IMPACT OF THE LOSS OF RAIL SYSTEM SERVICE ON A KEY SEGMENT OF NEW JERSEY'S URBAN INDUSTRIAL CORRIDOR: A CGE ANALYSIS [*]

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ABSTRACT. We describe the setting for and construction of a pilot economic simulation model that will be used to assess the regional economic impacts of hazards events on a major rail corridor. The idea is to use such a model to assist in the evaluation of the potential costs and benefits of making transportation systems more capable of withstanding events and rebounding from them. We test the robustness of the model by modifying labor-capital and trade elasticities. In general, we find the model's results are quite robust to these parameters. Our baseline estimates are also lower than what might be supposed through the implementation of partial equilibrium results obtained via panel data analysis.

INTRODUCTION

> "We can put Americans to work today building the infrastructure of tomorrow. From the first railroads to the Interstate Highway System, our nation has always been built to compete. There's no reason Europe or China should have the fastest trains, or the new factories that manufacture clean energy products. Tomorrow, I'll visit Tampa, Florida, where workers will soon break ground on a new high-speed railroad funded by the Recovery Act. There are projects like that all across this country that will create jobs and help move our nation's goods, services, and information."
>
> --President Barack Obama in the *State of the Union Address* (January 27, 2010)

As suggested above quote, politically speaking at least, there is a vision of an America rejoined by high-speed rail. Its implementation has economic, environmental, social, and other benefits. Naturally it also comes with risks. Rail transit systems are vulnerable to a plethora of mechanical and human failures that can result in disaster. In this regard, such transport systems get enhanced scrutiny in a post 9/11 world. In many ways, rail networks, which offer more

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points of entry, could make more inviting targets than air transport systems, especially since they lack passenger screening, and provide little security around stopped vehicles.

A hazardous event can disrupt service, cause injury, damage or loss of life at the site of the incident, and cause cascading effects throughout the transportation network, including delivery delays and economic losses. Should dependence on a national rail system increase, it seems only logical that measures to protect passengers and to respond as effectively as possible to hazardous/ disastrous events should advance as well. In short, the building of a world-class passenger rail system requires policy decisions to guide relevant strategic investments that will enable effective management of security risks.

Although government and academic researchers have focused attention on prevention and response at some of the key nodes along the Northeast Corridor and have evaluated specific technologies (Transportation Research Board, 2004), there has been limited research looking at the Corridor in large segments, let alone in its entirety, to determine ways to evaluate system resilience and response strategies so that cost-effective solutions can be discovered to reduce potential negative impacts. Indeed, if the U.S. does develop high-speed rail corridors, it is essential that we are able to protect the entire system and build up system resiliency around links that are already regularly blocked or that are deemed most likely to become blocked in the future.

A logical place to test security-related options is the Northeast Corridor (NEC) that runs over 450 miles from Washington to Boston. The NEC is the most heavily travelled by ridership and service frequency. For example, more than 1,600 people per minute move through New York's Penn Station during rush hour (Bushue, 2006).

There is no denying that a train station and area around it can be destroyed by bombs, tornadoes, or other natural and human-initiated events. Typically, estimates of the direct costs of event damage are available within a week to two weeks of an incident and are widely featured in the media and discussed by elected officials. They include human and animal deaths and injuries, severe and moderate damage to structures and their contents, vehicles, infrastructure, utilities and their delivery systems, landscapes and agriculture, as well as cleanup and response costs in these local areas (Mileti 1999). People in cutoff areas may not be able to go to work and school, and they may need to leave their homes. Physically handicapped may need special assistance (Berube & Katz 2005).

County, state, and regional impacts cannot be ignored, especially in the case of an event that disrupts a rail-corridor (see, e.g., Rose, 2004; Rose & Liao, 2005; Greenberg et al. 2007). A rail-related event doubtlessly leads to traffic congestion due to overburdened bridges, roads, and other impacts on parts of the transportation network. Some people may not be able to get to work, and some freight may not be delivered or be shifted to other modes. All of these will lead to reduced sales as the impact spreads across the landscape. Indirect effects cause lost sales as the impacts spread. These nonlocal impacts include declines in sales, wages, and profits due to loss of function in the areas impacted. Some affected households and businesses may be located many miles away from the event locale and, especially in the case of a rail corridor, can be quite extensive. These losses are attributable to reduced supplies and demand from the affected areas, and slowdowns in transporting products and people.

Induced effects come about when workers lose pay because of the direct and indirect effects. They buy less, especially of products that they do not immediately need. Government feels all these impacts because tax collections drop because of business losses and consequent reductions in worker earnings.

In the short run, the local area may benefit as insurance companies, not-for-profits, and government from outside of the state or region expend funds in the directly impacted area to restore it. Yet, in the worst case for the region, investors could lose confidence in the regions and withdraw their investments, leading to relocation of economic activity and jobs. Overall, estimating the spatial spread of impacts is an important objective of economic impact analysis.

Measuring the temporal spread of impacts is critical. The actual life cycle of a serious event is much longer than the period of active humanitarian, political and economic focus on it. For example, a derailment in which people are injured and killed may stop train traffic, and if the railroad administrators believe it is terrorist-related, then all traffic may stop. But repairs to infrastructure may be relatively inexpensive and quick to repair. In contrast, a bridge or tunnel collapse in an area with no alternative routes could seriously handicap an area economically and thereby yield effects that linger for an extended period. Such economic vulnerabilities could undermine a regional economy. It is in such susceptible regions that investors are most likely to hesitate about spending and perhaps choose not to. Decision makers could be misled into making unwise decisions about investments, if they are aware only of the short-term economic costs and benefits, when instead the bulk of the costs are incurred in the short term and the benefits accrue over a much longer period of time, or vice versa.

When engineered systems like rail lines, water pipelines, gas lines, power grids, dams, bridges and others fail, Greenberg et al. (2007) note that five managerial failures consistently are raised:

1. to protect engineered systems,

2. to implement land-use planning and design tools to reduce hazards,

3. to provide resources that build resiliency into systems and mitigate against economically disastrous outcomes,

4. to adequately consider and plan for evacuation/relocation, and

5. to understand the implications of different levels and staging of restoration.

All five failures are relevant to rail corridors, but numbers 1 and 3 are of particular interest for this study, because they draw attention to policy-significant tradeoff issues. For example, with respect to Hurricane Katrina, if the Corps of Engineers had spent more to bolster New Orleans's levees, would it have made much of a difference? What would they have needed to build the structures to cope with the hurricane? Yet, suppose one of those other locations suffered a serious event and the money it would have received to protect the location had gone to the New Orleans levees? Second guessing always follows events; however, it would be helpful to at least have proactive analyses that could place costs in the context of potential consequences for decision makers that must make the tradeoffs. It would also be helpful to know what the cost would have been to have an evacuation plan that included functioning buses and other capabilities.

