the scale economies in production is fixed costs. The assumption of IRTS in this model is that Cornell University has fixed costs and variable costs to operate its production. These payments (FC_j), which may be in the form of payrolls, are paid by Cornell to private institutes, i.e., households. So the functions of private saving (Sp), household demand for goods (Xp_i), and government tax revenue (Td) are modified based on the share of fixed costs (v_i) in the total capital service payment ($SAM_{(Capital,j)}$) of Cornell. The detail of additional and modified parameters, variables, and equations is shown in [Appendix 3](#).

5. Results

Using the methodology discussed above, the evidence of the university's role in the local economy is shown in the following order: SAM multiplier analysis, SPA, and CGE. The results of SAM analysis will show the socioeconomic impact of Cornell University's investment on real estate projects. In addition to the SAM multiplier analysis, the SPA will reveal paths of the impact and bottlenecks that may need a policy intervention. The results of the CGE model analysis will further illustrate a more realistic impact of the investment with feedback effects. Finally, the policy implications will be discussed.

5.1 Simulation using the framework of Social Accounting Matrix (SAM)

According to the proposal of the Collegetown Vision Statement, the exogenous shocks on the real estate and retail sectors are injected to the local economy to create a mixed-use community. In the simulation scenario, the 1% increases in the investment of each sector are assumed to be invested in real estate and retail development. The total additional economic impact from the \$0.46 million investment in College town is estimated to be \$2.05 million. Cornell, government, and rest-of-the-world sectors are treated exogenously.

The results from the simulation show that university spending on revitalization activities is more economically beneficial to medium- and high-income households than to low-income household. As a result of this additional investment in the real estate and retail sectors, the incomes of low-, medium-, and high-income households increase by 0.0066%, 0.0078%, and 0.0063%, respectively, suggesting that the economic impact of the revitalization plan benefit equiportionally local residents in all income groups.

This result supports the proposal of the Collegetown Vision Statement to create a commercially viable and mixed-use community as suggested in the development plan. The SAM analysis can now answer one of the two main questions of this study. Cornell spending on revitalization activities is economically beneficial to all households.

This simulation of the exogenous shocks, however, may not represent reality in the economy, as mentioned earlier, because of limitations of SAM analysis in which prices are treated exogenously and excess production capacity is assumed. In order to generate more realistic results, the simulation of exogenous shocks using a CGE model based on the database of 2009 Tompkins County SAM is needed.

5.2 Structural Path Analysis (SPA)

The result from the SPA simulation of Cornell's investment on mixed-used development using 2009 SAM of Tompkins County is based on the SAM multiplier analysis discussed earlier. [Table 1](#) shows that the production sectors that affect all households in the local economy are 'other sector', retail, professional services, others universities sector, and accommodation sector, which are ranked among the top five production sectors for all household groups. The global effects suggest that the retail sector generates higher economic transaction to high and medium income households than to low income household. For example, for every one dollar increase in the output from retail sector, it will generate \$0.041 increase in income of the low-income household, while contributing \$0.27 and \$0.304 to the medium- and high-income groups, respectively. Like the retail sector, the global effects of the real estate sector suggest that the retail sector generates higher economic transaction to high- and medium-income households than to the low-income household. The global effects of the real estate sector on low, medium, and high-income household are 0.037, 0.199 and 0.277, respectively.

The SPA results of the impact from Cornell's investment in the retail sector on three household groups, shown in [Figure 6](#), illustrate that professional services and others sectors also play an important role in the economic impact of the investment in the retail sector on all households. The orders of paths are ranked according to the global effects. The SPA result suggests that the economic impacts from the retail sector to all households via employment (Labor) are high.

Figure 7 shows the SPA results of the impact from the investment in the real estate sector on the three household groups. It demonstrates that the financial and ‘others sector’ also play an important role in the economic impact on the retail sector. The SPA result suggests that the economic impacts from the real estate sector to all households via capital are much higher than via employment. The results suggest the possible bottle necks to the transmission of economic impact to households, especially low-income households, are in the labor sector.

However, the results of the SPA can illustrate only structures and behavioral mechanisms of the economic impact. It cannot provide quantitatively the impact from the exogenous shock according to the development plan. Thus, in the following section the economic impact of Cornell is analyzed using a CGE model.

