BHI Policy Study

The Economics of Climate Change Proposals in South Carolina: A Preliminary Look

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Executive Summary

In February 2007, the Governor of South Carolina, Mark Sanford, established the South Carolina Climate, Energy and Commerce Advisory Committee (CECAC) through Executive Order 2007-04. With assistance from the Center for Climate Strategies (CCS), the Department of Natural Resources and the Department of Health and Environmental Control, CECAC is charged with the task to "consider, evaluate and compile a multi-sector set of recommended policy options" through a Climate, Energy and Commerce Action Plan to reduce the state's greenhouse gas emissions.[1]

In July 2008, CECAC released the South Carolina Climate, Energy and Commerce Committee Final Report containing the advisory group's recommendations for legislative, administrative and regulatory measures that would reduce greenhouse gas (GHG) emissions in South Carolina. The recommendations for reducing GHG emissions cover energy, transportation, land use, residential and commercial building, agriculture, forestry and waste management. The report provides estimates of the amount of the GHG reductions and estimates of the net present value (NPV) of the costs, or cost savings, of implementation.

CECAC provides an assessment of the impact of adopting its policy recommendations. The report estimates that if all 51 policy options were fully implemented, South Carolina's GHG emissions would be reduced by 421.05 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) at a NPV cost of between -$1.915 billion and $3.871 billion over the period of time between 2008 and 2020. CECAC also believes that the implementation of these measures would bring "significant cost savings opportunities for South Carolinians."[2] Additionally, the CECAC report quantifies costs for 36 of the 51 recommended options, claiming that 15 would generate net cost savings. However, CECAC does admit that "many of the policy recommendations will entail consumer costs."[3]

Table 1 summarizes the estimated reduction in total emissions and the costs for fourteen of the 51 options recommended by CECAC. The recommendations fall into two categories – Energy and

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[1] South Carolina Climate, Energy and Commerce Advisory Group, "Final Report;" July 2008; Internet; available at www.scclimatechange.us/plenarygroup.cfm.
[2] Ibid, EX-2.
[3] Ibid, EX-7.

Transportation. According to CECAC, implementing all 14 recommendations would reduce GHG emissions by a total of 173.23 $MMtCO_2e$ between 2008 and 2020 and would provide the citizens of South Carolina with either net savings of $1,855 million or net costs of $3,333 million over the same period. This wide dispersion of cost estimates result from the CECAC transportation estimates that used both high cost and low cost assumptions in producing their estimates.

Table 1: CECAC Estimates 2008-2020

Recommendation	Reduction ($MMtCO_2e$)	NPV of Cost Change ($, million)
Energy Demand and Supply	147.4	- 1,795
Transportation	25.8	-60 to $5,117
Total	**173.2**	**-$1,855 to $3,322**

The energy demand and supply proposals include a "Renewable Portfolio Standard" that would:

- target a specified percentage of renewable energy production in the electricity sector;
- create a new utility regulatory model to keep utility profit constant in the face of energy efficiency programs;
- dedicate a portion of private utility revenues to energy efficiency programs to reduce demand;
- remove barriers to distributed generation of renewable energy; dedicate funds to renewable energy financing and Green Power purchasing and marketing; and
- increase energy efficiency requirements of building codes for new and remodeled buildings.

CECAC estimates that these energy sector proposals would reduce GHG emissions by 76.1 $MMtCO_2e$ and confer net cost savings of about $1.37 billion between 2007 and 2020.

The CECAC recommendations for the transportation sector include "GHG Fuel Standard" that would:

- set targets to reduce the GHG emissions of transportation fuels;
- implement a proposal to adopt South Carolina Clean Car Standard on light duty vehicles;
- remove the current caps on income and sales incentives for efficient vehicles; and
- increase the gasoline tax to fund new mass-transit, pedestrian and bicycle infrastructure improvements.

According to CECAC, these transportation sector proposals would reduce emissions by 47.56 $MMtCO_2e$ and save South Carolinians $1.04 billion under a low cost scenario or cost $4.75 billion under a high cost scenario.