In this paper, we describe a prototype economic model that allows planners to assess the main economic consequences of system failures and the potential benefits and costs of investments in the system that are designed to reduce or mitigate losses. We view rail security as a classical problem in risk analysis. In order to plan strategically, decision makers should have scientifically grounded answers to the four basic questions in risk analysis (Kaplan & Garrick 1981; Haimes, 2009; Greenberg, 2009).

1. What events can occur?

2. What is the likelihood of those events occurring?
3. What are the consequences of those events?
4. What investments should be made to prevent intolerable consequences and enable ecosystems to recover as quickly as possible?

Answering the first two questions in the context of rail security implies understanding vulnerability and threat, using pre-emptive intelligence and monitoring system state. Once risk analysts answer the first two of the four questions, then the challenge is to understand the consequences and to eliminate or reduce them.

BACKGROUND AND RESEARCH APPROACH

Study Area

The study area for this pilot project is the State of New Jersey. In 2010, New Jersey has the highest population density of any U.S. state, more than 1,100 people per square mile. The state itself is most densely populated along the corridor between New York City in the northeast and Philadelphia in the west central part of the state. The central tread tying together this core of dense population is the Northeast Corridor Line. In New Jersey, more people now live and work in the suburbs that are not along the Corridor. Out of a total of 8.7 million in the year 2010, just over 1.0 million New Jersey residents live in a municipality that abuts this main rail transit corridor, although 3.4 million live within 10 miles of it.

We will focus the study on a segment of the Northeast Corridor rail line that is located along the main line from south to north beginning at the Elizabeth, New Jersey, station through to the southern terminus of Penn Station in New York. This highly traveled and highly trafficked segment is 15.4 miles long and runs through the most urbanized region in the United States, with two major bridges and an underground portion that tunnels under the Hudson River and into Manhattan. The line is used by Amtrak and New Jersey Transit for passenger service and by freight rail carriers. It operates by electric power with diesel available as a back-up. Further, the nodes (stations) along this system are intersection points for connecting transit lines operated by New Jersey Transit in New Jersey and by New York MTA trains at Penn Station, and its busy stations are filled with thousands of passengers daily who meet other surface transportation vehicles such as buses and taxis. While we will examine the direct effects emanating from the counties that constitute this region (Hudson, Essex, and Union), total economic impacts will be estimated for New Jersey as a whole.

Because this segment has examples of most of the infrastructure types that can be found on this, or any other corridor, and its nodes are connection points for numerous linking systems, it provides a rich laboratory to build and test an economic model that will be useful outside the immediate study area. The modeling is readily expandable up and down the corridor to other stations, and is only constrained by availability of data to add depth to the system data base.

Methods of Analysis

The model developed here for New Jersey will be integrated into a more comprehensive model that will include all of New Jersey and parts of New York State that border on New Jersey and are tied to it through the rail corridor. As a prototype, the example analysis presented later is not based on any single, real event. A more complete set of events will be tested with the final economic model at a later date. We opted to use an applied computable general equilibrium model for reasons discussed below.

Compared to other models, CGE models gain traction from a theoretical perspective in the case of disasters. Although widely used, standard input-output (I-O) models yield economywide average results of impacts: they are unable to take into account the reality that the least able (least profitable, least wealthy, and, hence, most vulnerable) agents will be the least likely to endure economic crises. Moreover, I-O models also cannot account for any substitution of key factors, goods, and services when they are in short supply. Generally speaking I-O models can be quite valuable in estimating, at least roughly, the magnitude of economywide consequences. But due to the aforementioned reasons, they are not so helpful in the case of disasters.

Another key model type used in impact analysis is the systems econometric time-series (SETS) model, typically used in forecast settings. Unlike I-O models, they *can* measure marginal impacts and also, in a rather intuitive sort of way, account for substitution and price effects, which I-O cannot. But what yields such value to them over I-O models also is their weakness—their reliance on history. That is, they measure marginal impacts and account for substitution and price effects based on the statistically measured recent history of economic relationships in the economy. Thus if an event occurs that is unlike anything in the data history measured by the SETS model, the model is unlikely to be able to measure well the likely economic consequences of the event.

While using I-O data at their core, applied CGE models apply economic theory and optimization techniques to enable substitution among factors and commodities. This in turn results in this model genre's ability to estimate marginal rather than average effects. And while specific elasticities among factor and commodity choices must be pre-specified, often even "borrowed" from prior experiences, post-analysis sensitivity analysis can be performed to test the robustness of findings to alternative specifications of the elasticities.

In the end, because of their versatility, CGE models are a logical choice for many policy applications. They make particular sense in transportation applications, because an outage of a single transportation segment has system-wide effects. These effects can be observed on individual households and firms; as well as, on more aggregate levels—consumers and industries. In many cases, deleterious transportation changes can disrupt production both at the firm and sector levels. Estimating the short-, medium-, and long-term effects of outages of lifelines like a commuter rail system has important implications. Model estimates can be used to determine who, if anyone, should be compensated and by how much. It can also be used to identify the potential costs of recovering from a disaster. But more importantly, CGE's may be used in advance of a potential threat to identify reasonable limits of efforts to mitigate a disaster, or at least to improve an economy's resilience in the wake of a disaster.

An ever broadening literature on CGER models shows they are being used more and more to assess the effect of disasters on economies. Nonetheless, we were unable to uncover research that considered a disaster that focused on a single, specific segment of a commuter rail network and its subsequent effect on the local economy. At best, it seems Bröcker & Mercenier (2010) have formulated such a model from a theoretical perspective. The existing literature does provide some other guidance, however. Sohn et al. (2003) provide some instruction in their focus on the relationship between final demand and transportation costs, for example. In the case of a discontinued transit segment, they suggest closer examination of fuel consumption (the change in final demand) due to a change in commute mode. But what is the economic loss? Losses are quite evident in the various works of Chang & Nojima (1997, 1998, 1999) and Chang (2000). In the case of commute changes, transportation costs are not just the change in the costs of transportation service itself, but also the opportunity costs of congestion time. This raises the question of how such costs are embedded in measureable household and business transactions, so that they can be measured via conventional economic models. The answer derives from a decision made by the commuting worker and comes down to an answer to the following question. Does the worker decide to keep pre-disaster work hours and let the added commute time eat into time that would otherwise be committed to leisure, or does the worker instead opt to reduce his/her work hours at least somewhat and thereby reduce her/his workplace productivity?