5.3 Simulation using the framework of Computable General Equilibrium (CGE)

The CGE model is based on the structure of standard CGE model developed by Hosoe et al (2010). In order to generate comparable results from the CGE simulation to those of the SAM multiplier analysis, the 1% increase each in retail and real estate sectors is invested from Cornell. As mentioned earlier, the university sector is categorized in SAM as one of the production sectors, not an institution. The exogenous shocks, therefore, are applied to the production sectors. The objective of the simulation is to maximize utility derived from private consumption, which is represented by the utility function shown in the Appendix 3. The results of the standard CGE model—with an assumption of constant-returns-to-scale production—are shown in Table 2.

In this simulation scenario, the result shows that the investment from Cornell would provide positive benefits to the local community as the utility level increases by 0.138%, from 496,756 to 497,442 units. The result also shows that total labor income ($\sum_j F_{LAB,j}$) increases by 0.22% from 2,843.918 to 2,850.28, suggesting that the revitalization plan will somewhat benefit the employment of local residents. In

Origin (Industry)	Destination (Household)	Global Effect
Other sector	Low-income	0.042
Retail	Low-income	0.041
Professional services	Low-income	0.410
Other universities	Low-income	0.039
Accommodation	Low-income	0.039
Other sector	Medium-income	0.282
Other universities	Medium-income	0.272
Retail	Medium-income	0.270
Professional services	Medium-income	0.266
Accommodation	Medium-income	0.263
Other sector	High-income	0.308
Retail	High-income	0.304
Professional services	High-income	0.301
Other universities	High-income	0.292
Accommodation	High-income	0.291

Table 1. The SPA global effect of production sectors to household groups.

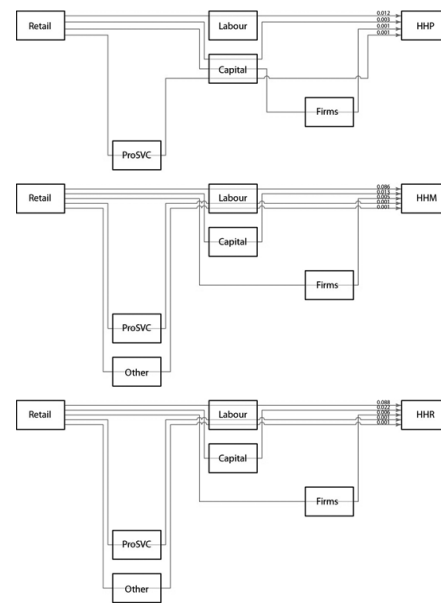


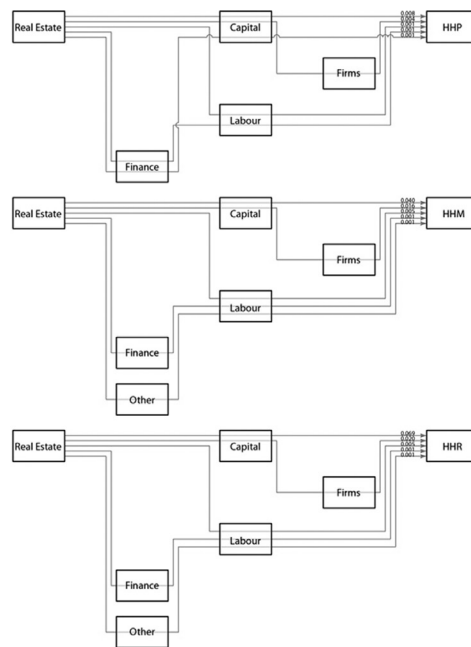
Figure 6. The paths from the investment on retail sector to households.

Economic Indicators	Base case	Investment	% Change
Utility	496756.413	497,442	0.14%
Total labor income	2843.918	2,850.281	0.22%
Total income-Poor HH	285.029	285.199	0.06%
Total income-Medium HH	729.297	729.669	0.05%
Total income-Rich HH	721.194	721.391	0.03%
Average price of composite goods	1.000	0.999	-0.05%
Tax revenue	220.031	219.798	-0.11%

Table 2. Simulation results from the standard CGE model.

the SAM of Tompkins County shown in the [Appendix 2](#), the amount of household saving is zero, indicating that households have no saving, and households spend all their disposable incomes on consumptions. Thus, household consumptions could be an indicator of household purchasing power. The total consumptions of low-, medium-, and high-income households ($\sum_i Xp_{i,hh}$) increase by 0.06%, 0.05%, and 0.02%, respectively, which contributes to higher overall utility as discussed previously.