The Beacon Hill Institute (BHI) has partnered with the South Carolina Policy Council to provide estimates of the economic and fiscal impact of selected CECAC proposals. To that end, BHI uses it's STAMP® (State Tax Analysis Modeling Program) for South Carolina (SC-STAMP), with which we estimated the economic effects of the fourteen CECAC recommendations.[4] We assume that the proposals become effective in 2008, and we report results in 2009. Table 2 summarizes the results.

Table 2: Summary of BHI Estimates for 2009

Recommendation	Net Employment (Jobs)	Investment ($millions)	Real Disposable Income ($ millions)	Real State GDP ($ millions)	State and Local Revenue ($ millions)
Energy Demand & Supply	-2,208	-56.24	-257.00	-331.00	472.36
Transportation	-11,334	-147.99	-909.51	-1,442.01	-128.66
Total*	**-13,542**	**-204.23**	**-1,166.51**	**-1,773.01**	**343.70**

*Minor differences are due to rounding.

We find that the proposals would exert significant negative effects on the state economy. By 2009, the state would shed more than 13,500 jobs. Annual investment would drop by about $204 million, real disposable income by more than $1,100 million and real State Gross Domestic Product (GDP) by about $1,773 million.

To implement these proposals, the state of South Carolina would need to raise additional tax revenue. We estimate that the revenue increases would outweigh the revenue losses and produce an additional $343.70 million in revenues in 2009. The proposals' negative economic and fiscal effects stem from the price and tax increases they would impose on the energy and transportation sectors.

CECAC recommends enacting many of the same policies in South Carolina that similar committees have recommended in over 20 other states. In fact, BHI found more than 20

[4] Detailed information about the South Carolina -STAMP® model can be found in Appendix A.

policy recommendations in the CECAC report that are, in fact, “carbon” copies of recommendations found in state GHG emission mitigation reports that utilized CCS as a consultant. The problem herein lies with the fact that CCS recommends the same policies for states that have vastly different geographic, economic, climate, demographic and cultural characteristics. These proposals fail to account fully for the differences between the rainy northwest and the mild southeast.

Many of the CECAC policy recommendations would achieve their goals through the use of more expensive production methods, which in turn, would raise prices. Proposals to increase gasoline taxes or to mandate low GHG fuel standards, for instance, arbitrarily increase the price of fuel as well as reduce the energy potential by diluting a gallon of gasoline with less efficient fuels. Increasing energy prices disproportionately impact low income consumers, whose income is already devoted mainly to the acquisition of the basic necessities of life.

BHI measures the progressivity of the CECAC proposals by estimating the cost increase that households in different income groups would face. The price increases would represent over 8.1% of the income of a household earning between $5,000 and $10,000 annually, while only 2.6% of the income of a household earning more than $70,000. On average, the proposals would inflate expenditures for South Carolina households by over $1,800 per year, or by 3.5% of their income.

However, income fails to capture the true lifetime earnings of individuals that find themselves temporarily in each income group, which is clearly evident by the discrepancy between income and expenditures experienced at the bottom of the income scale. The situation pushes average income levels down, relative to average expenditure, at the lower end of the scale. When we compare the expenditure increases due to the CECAC proposals against average annual expenditures, the difference between the income groups narrows significantly. Nevertheless, the distribution of the burden remains intact: households in the highest two income groups suffer lower burdens of between 3.9% and 4.4% of expenditures whereas households in the middle and lower income groups face a higher burden of between 4.8% and 4.7% of expenditures. Irrespective of our measure of income, the CECAC proposals will be a greater liability for South Carolina’s low income households than higher income households.

Not only do South Carolina's low-income households bear a higher burden of costs of the CECAC proposals, but these costs will be borne in the near term. However, any benefits that may accrue to these households will materialize over a period of ten or more years, if at all. Thus, poor households will experience a negative shock to their economic well being that, given their already limited financial means and the economic damage produced by the proposals, may well inhibit their ability to fully recover the lost ground in the medium term.