Given these two building blocks—the economic impact of fuel price rises and the economic impact of temporary declines in labor productivity—we started to parameterize the model. We characterized the short-, medium-, and long-term effects of service disruptions to the rail network by first focusing on the immediate- and long-term effects of gasoline consumption due to price changes. We then empirically examined the relationship between the labor compensation-to-GDP ratio on GDP growth, assuming that the ratio would rise in the wake of the disaster to be modeled. With these two tools in hand, along with some concept of the size of the affected labor force and the duration that the rail segment was disabled, we could reasonably use the prototype to predict the economic impact of rail system disruption.

DIRECT EFFECTS OF TRANSPORTATION INFRASTRUCTURE ON PRODUCTIVITY

Estimating the short-, medium-, and long-term effects of lifeline outages – such as a commuter rail system – has important implications in determining economic and social losses. While the existing literature shows a growing use of integrated analytical models to capture the economic costs with respect to changes in transportation infrastructures; as noted above, it does not assess the effects upon an entire transportation network that result from a disruption to a specific link—namely the localized effects of increased road congestion subsequent disruption of rail service. As Fernald (1999) and Baird (2005) showed, congestion has negative effects on productivity. Using an integrated network model and CGE analysis, we put forward that there are significant implications of time-delays due to congestion, and that increased levels of traffic on local road networks result from substitution of auto for rail transport. Following Fernald, as road networks become more built out, congestion rises – since transport planners are able to develop fewer alternative routes to add to the existing system. Thus, as road systems reach capacity and become saturated, output is dampened. In summary, we assume that increases in the consumption of road transport results in increases in fuel costs and time-delays, which together have negative effects on productivity.

Gauging the Effect of Changes in Gasoline Consumption

In preparing the model, we examined the temporal relationship between motor gas prices and motor gas consumption in both directions: price increases affecting consumption and consumption affecting prices. The purpose of this was to determine how diversion from rail transit would inevitably hit New Jersey's road system, either through increased bus service, or by a return to the use of autos. Either way, the loss of rail service would increase the consumption of petroleum-based fuels, both gasoline and diesel fuel. Subsequently, the rise in fuel consumption should cause fuel prices to rise, at least in the very short run. In the long run, however, worldwide effects of OPEC-cartel oil prices would override any short-term effects that a localized change in consumption would have on local oil prices. From a theoretical perspective then, any short-run rise in price should feedback to cause fuel consumption to decline, at least in the long run, as commuters adapt, opting either to find another job closer to home, or carpool, or as consumption and prices typically should converge to something close to their long-run equilibriums.

To estimate the elasticity of fuel consumption to its price, we used data for 1978 through 2009 from the Energy Information Administration (EIA) of the U.S. Department of Energy. Equation (1) shows the results of a simple bivariate time-series regression that was derived.

$$(1)\quad c = 3340062 \cdot p^{-0.0184} \cdot p_{t-1}^{-0.0149}$$

where

p = Average U.S. retail motor gasoline prices (all grades), dollar per gallon,

c = Total U.S. consumption of finished motor gasoline (thousands of barrels), and

t = time in years.

A Prais-Winsten and Cochrane-Orcutt generalized least squares regression approach was employed, which corrects for any serially correlated error. The effect of price on demand shows that a 1.0 percent rise in the price of gasoline results in a decline of gasoline consumption of 0.018 percent in the short run. Interestingly, longer-term effects (a second year only) almost double the small, short-term effect. But no more consumption effects attenuate beyond the second year after a change in fuel price. That is, all further effects tested were undetectably different from the null and are not reported here. We also attempted to derive an equation about the relationship of demand on price. Logically, greater demand should drive up price, but we could not derive a stable equation, at least partly, we think, because of the aforementioned overarching role of OPEC on local prices.

In summary, as transport options become reduced and transit commuters resort to roads for travel, the expected demand for motor gasoline that would result would cause a temporary spike in gas prices. The spike in prices should cause gas consumption to moderate in the short-term, but return to usual gasoline demand expectations in the long run. Regardless, long-run changes in petroleum consumption, due to congestion-derived price changes alone, are expected to be small.

Congestion Effects: A Question of Commuters' Productivity

As mentioned previously, required diversions from rail transit would undoubtedly increase usage of New Jersey's road infrastructure, causing congestion on freeways, motorways, arterials, and surface streets between the homes and workplaces of former rail commuters. We would expect that all commuters' travel times, not just those of rail commuters, would rise due to the increased demand on the roadway network. This is because traffic slows and accident frequencies rise as roads exceed their capacities. In the short-run, this increase in travel time would leave commuters three possible options: work from home, reduce their leisure time, or reduce work hours. In the longer run, however, they can change jobs.

While flex-place is a policy in which many firms participate when emergencies arise, the policy is generally applied as a temporary solution to problems, both personal and systemwide. An exception can be the set of workers who engage in project-based work activities that are not heavily team-oriented. For the most part, however, heightened congestion is likely to have a negative impact on productivity; either, individuals are likely to become increasingly fatigued at their workplace due to declines in leisure activities, or they wind up spending less time in the workplace, essentially counting time in transit as work hours. To measure the effects of such productivity decline, we analyzed the relationship between gross domestic product (GDP) and labor compensation in New Jersey's industries. We used data from the U.S. Bureau of Economic Analysis of the Department of Commerce and examined the effect of labor's share of GDP on the GDP yield in New Jersey across 69 industries from 1997 to 2008.[1]

[1] The US BEA data set for GDP by state identifies 81 industries, of which 69 are used in this model due to federal data disclosure issues.

To examine the relationship, we used a random-effects panel regression approach with New Jersey's industries as panel variables. As with our examination of fuel consumption, we examined both short- and intermediate-term effects, but this time GDP is the focus of the unexpected changes in transportation options and patterns, see Equation (2).

$$(2)\ \ Y_t^i = 0.987084\ \left(Y_{t-1}^i\right)^{1.0058}\left(w_t^i/Y_t^i\right)^{-0.8332}$$

where Y_t^i is the GDP (in $ millions) of industry *i* in year *t* and w_t^i is the total industry compensation for industry *i* in year *t*.

The implication of Equation (2) is that for each percentage rise in the compensation/GDP ratio, GDP falls almost equivalently—by 0.833 percent. Moreover as no other lagged versions of the compensation/GDP ratio were able to enter the equation in a statistically significant fashion, the fall is permanent unless the compensation/GDP ratio itself rebounds. In the case of our simulations, the ratio rebounds only when the rail lines are back in operation and former rail commuters return to them.