Figure 7. The paths from the investment on real estate sector to households.



Economic Indicators	Base case	Investment	% Change
Utility	496,756.413	494,086.708	-0.54%
Total labor income	2,843.918	2,850.281	0.22%
Total income-Poor HH	285.029	284.138	-0.31%
Total income-Medium HH	729.297	728.139	-0.16%
Total income-Rich HH	721.194	720.710	-0.07%
Average price of composite goods	1.000	1.006	0.56%
Tax revenue	220.031	221.264	0.56%

Table 3. Simulation results from the modified CGE model with IRTS.

The effect of the investment is found to be unevenly distributed, and the low- and medium-income households receive more benefit than the high-income household. The investments from Cornell also put a downward pressure on the overall prices. As can be seen, the average price of composite goods ($\sum_i p q_i$) decreases by 0.05%. In addition, the government received less total production tax ($\sum_i T d_i$) by 0.11%.

Since Cornell University is a major employer and purchaser in Tompkins County, the next analysis undertaken assumes the behavior of Cornell is represented by an increasing-returns-to-scale production function. Thus, in this modified CGE model, the share of fixed costs in capital costs (v_i) of Cornell is introduced and assigned to 0.01, while the share of the other sectors is assigned to 0. With the same amount of exogenous shock, the results of economic indicators are shown in [Table 3](#). Unlike the previous results, when Cornell's production function is assumed to be constant-return-to-scale, the utility level decreases by 0.53%, from 496,756 to 494,086 units. This is because the total consumptions of low-, medium-, and high-income households ($\sum_i Xp_{i,hh}$) decreases by 0.3126%, 0.1588%, and 0.0671%, respectively.

The impact is distributed unevenly, and the low-income group seems to be the hardest hit. The investment of Cornell also puts an upward pressure on the price of composite goods. The average price of composite goods ($\sum_i p d_i$) increases by 0.56%. The total labor income ($\sum_j FLAB_j$) increases by 0.22% from 2,843.918 to 2,850.281, suggesting that the plan will benefit the local labor market. The government also benefits from the investment as it receives more total production tax ($\sum_i T d_i$) by 0.56%.

5.4 Policy Implication

The SAM, SPA, and CGE analyses of the economic impact of Cornell University's investment in mixed-use development projects show that the impact would not always be positive and evenly distributed to the local community. The impacts of Cornell's investment to some degree vary, depending on assumptions about the structure of local economy employed in different analytical methods. The SAM multiplier analysis suggests only positive effects from the investment. The CGE models, on the other hand, suggest both positive and negative impacts. With CTRS assumption in the CGE simulation, the economic impacts are found to be positive, and the medium- and high-income groups seem to enjoy the benefit more than the low-income group.

Since Cornell is a major employer and purchaser in Tompkins County, results from the CGE simulation with the IRTS assumption would seem to be more realistic. The results from the CGE simulation with the IRTS assumption show that the investment would benefit the local labor market. However, the benefits may be offset by the increase in an average commodity price, resulting in lower household consumption and overall utility level. This hike in the price would heighten tensions between Cornell and local communities. The impact hits low-income households the hardest in terms of total household consumption. The SPA results suggest that this is because of the presence of a bottleneck in the transmission mechanism to low-income households in the labor sector. Thus, to reduce tensions between the university and local communities, more attention should be paid to the labor market, particularly of the low-income group. This outreach to the local labor market would improve town-and-gown relations between Cornell and its local communities. As an economic engine in Tompkins County and New York State, Cornell can enhance its role in the pursuit of equality by further investing in local communities.

6. Conclusions

The quantitative analyses of the university-led revitalization plan, using SPA, SAM analysis, and CGE models confirm that Cornell University indeed plays an important role in Tompkins County, New York. The SPA has illustrated the paths of economic impact from university economic activities that pass through other production sectors and factors of production to households in the local economy. The SAM analysis shows that the investment in mixed-use development in Ithaca Collegetown will benefit all local residents.

However, it might widen disparity in the community due to disproportional income distribution. While the study using CGE modeling suggests that the Cornell investment in Collegetown stimulates "a diverse, commercially viable, mixed-use community," the investment may not benefit all residents in the local community equally. The result from the CGE simulation with CRTS shows that the distribution of the impact is likely to benefit the medium and high-income households more than the low-income households. On the other hand, the result from CGE simulation with IRTS suggests that the benefit to labor incomes may be offset by the increase in commodity prices. As a leader in education and economic activities in local communities and New York State, Cornell should pay more attention to its investment as its impact may not be equally distributed to the local residents. Cornell's contributions to the lives and livelihood of its students, faculty members, staffs, and local residents certainly play an important role in its success globally, proving that big success can start in small places.

