



## CAC and Iwan Azis

### Modeling Cornell's Economic Impact on New York

What is the direct and indirect economic impact of Cornell University on Tompkins County, central New York, New York City and New York State?

#### Finding the Answer

Cornell's spending on payroll, purchasing, and construction – and the jobs associated with that spending – provide a direct measure of the University's impact on the economy. The University's local, regional and statewide impacts, however, go beyond these direct measures. Each dollar the University spends produces what economists sometimes call indirect or induced effects – the “multiplier effect.”

Cornell's indirect impact is a product of spending by the local, regional or New York State companies from which the University buys goods and services. Construction contractors, utility companies, temp services, caterers and other firms use the payments they receive from Cornell to pay their employees, rent space, and buy equipment, supplies and telephone services – and all of these expenditures have an impact on the economy. The University's *induced* impact represents the impact of routine household spending by its own employees – for rent, food, clothing, transportation, and child care – and by the employees of its suppliers.



Cornell serves as a powerful economic force on New York State

Iwan Azis, Professor of City and Regional Planning and Adjunct Professor of Economics at the Johnson School at Cornell and his colleagues, Professors Kieran Patrick Donaghy and Susan Christopherson, and their research associates, Cornell City and Regional Planning graduate students Nij Tontisrin and Sutee Anantsuksomsri used an economic impact model based on Social Accounting Matrices (SAM) to determine the indirect and “multiplier effect” of Cornell on the regional and statewide economy. The computational approach is based on a mathematical input-output (I/O) and SAM model developed by, respectively, Wassily Leontief, the 1973 Nobel laureate in economics and Sir Richard Stone, the 1984 Nobel Laureate in economics, and was later extended by Jacques Defourny and Erik Thorbecke at Cornell.

## Understanding the “Multiplier Effect”

While economists generally agree that these “multiplier effects” exist, they are difficult to measure. Patterns of spending and employment among supplier firms and employee households can vary over time and from one region to another. Within any given industry, the extent to which their inputs are bought locally can vary greatly from one firm to another.

There are nevertheless several quantitative economic models that can provide an approximate measure of indirect and induced effects. Using one of these models – Professor Azis and his colleagues have calculated the impact of spending by Cornell University on total economic output, wages and employment in Tompkins County, other local counties, the Central New York region and the state. They used the same modeling system to estimate the impact of Weill-Cornell Medical School on New York City and New York State.

## Improved Research

### Research Metrics

- Improve application efficiency: reimplement code on a modern matrix-oriented platform (research code modernization)
- Reduce compute runs from approximately 2 weeks to less than 3 hours

### Research Challenge

Input-output models are complex. They must calculate the flow of payments for goods and services across different industry sectors, and between households and industries. A Social Accounting Matrix can be envisioned simply as a table with hundreds of rows and columns, with all industries (plus households) listed down the side as producers; and the same industries and households listed across as consumers. Spending by any consumer industry – in this case, the University – is allocated across all the producing industries and the household sector. Each of these producer industries in turn purchases its own distinct set of inputs from other industries and households in order to produce the output it sells to Cornell.

Just as the University spends some of its resources within Tompkins County and elsewhere, Cornell’s local suppliers spend part of *their* revenues within the County, and some is paid to businesses elsewhere in New York, in other states or overseas. Through each successive round of spending, the money that was originally spent within the County is eventually diffused throughout the broader economy.

The original Cornell Social Accounting model was written in Visual Basic and the estimated run time for the model with 553 matrix factors on a PC was 12-14 days, much longer than desired for reporting purposes and model refinement.

### Solution

MATLAB



To improve the code efficiency and reduce the run time so that multiple runs could occur within a day, a CAC senior research associate reimplemented the code from scratch using MathWork’s MATLAB. The code was then optimized with the aid of the MATLAB profiler.

The model now runs in 2.75 hours enabling researchers to meet their goal of running 8 iterations within a 24 hour period. A research paper by Cornell H.E. Babcock Professor of

Economics and Food Economics, Emeritus, Erik Thorbecke was helpful to CAC in developing the code.

This model enables Cornell to trace the impact of each dollar of University spending as it ripples through other industry sectors in Tompkins County, and to translate the allocation of spending across industries into estimates of employment and wages. It also allows Cornell to repeat that calculation for the surrounding counties – for the Central New York region – and for New York State. The model similarly allows Cornell to trace the impact of Weill Cornell's spending in New York City and New York State.

Cornell generated over \$3.3 billion statewide and led universities in the state in research expenditures, totaling more than \$650 million, according to the latest economic impact report released by the university.

### **The Client**

Iwan Azis, Professor and Director of Graduate Studies, Regional Science program and Adjunct Professor of Economics, the Johnson School at Cornell

- Current research includes how macroeconomic policies interact with business and social indicators, and the role of international organizations in a financial crisis
- Conducted research and consulting for governments, the World Bank, the Asian Development Bank, the United Nations, USAID, and the Research Triangle Institute
- Teaches macroeconomics and international trade, economics of financial crisis, and planning and policy modeling



Iwan Azis

### **The Collaborative Relationship**

“The Cornell Center for Advanced Computing played a pivotal role in modernizing our code and speeding up computation time. This helped to enable completion of Cornell’s economic impact report and will make future report generation easier, faster, and more accurate. CAC’s expertise in code implementation and optimization are a unique skill set that does not exist within City and Regional Planning or my research group. It is not our core expertise, but it is essential to generating timely research insights.”

*Iwan Azis*

*Professor and Director of Graduate Studies, Regional Science program  
and Adjunct Professor, the Johnson School at Cornell*