THE MODEL

Domestic and Foreign Production

In our eleven-industry CGE model[2] we assume that there is some degree of substitution between domestic and imported commodities in all production processes. Thus, for tradable goods total output in each production sector *i* is a composite of domestic (q_{d_i}) and imported (q_{m_i}) production obtained through CES technology:

[2] The SAM and closure rules for the model are elaborated in the Appendix. Details on the construction and character of applied CGE models can be gleaned from Shoven and Whalley (1992), Robinson et al. (1999) and Cardenete, Guerra, and Sancho (2012).

(3) $$q_i = \left[\left(a_{d_i} q_{d_i} \right)^{\rho_{A_i}} + \left(a_{m_i} q_{m_i} \right)^{\rho_{A_i}} \right]^{\left(1/\rho_{A_i} \right)} \quad \forall \ i \in 1,\ldots,11$$

where a_{d_i}, a_{m_i}, and ρ_{A_i} (in our case, ρ_{A_i} = 0.7 for all *i*) are, respectively, the domestic and foreign direct coefficients and the ρ_{A_i} is the parameter that identifies the elasticity of substitution between the, $\sigma_{A_i} = 1 / \left(1 - \rho_{A_i} \right)$, which is often termed the Armington elasticity. We assume New Jersey is a price taker, so prices are exogenous to the model.

Domestic Production. Production of the domestic good in each sector *i* is structured using a KLM (Capital, Labor, and Materials) nested production function. A materials-inputs composite good is introduced along with the value-added composite good following Leontief technology:

(4) $$q_{d_j} = \min \left[\frac{x_{1j}}{a_{1j}}, \ldots, \frac{x_{11j}}{a_{11j}}, \frac{v_j}{\upsilon_j} \right] \quad \text{for } \forall \ i = j \in 1,\ldots,11$$

where a_{ij}, x_{ij}, υ_j, and v_j refer, respectively, to a direct Leontief coefficient for the use of sector *i* production in sector *j*, the total use of sector *i* production in sector *j* (intermediate demand) , value-added technical coefficient for sector *j*, and total value added of sector *j*.

Production of value added, v_i, however, responds to a CES technology:

(5) $$v_i = \left[\left(a_{L_i} L_i \right)^{\rho_i} + \left(a_{K_i} K_i \right)^{\rho_i} \right]^{\left(1/\rho_i \right)}$$

where a_{L_i}, a_{K_i}, ρ_i (again, we assume for now that ρ_i = 0.7 for all *i*) are, respectively, the labor and capital technical coefficients plus the parameter that refers to the elasticity of substitution between them.

Households. Consumption (*C*) and savings (S_h) activities of a representative household are characterized using a Cobb-Douglas utility function:

(6)
$$U(C,S)=\prod_{i=1}^{n} C_i^{\alpha_i} S_h^{\left(1-\sum_{i-1}^{n}\alpha_i\right)}$$

Under this assumption, consumption and household savings of a representative utility maximizing household are constant shares of disposable income, yn_i. Total consumer income or income "before taxes", y_i, is composed of labor income, capital returns, and overall transfers.

Government. The state government collects taxes from retail sales, property taxes, and income taxes. Total tax revenues (T) allows the public sector to buy goods for public consumption in fixed proportions (C_g) and undertake transfer operations to other agents in the economy as well as it also receives this kind of inflows from them. We then express government transfers in net terms (Tr_g). Thus, the amount of government's savings (S_g) is endogenous in this model and represents the state government deficit or surplus:

(7)
$$S_g = T - \sum_{i=1}^{n} C_g \cdot p_i - Tr_g$$

Where p_i is the average price of commodity i.

Foreign Sector and Macroeconomic Closure Rule. Since New Jersey is an open economy, trade need not balance. Still, macroeconomic consistency rules mandate that the trade balance between this economy and foreign ones must be translated into foreign sectors' savings (S_m)—a component of total savings:

(8)
$$S_m = p_m \cdot \left[\left(\sum_{i=1}^{n} q_{m_i}\right) - e\right] + Tr_m + T_m$$

In our model, the foreign sector is a composite of the Federal government and the rest of the world. As indicated in Equation (8), foreign sectors' savings corresponds to the difference between total imports and total exports ($e=\sum_{i=1}^{11} e_i$ in value terms plus the deflated net transfers to the foreign sector (Tr_m). plus taxes collected by the federal government through foreign sector activity i.e., labor taxes and federal income tax revenues. Exports in the model are not price sensitive.

The price of the trade balance is a price index that refers to a weighted average of exports valued or final gross prices of each commodity:

(9) $$p_m = \sum_{i=1}^{11} p_i \cdot \left(\frac{e_i}{e} \right)$$

Where e_i refers to the total exports of sector *i*.

The model's macroeconomic closure rule refers then to the balance between investment and savings. Therefore total investment in the economy is the sum of overall agents' savings. As usual in CGE models, Leontief technology with fixed coefficients defines the allocation of total investment to sectors' final demands. As in the case of the trade balance, the price of investment activities is a weighted average of commodities final gross prices.

Data

In general, the data used in the CGE model were based on data available from the U.S. Quarterly Census of Employment and Wages for 2008 with some federal disclosure issues filled in using data mining techniques along the lines discussed by Gerking et al. (2001). These then were enhanced as suggested by Lahr (2001) to match up with 2008 compensation estimates produced by the U.S. Bureau of Economic Analysis (BEA) and subsequently with 2008 GDP by

State estimates from that agency as well.[3] Data were also pulled from the BEA website for transfer payments, aggregate personal income, and state residents' propensity to retain labor income earned within its boundaries. Both international and domestic trade data were also estimated as suggested by Lahr (2001). The share of personal income that is spent annually was derived from The U.S. Department of Labor's Consumer Expenditure Survey. Federal as well as state and local effective income tax rates were estimated from the Survey of Governments produced by the U.S. Department of Census. Effective property tax rates, as well as, spending by the state and sources of state revenues, were obtained from the website of the State of New Jersey Treasurer's Office. Some hand reconciliation of these various data sources was performed once it was all compiled. More details are provided in the Appendix to this paper.

DISASTER SCENARIOS

To investigate the possible economic impacts of a catastrophe occurring to rail transit on the economy of the State of New Jersey, we generated two basic scenarios. The first, is the larger of the two and emanates from the tunnel into New York City from which full recovery takes about three years. The second is at Newark's Penn Station from which recovery takes about a year. Please note that these are hypothetical to illustrate the model.

> ***Scenario 1*****:** In this case, the disaster is much more localized. It is focused on Newark's Penn Station and some structures in the immediate neighborhood. Track and a temporary station are quickly built and are functional about a year later. Still, direct rail traffic into New York City from areas south of Elizabeth is disabled. So all of the alternative transportation strategies needed for Scenario 2 must be employed, but for a single year only.