Appendix 1

Description of 17 production sectors in 2009 Tompkins SAM using in the model

AGR	Agricultural sector
MIN	Mining sector
UTL	Utilities sector
CON	Construction sector
MFG	Manufacturing sector
WSALE	Wholesale sector
RETAIL	Retail sector
TRANS	Transportation sector
INFO	Information sector
FIN	Financial sector
RE	Real estate sector
PROSVC	Professional sector
CORNELL	Cornell University
UNIV	Other universities sector
ACCOM	Accommodation sector
FOOD	Food service sector
OTH	Others sector

Appendix 2

The SAM of 2009 Tompkins County

Sectors	AGR	MIN	UTL	CON	MFG	WSALE	RETAIL
AGR	16.77287	0.050457	0.000141	0.079395	7.063268	0.000782	0.077965
MIN	0.01219	11.26765	2.037016	0.111735	5.561095	0.000415	0.000589
UTL	0.864422	1.636412	159.1691	0.622139	16.09445	0.36773	1.26057
CON	0.104412	0.910899	1.149838	174.8695	1.638935	0.05282	0.196442
MFG	0.471963	0.473813	0.184214	1.711346	64.44189	0.131351	0.142274
WSALE	0.649449	0.569684	0.22556	1.788524	17.62683	74.01084	0.53579
RETAIL	0.03443	0.144467	0.020276	5.173808	1.914904	0.073549	240.8286
TRANS	0.530492	0.747576	2.761477	1.127313	9.622649	1.226939	1.582307
INFO	0.021999	0.096946	0.161095	0.569028	3.007821	0.26971	0.516838
FIN	0.677892	0.64404	1.167593	0.784763	2.191723	0.863679	1.819696
RE	1.698872	0.260371	0.372353	0.545998	2.182666	0.763497	3.326767
PROSVC	0.359063	3.904414	3.824587	11.41977	24.59816	3.491098	5.090456
CORNELL	0.144364	0.000124	0.129311	0.006288	0.014672	0.047356	0.203708
UNIV	0.111221	9.53E-05	0.016484	0.003127	0.007296	3.33E-07	0.1013
ACCOM	1.89E-06	2.77E-05	0.000138	9.12E-05	0.000542	4.8E-05	2.65E-05
FOOD	0.024529	0.073408	1.102571	0.280609	2.046578	0.237816	0.447967
OTH	0.216179	2.223563	36.46853	2.530947	16.63837	2.339883	3.175744
LAB	24.11723	15.63933	36.2442	56.29709	231.806	29.7254	137.4371
CAP	6.269607	41.07222	65.99634	22.88158	93.66258	11.43247	45.86458
IDT	0.955347	3.252364	21.65613	1.092841	11.64108	11.24233	47.94167
TRF	0	0	0	0	0	0	0
HHP	0	0	0	0	0	0	0
HHM	0	0	0	0	0	0	0
HHR	0	0	0	0	0	0	0
GOV	0.100702	0	0.161413	0	0	0	0
FIRM	0	0	0	0	0	0	0
INV	0.000424	0.000111	0	0	2.502494	0	0
EXT	31.13157	44.9867	37.99264	72.43665	636.203	17.41775	24.46023

The SAM of 2009 Tompkins County (continue)