Finally, the CECAC study suggests that its recommendations would result in a 46% reduction in South Carolina emissions by 2020 (64.3 vs. 119.7 $MMtCO_2e$), which amounts to a net decrease of 0.012% in projected 2025 global emissions. Because South Carolina's GHG emissions are so small relative to the rest of the world's emissions, it is quite apparent that no policy adopted by South Carolina would have any discernable impact on global climate change and thus no measurable economic benefit.

Introduction

In February 2007, the Governor of South Carolina, Mark Sanford, established the South Carolina Climate, Energy and Commerce Advisory Committee (CECAC) through Executive Order 2007-04. With assistance from the Center for Climate Strategies (CCS), the Department of Natural Resources and the Department of Health and Environmental Control, CECAC is charged with the task to "consider, evaluate and compile a multi-sector set of recommended policy options" through a Climate, Energy and Commerce Action Plan to reduce the state's greenhouse gas emissions.[5]

In July 2008, CECAC released the South Carolina Climate, Energy and Commerce Committee Final Report containing the advisory group's recommendations for legislative, administrative and regulatory measures that would reduce greenhouse gas (GHG) emissions in South Carolina. The recommendations for reducing GHG emissions cover energy, transportation, land use, residential and commercial building, agriculture, forestry and waste management. The report provides estimates of the amount of the GHG reductions and estimates of the net present value (NPV) of the costs, or cost savings, of implementation.

CECAC provides an assessment of the impact of adopting its policy recommendations. The report estimates that if all 51 policy options were fully implemented, South Carolina's greenhouse gas emissions would be reduced by 421.05 million metric tons of Carbon Dioxide Equivalent ($MMtCO_2e$) at a NPV cost of between -$1.915 billion and $3.871 billion over the period of time between 2008 and 2020. CECAC also claims that the implementation of these measures would bring "significant cost savings for the State's economy."[6] Additionally, the CECAC report quantifies costs for 36 of the 51 recommended options, claiming that 15 would generate net cost savings. Nevertheless, CECAC does admit that "many of the policy recommendations will entail consumer costs and require consumer acceptance."[7]

[5]Final Report, EX-2.
[6] Ibid, EX-2.
[7] Ibid, EX-7.

The Beacon Hill Institute (BHI) provides independent estimates of the economic and fiscal impact of selected CECAC proposals. BHI has reviewed all 51 CECAC proposals and identified 14 for analysis. In this report, BHI provides a short discussion of our economic model for South Carolina and a general analytical approach to the CECAC proposals.

The STAMP Model and the BHI Approach

To produce accurate estimates of the economic impact of the CECAC recommendations, BHI has created a computable general equilibrium (CGE) model for South Carolina. The purpose of the model, called SC-STAMP (South Carolina State Tax Analysis Modeling Program) is to identify the economic effects of a variety of state policy changes.

SC-STAMP is a five-year dynamic CGE model that has been programmed to simulate changes in taxes, costs (general and sector specific) and other economic inputs. As such, it provides a mathematical description of the economic relationships among producers, households, government and the rest of the world. It is general in the sense that it takes all the important markets, such as the capital and labor markets, and flows into account. It is an equilibrium model because it assumes that demand equals supply in every market (goods and services, labor and capital). This equilibrium is achieved by allowing prices to adjust within the model. It is computable because it can be used to generate numeric solutions to concrete policy and tax changes.[8]

To reduce GHG emissions, the CECAC proposals seek to alter the economic decisions made by producers, consumers and governments. They do so by changing the incentives, both negative and positive, faced by all three sectors of the economy. CECAC employs numerous implementation tools to achieve this end, each affecting economic decisions and economic

[8] For a clear introduction to CGE tax models, see John B. Shoven and John Whalley, "Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey," *Journal of Economic Literature* 22 (September, 1984), 1008. Shoven and Whalley have also written a useful book on the practice of CGE modeling entitled *Applying General Equilibrium* (Cambridge: Cambridge University Press, 1992).