[3] The GDP by State estimates were the latest available at the time the model was built and, hence, identified the year of the model data.

Scenario 2**:** In this scenario, a disaster occurs from Newark Penn Station to New York's Penn Station. All traffic that uses that section of track, including the North River Tunnels, is discontinued for three years. Post-disaster, all traffic from the south must terminate in Elizabeth, New Jersey, and only that rolling stock that did not enter the North River Tunnels during the disaster can be used. Highway bridges, road tunnels, PATH trains, buses, and ferry systems into New York City operate without disruption. NJ Transit provides buses and shuttle service from Elizabeth to a nearby PATH station and to the Port Authority's bus terminal to help the usual 80,000 passengers daily to get into New York City.

Regardless of the scenario, on the order of about 80,000-100,000 former rail passengers would find they must use alternative means of getting to work and, otherwise, visiting New York City and the Meadowlands arenas—the latter would no longer be accessible via Secaucus Station. In the wake of the disasters, workplaces generally accommodate their workers' commute issues, but at the expense of the firms' profit lines. The types of companies affected are those that pay their employees enough to enable the longer, more-expensive rail commutes. In Essex and Hudson counties—the core work areas in New Jersey that would be affected by the altered commuting patterns—jobs of this sort are concentrated in producer services, which are described best via the following seven industry titles: Security and commodity brokerage; Insurance carriers; Computer and data processing services; Advertising; Legal services; Engineering, architectural, and surveying services; and Accounting, auditing, and bookkeeping, and related services. Almost 60,000 people with an average pay of about $115,000 are presently employed in these Hudson-Essex industries, and they account for about 7.6 percent of the 790,000 jobs in the two counties. This set of industries in these two counties produces on the order of $15.3 billion (3.1 percent) of the state's total $478.4 billion in GDP annually. Moreover, Essex and Hudson counties maintain roughly 21.9 percent of the state's total payroll for these industries but about 17.1 percent of the state's payroll across all industries. Therefore, the region that we have targeted to be most affected by a scenario for a change in transportation patterns is particularly well endowed with producer services, the workers of which are likely to have their commutes altered most by the hazard scenarios.

We base our analysis of the productivity consequences of the longer commutes that result from the disaster on state-based GDP by focusing on the aforementioned producer-service industries. Constraining the direct effects to workers in this small set of industries simplifies simulations, a necessity since the modeling process is complex. Still, the industries represent very well the broader group of sectors likely to be affected by the sort of disasters that are the focus of the study.

Economic Impacts of Scenario 1

As suggested in the formulation of this scenario, the basic direct effects are essentially the same. That is, the commutes for the same number and distribution of workers are disrupted through the disabling of the Northeast Corridor rail line from Elizabeth to Manhattan. The difference is strictly in the duration of the event. In this case, impacts that result from the event last a single year during which the line is repaired and after which it is operating. Note in this case and in the case of a long-run disruption, the reconstruction effects are not included. This is strictly because they are not easy to estimate without more precision in the scenarios. They would be included in a more-detailed study.

In the case of the long-run scenario, Table 1 showed the peak annual long-run losses that would be achieved in perpetuity. In the case of an event that curtails commutes by rail, on the key section of the Northeast Corridor Line for a single-year, Table 1 shows the totality of the impacts. That is, the losses are incurred by the businesses for the year, but with the promise of the resumption of rail service operations and the clearing up of the congestion that resulted from its absence, affected businesses immediately rebound. That need not be the case. Some business might choose to relocate away from unreliable rail service, which would be costly. This illustration does not speak to those possibilities.

Economic Impacts of Scenario 2

In this case, we did not perturb the demand for gasoline that would result through any heightened increase in the use of road-based transportation. The only long-run effect of fuel usage is that real prices of gasoline would rise very modestly. That is, our time-series analysis of the effect of fuel prices on fuel consumption suggests that the rapid rise in gasoline consumption would relax downward to long-run levels. This likely would occur since, in the long run, households engage in measures that improve the efficiency of gasoline use: move closer to workplaces, change to workplaces that are closer to home, use alternative transportation (walking, bicycle, bus, carpooling), and use more fuel-efficient autos.

We did, however, disturb production levels of key producer services in Essex and Hudson counties. We did this by assuming workers reduced their time at work by 7 percent. The 7 percent is obtained by assuming workers on average subtract the 30 minutes of added daily commute from a typical 7.5-hour work day. Given that a 1 percent rise in compensation’s share of value added decreases GDP on average by 0.833 percent, a 7 percent rise is expected to cause annual GDP partial equilibrium fall on the order of 5.83 percent in the case of severe Scenario 1. Reiterating here for the sake of clarity, we limited these effects to the selected set of producer services that are clustered in Hudson and Essex County. We assumed all area workers in the industries were equally affected.

Table 1: Results for Scenario 2, Changes in GDP Components by Sector

Sector	GDP	Indirect Taxes	Labor Income	Property-type Income
1.Primary Industries & Construction	-3.54	-2.76	0.24	-9.01
2.Manufacturing	-2.52	-1.41	0.19	-9.06
3.Wholesale trade	-3.94	-3.48	-1.13	-10.25
4.Retail trade	-2.53	-2.53	-0.30	-9.50
5.Transportation & warehousing	-2.71	-2.30	0.03	-9.20
6.Information	-3.27	-2.83	5.72	-9.44
7.Fin., insur., real estate, & rental/leasing	-4.28	-3.66	6.97	-8.37
8.Professional & business services	1.50	0.08	5.42	-9.71
9.Education, health care, & social assistance	0.24	-1.73	2.95	-11.82
10.Entertainment, art, & hospitality services	-2.32	-2.05	0.13	-9.11
11. Other services, except government	-1.86	-2.11	0.27	-8.98

MODEL RESULTS

Core findings

The effective 7 percent rise in the compensation of workers in selected producer services would hit New Jersey's economy rather hard and would be pervasive throughout the economy. Sectors hurt by direct productivity declines in their workers absorb the added worker costs, so their total payrolls (labor income distributions) rise substantially as shown in Table 1.

Furthermore they and other industries are forced to forgo capital investment that enables long-run profitability. According to Table 1, which presents long-run losses property-type income, largely profits, would take the brunt of the loss—on the order of a 9-11% drop. These losses would be observed in perpetuity. Presumably, the rising costs of wage-taking producer service firms push firms that use their services to reduce their profitability.