Sectors	TRANS	INFO	FIN	RE	PROSVC	CORNELL	UNIV
AGR	0.000175	4.93E-05	1.98E-05	0.069221	0.035571	0.22293	0.152465
MIN	0.005735	0.005323	5.48E-05	0.020193	0.013641	0.000128	8.77E-05
UTL	0.267108	0.42133	0.29305	2.809097	1.259483	59.23833	40.51384
CON	0.273663	0.314071	0.571988	7.216581	0.634558	0.003262	0.002231
MFG	0.451672	0.288909	0.086915	0.284037	4.042378	2.32285	1.588627
WSALE	0.302012	0.398822	0.127442	0.340825	0.59964	4.041477	2.764017
RETAIL	0.201047	0.023659	0.118027	1.354632	0.135796	0.058972	0.040332
TRANS	57.04419	0.724311	0.560057	0.340199	2.070171	2.983802	2.04066
INFO	0.197584	76.2302	1.279813	0.322817	21.27134	8.64949	5.915496
FIN	1.297844	0.875369	237.0682	29.6829	4.729981	1.50178	1.027087
RE	0.593348	1.27354	2.167507	551.4986	6.799602	45.98132	31.44721
PROSVC	1.318485	8.406829	10.23088	6.94289	318.8705	27.38789	18.73093
CORNELL	0.007256	0.070448	0	1.34E-05	0.041282	41.76418	28.56305
UNIV	0.003483	0.002381	0	2.59E-05	0.003859	0.012786	0.008744
ACCOM	3.16E-05	0.000281	0.000592	2.744966	0.001273	0.001558	0.001065
FOOD	0.355119	0.638116	2.331358	0.667217	4.772582	5.821309	3.981267
OTH	7.280183	4.480294	5.502249	12.88757	10.11517	22.90262	15.6634
LAB	26.70032	30.37875	68.23823	17.13632	164.0171	636.1106	435.0441
CAP	12.66166	32.21723	65.59613	296.6192	51.4341	14.71925	10.06668
IDT	2.907963	4.271737	5.281504	63.00681	6.314043	10.37269	7.094017
TRF	0	0	0	0	0	0	0
HHP	0	0	0	0	0	0	0
HHM	0	0	0	0	0	0	0
HHR	0	0	0	0	0	0	0
GOV	0	0.140086	0	0	0.11319	0.301976	0.206525
FIRM	0	0	0	0	0	0	0
INV	6.78E-06	0.000183	0	0	0	0	0
EXT	26.36818	42.98003	58.5378	90.56815	75.72412	249.2291	170.451

The SAM of 2009 Tompkins County (continue)

Sectors	ACCOM	FOOD	OTH	LAB	CAP	IDT	TRF
AGR	0.025598	0.392298	0.345558	0	0	0	0
MIN	0.006935	0.004835	0.889084	0	0	0	0
UTL	4.604606	4.091451	10.97384	0	0	0	0
CON	0.826749	0.369455	5.841894	0	0	0	0
MFG	0.268584	1.453607	4.080204	0	0	0	0
WSALE	0.334867	2.672343	5.45949	0	0	0	0
RETAIL	0.038867	0.80681	1.905277	0	0	0	0
TRANS	0.511645	1.123327	5.659552	0	0	0	0
INFO	1.009854	1.179567	6.177132	0	0	0	0
FIN	1.503825	2.321496	25.82271	0	0	0	0
RE	1.682359	5.807528	27.70837	0	0	0	0
PROSVC	9.140907	7.732035	41.91933	0	0	0	0
CORNELL	0	0	0.072103	0	0	0	0
UNIV	0	0	0.049312	0	0	0	0
ACCOM	0.081537	0.000282	0.001026	0	0	0	0
FOOD	3.034946	177.92	6.990554	0	0	0	0
OTH	7.109566	7.523762	1119.126	0	0	0	0
LAB	71.90447	115.9787	753.5073	0	0	0	0
CAP	13.89527	31.66986	131.9724	0	0	0	0
IDT	4.653313	17.31321	1.033785	0	0	0	0
TRF	0	0	0	0	0	0	0
HHP	0	0	2.357556	125.2274	31.40076	0	0
HHM	0	0	10.95988	923.1969	157.2794	0	0
HHR	0	0	8.220007	934.7146	267.0941	0	0
GOV	8.07E-05	0	33.81874	341.5899	7.908013	220.0308	0
FIRM	0	0	0	1.831327	221.6481	0	0
INV	0	0	14.02166	0	377.1231	0	0
EXT	35.10574	85.24179	298.4957	523.722	0	0	0

The SAM of 2009 Tompkins County (Continue)