What is surprising in Table 1, is the rise in overall GDP in both Professional & business services and Education, health care and social assistance services, respectively, mild bump-ups of 1.5 and 0.2 percent. Overall income drops in Wholesale and Retail trade, 1.1 and 0.3 respectively, make it clear that these sectors suffer also from job declines.

The overall estimated loss as depicted in Table 1 in terms of total GDP is on the order to $12.9 billion—about 2.3% of New Jersey's annual level (estimates made from GDP levels reported in Appendix Table A1). Just over 44% of the GDP losses would be incurred in the Finance, insurance, real estate and rental/leasing sector. This is just more than the next three top-ranking sectors in terms of GDP loss—Manufacturing (17.7%), Primary industries & construction (13.4%), and Wholesale trade (12.6%), which combine for another 43.7 % of the total GDP losses the state would incur. Recall again that in the case of Scenario 2, these would be permanent losses to the economy. That is, firms and workers would flee the state due to the costs incurred while the rail way was inoperable. The fear of it happening again would keep other entities from replacing those that depart.

The fall in state and local tax collections would be similar, about 2.9% off of current normal levels (about $1.2 billion annually). Understand that 2008 was the fourth straight year during which New Jersey had tightened its spending belt. So any further reductions, especially on this order, would cut deeply in much needed service levels. With the exception of Manufacturing, those sectors less able to contribute to government revenues would be the same—with the reductions in the Finance sector alone accounting for nearly half of all state and local tax revenue losses.

These stark losses give some guidelines as to what New Jersey might wish to expend if its policymakers perceive that the threat of such a disaster is really possible. Of course, some smaller share might be worthwhile to be prepared for a wider array of less-disastrous events, such as that proposed by Scenario 1. For example, in comparison it might not cost to have excess bus rolling stock available to enable the rapid deployment of a regular short-interval shuttle services from Elizabeth to Harrison Station on PATH, or Secaucus Station on the NE Corridor Line could be sufficient to cut productivity losses in half.

Sensitivity Analysis

As we noted in our description of the model, we made a number of assumptions when constructing it. One core assumption pertains to the response of GDP by industry to relative intensities of capital investments and labor. The other is the relative attractiveness of imports (inflows) to domestic New Jersey production. As a default, we had set the elasticities of both to 0.7. In this section, we relax those assumptions to examine the relative robustness of our findings to them.

The simulation strategy consists in two additional steps. First, we carry out a sensitivity analysis with respect to the values of Armington elasticity. Then we do so, taking into account three different degrees of substitution between labor and capital, i.e., the base "inelastic scenario" with $\sigma_{LK} = 0.7$, a "close" C-D scenario where $\sigma_{LK} = 1.1$, and an elastic scenario where $\sigma_{LK} = 1.5$.

We present the results in Table 2 for the state's contribution to GDP. In general, the results appear quite robust to variation in the two elasticities. Some cells in the table highlighted since they present some change, albeit minor. For example, we see by looking at the light orange and brown shaded cells that as we let labor-capital elasticity become more elastic, the dips in Information and Finance sectors become modestly less severe, while the Education and Hospitality sectors become more heavily affected. Generally, the effects of changes in this elasticity attenuate only to the sectors that suffer the direct productivity losses, and they do so under all Armington elasticities we simulated.

Table 2: Percent Change in GDP in New Jersey Due to a Loss of Service to New York Penn Station
(7% Rise in Compensation for Producer Services)

	0.275			0.95			1.625		
Elasticity of Substitution between Labour and Capital	0.7	1.1	1.5	0.7	1.1	1.5	0.7	1.1	1.5
Primary	-3.87	-3.90	-3.92	-3.68	-3.72	-3.74	-3.49	-3.53	-3.56
Manufacturing	-3.54	-3.75	-3.85	-3.52	-3.70	-3.79	-3.50	-3.65	-3.72
Wholesale trade	-4.70	-4.82	-4.87	-4.57	-4.70	-4.75	-4.43	-4.57	-4.63
Retail trade	-2.97	-3.05	-3.08	-2.91	-2.98	-3.01	-2.85	-2.91	-2.94
Transportation & warehousing	-3.45	-3.59	-3.66	-3.35	-3.47	-3.53	-3.25	-3.35	-3.40
Information	-2.29	-2.08	-1.98	-2.33	-2.15	-2.06	-2.38	-2.22	-2.14
Fin, insur, real estate, rental, & leasing	-2.24	-1.82	-1.61	-2.22	-1.83	-1.63	-2.20	-1.83	-1.65
Professional & business services	-0.19	-0.52	-0.68	-0.27	-0.59	-0.75	-0.35	-0.66	-0.81
Education, health care, & social assistance	-0.28	-0.42	-0.48	-0.50	-0.61	-0.67	-0.72	-0.81	-0.85
Hospitality and entertainment	-2.93	-3.06	-3.12	-2.89	-3.00	-3.05	-2.85	-2.94	-2.98
Other services, except government	-3.09	-3.33	-3.45	-3.05	-3.27	-3.38	-3.01	-3.21	-3.31
Sectors' Average	**-2.69**	**-2.76**	**-2.79**	**-2.66**	**-2.73**	**-2.76**	**-2.64**	**-2.70**	**-2.73**

Table 3: Percent Change in Compensation per Worker in New Jersey Due to a Loss of Service to New York Penn Station
(7% Rise in Compensation for Producer Services)

	0.275			0.95			1.625		
Elasticity of Substitution between Labor and Capital	0.7	1.1	1.5	0.7	1.1	1.5	0.7	1.1	1.5
Primary	-3.74	-3.96	-3.72	-3.54	-3.76	-3.52	-3.34	-3.56	-3.33
Manufacturing	-3.48	-3.83	-3.75	-3.46	-3.77	-3.68	-3.44	-3.72	-3.61
Wholesale trade	-4.72	-5.00	-4.86	-4.59	-4.86	-4.73	-4.45	-4.72	-4.60
Retail trade	-3.03	-3.26	-3.16	-2.96	-3.17	-3.07	-2.90	-3.09	-2.98
Transportation & warehousing	-3.36	-3.64	-3.52	-3.26	-3.52	-3.39	-3.16	-3.39	-3.26
Information	-0.73	-2.48	-3.69	-0.79	-2.55	-3.77	-0.84	-2.62	-3.85
Fin, insur, real estate, rental, & leasing	-0.33	-2.34	-3.76	-0.31	-2.35	-3.78	-0.30	-2.35	-3.79
Professional & business services	0.53	-0.66	-1.40	0.44	-0.74	-1.47	0.35	-0.82	-1.55
Education, health care, & social assistance	0.26	-0.48	-0.96	0.02	-0.69	-1.15	-0.22	-0.90	-1.34
Hospitality and entertainment	-2.89	-3.15	-3.05	-2.85	-3.08	-2.97	-2.81	-3.01	-2.89
Other services, except government	-3.03	-3.38	-3.36	-2.99	-3.32	-3.30	-2.95	-3.26	-3.23
Sectors' Average	**-2.23**	**-2.93**	**-3.20**	**-2.21**	**-2.89**	**-3.17**	**-2.19**	**-2.86**	**-3.13**