Sectors	HHP	HHM	HHR	GOV	FIRM	INV	EXT
AGR	0.6235	1.572777	1.250029	0.053481	0	1.26E-05	56.48067
MIN	0.000771	0.00214	0.00167	0.011091	0	0.004563	107.9977
UTL	10.11662	22.41344	15.65406	1.592106	0	0	16.57782
CON	0.00001	0.00001	0.00001	48.12212	0	106.508	4.725101
MFG	3.141507	7.803974	6.494776	1.245396	0	6.751843	1042.605
WSALE	2.575348	14.91256	12.889	1.448573	0	1.770039	7.652336
RETAIL	30.71987	82.81991	107.5118	0.008297	0	7.524111	33.55318
TRANS	3.901718	8.386318	8.622623	1.397082	0	0.340667	24.93199
INFO	3.974478	9.874855	9.005026	2.301605	0	4.462081	47.64718
FIN	12.62856	45.37024	48.16837	1.179958	0	0	36.66411
RE	59.01835	159.6944	180.0112	1.450925	0	0	0.227472
PROSVC	4.598727	14.27532	11.67886	14.6379	0	65.65742	58.7829
CORNELL	13.22064	12.84174	14.41564	0.985974	0	0	1049.772
UNIV	9.041767	8.782631	9.859038	0.67432	0	0	717.9527
ACCOM	0.015476	0.02576	0.032673	0.000304	0	0	152.832
FOOD	20.57175	59.36719	59.84215	2.32154	0	0	110.7738
OTH	110.8786	281.1543	235.7557	385.1051	0	0.673487	227.6572
LAB	0	0	0	0	0	0	0
CAP	0	0	0	0	0	0	114.4224
IDT	0	0	0	0	0	0	0
TRF	0	0	0	0	0	0	0
HHP	0.402473	1.167817	3.964649	233.7875	18.64766	93.13975	1.704161
HHM	1.743481	5.058808	17.17426	256.9322	82.2215	8.902362	7.922361
HHR	2.265505	6.573484	22.31648	98.84552	100.7343	92.57186	5.94184
GOV	0.674234	154.9559	272.1055	1005.804	90.90714	638.0032	19.56279
FIRM	0	0	0	16.62547	0	52.40572	0
INV	0	0	0	626.5541	0	50.19245	300.7243
EXT	221.6864	574.3376	502.5242	85.29973	0	242.2112	0

Appendix 3

Description of sets in the CGE model

i or j	Production sectors
h	Factors of production (labor and capital)

Description of parameters in the CGE model

FF_h	Factor endowment of the h^{th} factor
v_i	Share of fixed costs in capital costs (in the CGE model with IRTS)
pWe_i	Export price in US dollars
pWm_i	Import price in US dollars
τz_i	Production tax rate
τm_i	Import tariff rate
σ_i	Elasticity of substitution
φ_i	Elasticity of transformation
η_i	Substitution elasticity parameter
φ_i	Transformation elasticity parameter
α_i	Share parameter in utility function
$\beta_{(h,i)}$	Share parameter in production function
b_j	Scale parameter in production function
$ax_{(i,j)}$	Intermediate input requirement coefficient
ay_j	Composite factor input requirement coefficient
μ_i	Government consumption share
λ_i	Investment demand share
δm_i	Share parameter in Armington function
δd_i	Share parameter in Armington function
γ_i	Scale parameter in Armington function
ξd_i	Share parameter in transformation function
ξe_i	Share parameter in transformation function
θ_i	Scale parameter in transformation function
ssp	Average propensity for private saving
ssg	Average propensity for government saving
taud	Direct tax rate

Description of variables in the CGE model

Y_j	Composite factor
$F_{(h,j)}$	The h^{th} factor input by the j^{th} firm
FC_j	The fixed costs in j^{th} firm (in the CGE model with IRTS)
$X_{(i,j)}$	Intermediate input
Z_j	Output of the j^{th} good
Xp_i	Household consumption of the i^{th} good
Xg_i	Government consumption
Xv_i	Investment demand
E_i	Exports
M_i	Imports
Q_i	Armington's composite good
D_i	Domestic good
Sp	Private saving
Sg	Government saving
Sf	Foreign saving in US dollars
Td	Direct tax
Tz_j	Production tax
Tm_i	Import tariff
UU	Utility (fictitious)

Equations in the CGE Model

The following system of equations is used in the CGE model in this study:

Domestic production:

1. The composite factor aggregating function

$$Y_j = b_j \cdot \prod_h (F_{hj})^{\beta_{hj}}$$

2. The factor demand function

$$F_{hj} = \frac{\beta_{hj} \cdot p y_j \cdot Y_j}{p f_h}$$

In the model with increasing-returns-to-scale, the additional variable of the fixed costs in the j^{th} firm is incorporated into the model.