Meanwhile, perturbations of the Armington elasticity appear to yield even more modest changes as observed from the rose and brown shaded cells. The changes not surprisingly affect the Wholesale Trade and Transportation sectors, which are heavily engaged in extra-regional trade. They also affect the Hospitality & entertainment sector, which caters to tourists and the out-of-town business trade. Most surprising, are the affects felt by the Information and Education sectors by a change in the Armington elasticity. Still, all are minor effects with changes of less than 0.3 of a percentage point. In this regard then, our findings on the lack of sensitivity to Armington elasticities align well with those of Bilgic et al. (2002) and Turner et al. (2012).

Table 3 presents findings on the wage rate, which were not evident in Table 1. As for the case of GDP, alterations toward a more elastic substitution between labor and capital appear mostly to affect, detrimentally, those sectors that are directly affected by the disaster (again by observing changes in the light orange and brown cells). In this case the changes are greater—as much as a 3 percentage point fall in the wage rate in the Finance sector. Variations in the Armington elasticity demonstrate even less change in the wage rate than in GDP, however. Still, the same sectors are engaged in the change, plus the addition of Primary industry & construction. In summary, the sensitivity analysis lends a lot of credence to the baseline findings. Still some underlying differences in the wage rate suggest that the quality of jobs that leave the state is likely to be affected by the actual labor-capital elasticity of substitution practiced by firms versus that we apply in our baseline simulations (0.7). On the whole, however, we are generally gratified, even there, that the simulations display modest differences from our baseline estimates.

CONCLUSIONS

We build and apply a CGE model for the State of New Jersey to investigate the economic impact of a loss in regular commuter rail service. We assume that producer-service sectors, whose employees form the main body of rail commuters to northern New Jersey, are most affected by this loss in the form of a decline in productivity, which we affect in the form of a 7% rise in the ratio of compensation to value added. We estimate that the state's economy would suffer a $12.9 billion—about 2.3% of New Jersey's current annual level. This is substantially below a rough partial equilibrium estimate from a panel model, which suggests a 5.8% reduction. Percentagewise state tax coffers would fall slightly more, about 2.9% off of current normal levels (about $1.2 billion annually). We find the full set of results robust to change in Armington and capital-labor substitution elasticities.

Naturally, more results under more scenarios would need to be developed to enable our results to inform fiscal policy viably. From a modeling perspective, it would be beneficial to build a model with greater sectoral detail and with linkages to key neighboring economies. Here, at least the rest of the New York metropolitan area and possibly Philadelphia's as well—is undoubtedly warranted since New Jersey's economy in inexorably intertwined with both. Also we have assumed, because we took a strict long-run perspective that no slack in the labor market would obtain. In this vein, it might be interesting to enable some slack and, therefore, examine possible effects that might attenuate via unemployment and related matters.

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APPENDIX A: DETAILS ON THE CONSTRUCTION OF THE SOCIAL ACCOUNTING MATRIX FOR NEW JERSEY 2008

Distribution of Taxes:

Four types of taxes are considered:

- *Social Contributions paid by Employers (SCER)* charged on labor income, an ad valorem tax paid by employers (as a way of a tax on labor) and collected by the Federal Administration (ROW) trough out the SAA (Social Security Administration).
- *Social Contribution paid by Employees* (SCER) charged on labor income also as an ad valorem tax paid by Employees and that is collected by the Federal government (ROW) through the SAA (Social Security Administration).
- *Net Indirect Taxes* conforms the Sales and Use Tax (7% in New Jersey) plus subsidies, plus taxes on imports. While a strong assumption, it considered that this indirect tax is "recycled" by the State of New Jersey. In the model, this tax is charged to final production as an ad valorem tax as well.
- *Income Tax and Property Tax*: According to the reports from the BEA and the State of New Jersey Department of Treasury, there are two types of income tax: the Federal Income Tax and the State Income Tax. In the SAM, each of them has been redistributed accordingly. While largely levied locally, in the model Property Tax is considered to be collected by the State government. Nevertheless, though it is possible to disaggregate this tax throughout considering three types of primary factors, i.e. proprietors' services provided to production sectors, labor and capital, for our proposes it was not critical since evaluating changes in the property tax of the State of New Jersey. Generally, CGE models do not distinguish between income taxes and property taxes. This does not imply that the property tax is unimportant

because it seems to be the main source of income from taxes obtained by local governments and some state governments in the UA.

Distribution of Savings:

- *Households' Savings*: According to the U.S. BEA, on average in USA, Households' savings represent approximately 5% of disposable income; in this case: $19,353,26 millions in 2008. Of this, around 40 % is devoted to investment activities in the State of New Jersey and 60 % to investment activities "out the State" considered as a transferred from Households (H) to the Federal government and foreign sector (ROW).
- *State Government Savings*: It is considered as 3% of total savings in the State economy.
- *Federal Government and Foreign Sector (ROW) Savings*: The savings for this account is considered a residual, making the difference between the value of total investment and other savings, where the amount of "other savings" is accounted for in households and state government as discussed above.

In sum, the distribution of the savings in the SAM seems to make sense in that we can expect in a region that (1) most of the investment activities are financed via "out of the State" savings and, secondly, (2) especially in New Jersey, which is one of the richest states in the nation, private investment is larger than public investment.

Distribution of Transfers

From Households:

To the State Government: None

To the Federal Government and Foreign Sector: Households' investment activities "out of the State" plus a residual to adjust the sum of the Households' row and column to the NJ Total Personal Disposable Income, i.e. $447,988.67 million in 2008.

From the State Government:

To Households: Unemployment Insurance compensation plus a residual to adjust the SAM.

To the Federal Government and Foreign Sector: Treated as a residual to adjust the SAM.

From the Federal Government and Foreign Sector:

To Households: Current transfer receipts of individuals from governments plus a residual to adjust the SAM.

To the State Government: Intergovernmental Revenue plus a residual to adjust the SAM.

Appendix Table A1: 14-Industry Social Accounting Matrix for New Jersey for 2008, Millions of Dollars

	i1	i2	i3	i4	i5	i6	i7	i8	i9	i10	i11	i12	i13	i14
i1	327,098	0,000	0,001	1,493	600,185	1,080	22,801	0,376	0,002	0,060	11,122	0,924	19,573	0,542
i2	3,244	25,490	0,562	176,622	121,404	0,014	0,006	2,312	0,161	0,712	4,510	0,255	0,004	0,006
i3	68,660	22,777	1,752	77,381	1.606,828	209,323	501,703	130,487	82,458	489,136	320,584	469,022	517,586	233,200
i4	23,864	2,591	85,879	18,764	686,292	67,158	148,339	125,137	178,768	466,207	329,035	105,435	133,865	153,726
i5	431,768	16,273	28,124	3.316,924	22.007,097	634,213	654,756	763,636	579,895	370,410	1.276,377	1.783,229	1.023,191	511,712
i6	192,063	9,597	12,411	778,391	11.677,867	1.772,158	751,803	271,048	217,627	354,229	503,349	781,270	517,719	362,642
i7	3,492	0,476	0,660	1.303,966	734,286	52,006	121,146	81,210	5,229	34,931	51,454	88,624	74,361	286,990
i8	97,882	20,592	74,856	323,571	2.634,194	1.262,526	1.019,302	2.221,740	270,918	364,468	1.011,423	300,613	236,799	287,547
i9	5,617	2,189	11,490	227,729	1.188,571	499,797	512,085	265,346	3.244,328	1.444,849	2.501,492	604,504	312,386	437,624
i10	329,312	42,912	77,537	854,516	4.003,722	2.465,789	4.349,386	1.562,362	1.436,617	22.251,159	7.786,570	5.546,224	2.215,816	3.752,905
i11	81,185	76,897	139,428	2.261,758	29.740,954	5.818,641	3.924,624	2.695,504	2.997,040	7.903,061	14.908,099	4.798,755	3.290,446	2.276,073
i12	18,389	0,000	0,861	1,026	4,870	24,982	94,662	2,033	13,039	2,436	26,359	837,045	16,428	85,766
i13	5,030	0,507	23,013	52,138	438,889	170,122	185,177	138,449	287,704	518,676	1.459,672	358,840	552,549	221,635
i14	11,308	0,976	8,013	321,235	862,215	637,183	503,432	842,575	276,798	694,516	1.085,738	524,781	480,207	343,644
L	336,748	112,249	1.450,890	11.423,441	24.987,967	18.629,653	15.742,716	8.995,705	8.561,551	26.100,254	47.652,097	29.182,932	9.418,727	6.738,662
B	476,000	0,000	4.859,000	4.904,000	11.515,000	9.473,000	5.418,000	4.141,000	13.468,000	79.665,000	17.588,000	6.742,000	3.724,000	2.163,000
H	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
INV	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SCER	26,252	8,751	113,110	890,559	1.948,033	1.452,347	1.227,284	701,295	667,449	2.034,746	3.714,903	2.275,068	734,273	525,338
NIT	2,000	29,000	1.803,000	292,000	1.993,000	7.494,000	6.025,000	819,000	548,000	16.085,000	2.905,000	1.989,000	1.309,000	475,000
IPT	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SCEE	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SG	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
ROW	1.239,566	80,631	2.692,121	5.130,889	50.346,509	4.279,063	4.427,517	3.894,698	3.971,248	9.135,619	7.838,162	5.823,593	3.599,219	2.687,381

Appendix Table A1 (continued): 14-Industry Social Accounting Matrix for New Jersey for 2008, Millions of Dollars

	L	B	H	INV	SCER	NIT	IPT	SCEE	SG	ROW
i1	0,000	0,000	1.166,730	-203,766	0,000	0,000	0,000	0,000	25,029	1.706,227
i2	0,000	0,000	5,192	5,063	0,000	0,000	0,000	0,000	31,352	75,000
i3	0,000	0,000	5.603,900	0,000	0,000	0,000	0,000	0,000	740,965	306,945
i4	0,000	0,000	0,000	2.509,459	0,000	0,000	0,000	0,000	12.155,434	15.166,450
i5	0,000	0,000	27.237,767	5.679,758	0,000	0,000	0,000	0,000	4.045,209	96.737,543
i6	0,000	0,000	28.019,930	3.604,337	0,000	0,000	0,000	0,000	1.753,314	3.363,301
i7	0,000	0,000	41.888,447	430,905	0,000	0,000	0,000	0,000	13,483	458,075
i8	0,000	0,000	10.048,886	442,747	0,000	0,000	0,000	0,000	1.172,646	5.863,204
i9	0,000	0,000	20.788,026	759,723	0,000	0,000	0,000	0,000	2.458,349	1.542,727
i10	0,000	0,000	66.077,831	995,998	0,000	0,000	0,000	0,000	2.572,117	41.594,697
i11	0,000	0,000	14.110,173	5.286,983	0,000	0,000	0,000	0,000	10.436,347	227,979
i12	0,000	0,000	55.057,791	0,000	0,000	0,000	0,000	0,000	720,302	5.306,124
i13	0,000	0,000	18.084,276	0,000	0,000	0,000	0,000	0,000	631,548	5.047,924
i14	0,000	0,000	10.680,959	0,000	0,000	0,000	0,000	0,000	988,623	3.281,190
L	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
B	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
H	209.333,591	164.136,000	0,000	0,000	0,000	0,000	0,000	0,000	18.386,500	53.128,991
INV	0,000	0,000	8.164,921	0,000	0,000	0,000	0,000	0,000	601,400	10.744,886
SCER	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
NIT	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
IPT	0,000	0,000	108.795,310	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SCEE	0,000	0,000	18.066,609	0,000	0,000	0,000	0,000	0,000	0,000	0,000
SG	0,000	0,000	0,000	0,000	0,000	41.768,000	35.313,248	0,000	0,000	0,000
ROW	0,000	0,000	11.188,334	0,000	16.319,409	0,000	73.482,062	18.066,609	20.348,630	0,000

Table A2: Key for Industries in Table A1

i1	Agriculture, forestry, fishing, and hunting	i9	Information	H	Households
i2	Mining	i10	Finance, insurance, real estate, rental, and leasing	INV	Gross Capital Formation
i3	Utilities	i11	Professional and business services	SCER	Social Contributions Employers
i4	Construction	i12	Educational services, health care, and social assistance	NIT	Net Indirect Taxes
i5	Manufacturing	i13	Arts, entertainment, recreation, accommodation, and food services	IPT	Income and Property Tax
i6	Wholesale trade	i14	Other services, except government	SCEE	Social Contributions Employees
i7	Retail trade	L	Income from Labor	SG	State Government
i8	Transportation and warehousing	B	Net Operating surplus	ROW	Federal Government+Foreign Sector