$$FC_j = v_j \cdot SAM_{\text{Capital},j}$$

3. The intermediate demand function

$$X_{i,j} = a x_{i,j} \cdot Z_j$$

4. The composite factor demand function

$$Y_j = a y_j \cdot Z_j$$

5. The unit cost function

$$p z_j = (a y_j \cdot p y_j) + \sum_i (a x_{i,j} \cdot p q_i)$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$T d = \text{taud} \cdot \sum_h (p f_h \cdot F F_h)$$

Government Behavior:

6. The direct tax revenue function

$$p z_j = (a y_j \cdot p y_j) + \sum_i (a x_{i,j} \cdot p q_i) + \frac{FC_j}{z_j}$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$T d = \text{taud} \cdot (\sum_h (p f_h \cdot F F_h) + \sum_j FC_j)$$

7. The production tax revenue function

$$T z_j = \text{tauz}_j \cdot p z_j \cdot Z_j$$

8. The import tariff revenue function

$$T m_i = \text{taum}_i \cdot p m_i \cdot M_i$$

9. The government demand function

$$X g_i = \frac{\mu_i \cdot (T d + \sum_j T z_j + \sum_j T m_j - S g)}{p q_i}$$

Investment Behavior:

10. The investment demand function

$$X g_i = \frac{\lambda_i \cdot (S p + S g + (\epsilon \cdot S f))}{p q_i}$$

Savings:

11. The private saving function

$$S p = \text{ssp} \cdot \sum_h (p f_h \cdot F F_h)$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$S p = \text{ssp} \cdot (\sum_h (p f_h \cdot F F_h) + \sum_j FC_j)$$

12. The government saving function

$$S g = \text{ssg} \cdot (T d + \sum_j T z_j + \sum_j T m_j)$$

Household (Private) Consumption:

13. The household demand function

$$X p_i = \frac{\alpha_i \cdot (\sum_h (p f_h \cdot F F_h) - S p - T d)}{p q_i}$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$X p_i = \frac{\alpha_i \cdot (\sum_h (p f_h \cdot F F_h) + \sum_j FC_j - S p - T d)}{p q_i}$$

Trade:

14. The world export price equation

$$p e_i = \epsilon \cdot p W e_i$$

15. The world import price equation

$$p m_i = \epsilon \cdot p W m_i$$

16. The balance of payments

$$S f = \sum_i (p W m_i \cdot M_i) - \sum_i (p W e_i \cdot E_i)$$

Armington Function:

17. The Armington function

$$Q_i = \gamma_i \cdot [\delta m_i \cdot M_i^{\eta_i} + \delta d_i \cdot D_i^{\eta_i}]^{\frac{1}{\eta_i}}$$

18. The import demand function

$$M_i = \left[\frac{\gamma_i^{\eta_i} \cdot \delta m_i \cdot p_{qi}}{(1 + \tau m_i) \cdot p_{m_i}} \right]^{1-\eta_i} \cdot Q_i$$

19. The domestic good demand function

$$D_i = \left[\frac{\gamma_i^{\eta_i} \cdot \delta d_i \cdot p_{qi}}{p_{d_i}} \right]^{1-\eta_i} \cdot Q_i$$

Transformation Function:

20. The transformation function

$$Z_i = \theta_i \cdot [\xi e_i \cdot E_i^{\phi_i} + \xi d_i \cdot D_i^{\phi_i}]^{\frac{1}{\phi_i}}$$

21. The domestic good supply function

$$D_i = \left[\frac{\theta_i^{\phi_i} \cdot \xi d_i \cdot (1 + \tau z_i) \cdot p_{z_i}}{p_{d_i}} \right]^{1-\phi_i} \cdot Z_i$$

22. The export supply function

$$Q_i = X_{p_i} + X_{g_i} + X_{v_i} + \sum_j X_{i,j}$$

Market clearing Condition:

23. The market clearing condition for composite good

$$Q_i = X_{p_i} + X_{g_i} + X_{v_i} + \sum_j X_{i,j}$$

In the 2009 SAM of Tompkins County from IMPLAN, the amounts of import and export goods are much larger than the amount of intermediate goods. Therefore the definition of the market clearing condition for composite good is the combination of domestic and import goods:

$$p_{qi} \cdot Q_i = p_{d_i} \cdot D_i + p_{m_i} \cdot M_i$$

24. The factor market clearing condition

$$\sum_j F_{h,j} = FF_h$$

Fictitious Objective Function:

25. The utility function

$$UU = \prod_i (X_{p_i}^{\alpha_i})$$

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