activity in South Carolina. These tools include increasing taxes and tax credits, providing state-financed low interest loans, mandating the purchase of more energy efficient products and renewable energy production levels and reforming of the rate structure in the utility sectors. Since CECAC assumes these recommendations will change economic behavior, we can assume that current economic agents are not making these choices in their absence. Moreover, since agents are not making these choices today, the proposals impose a higher cost than those currently employed. If the implementation of these proposals imposed no cost, or produced a cost savings, economic actors would have already adopted them. Therefore, we can assume the implementation of these proposals would involve increased costs, at least in the short to medium term.

BHI examined 14 CECAC proposals and estimated their effect on the South Carolina economy. Each proposal was treated as a change in state or local tax policy or as a change in the price of goods and services within a specific industry. For example, the proposals to increase the gasoline tax and to increase the tax credit for fuel efficient vehicles were treated as straight forward tax changes. However, the proposals to mandate a reduction in the carbon intensity of motor vehicle fuels or a Renewable Portfolio Standard (RPS) requiring that a portion of electricity production comes from renewable sources would likely alter the prices of motor fuels and electricity in South Carolina.

Once we quantified the tax and cost changes, we simulated their effects on the state economy using the SC-STAMP model. The model provides estimates of the proposals' impact on state Gross Domestic Product (GDP), employment, investment and income in South Carolina. Each estimate represents the change that would take place in the indicated variable against a "baseline" assumption about the value that variable would take in the indicated year.

CECAC Recommendations

Here we provide an analysis of 14 policies recommended by CECAC. Table 3 contains the recommendations and the expected reduction in total emissions and in total costs, in net present value terms, for 2008 to 2020, as calculated by CECAC. We divide the recommendations under the categories *Energy Demand*, *Energy Supply* and *Transportation*.

The 14 CECAC recommendations listed in Table 3 would reduce GHG emissions by 173.23 $MMtCO_2e$ between 2008 and 2020. CECAC provides a wide range of possible cost estimates for the reduction in GHG, reporting that the estimates would either provide net savings of $1,863 million or net cost of $3,314 million to the citizens of South Carolina.

Table 3: CECAC Policy Recommendations for BHI Simulations

Recommendation	GHG Reduction 2007-2020 ($MMtCO_2e$)	Net Present Value of Costs ($ million)
Energy Demand		
RCI-1: Expand Energy Efficiency Funds	43.0	-$1,127
RCI-2: Demand side Management	4.5	-$379
RCI-6: Improving Building Efficiency	40.4	-$665
RCI-7: Improved State and Local Govt. Buildings	24.6	-$800
Energy Supply		
ES-1b: Renewable Portfolio Standard	25.3	$489
ES-2: Technology Research and Development	Not Quantified	Not Quantified
ES-3: Renewable Energy Financing	7.1	$591
ES-4: Utility Regulatory Model	Not Quantified	Not Quantified
ES-6: Green Power Purchases and Marketing	1.7	$46
ES-8: Distributed Renewable Energy	0.8	$42
Transportation		
TLU-1: South Carolina Clean Car Standards	7.04	-$323 to $1,598
TLU-3: Tax Credits for Efficient Vehicles	0.68	$244
TLU-5: Transit & Bike-Pedestrian	0.22	-$1
TLU-12: Low GHG Fuel Standard	17.89	$20 to $3,276
Total	173.23	-$1,863 to $3,314

Two Transportation and Land Use (TLU) recommendations, TLU-1 South Carolina Clean Car Standards and TLU-12 Low-GHG Fuel Standards, are responsible for the large variation in estimate the costs. Given the 12-year timeframe and the level of uncertainty involved in the assumptions that support the estimates, providing a range of estimates is a method employed by the CECAC transportation working group.

Not South Carolina Specific

Critiques of previous greenhouse gas (GHG) mitigation plans where the Center for Climate Strategies (CCS) provided procedural and technical assistance have focused on the recurring faulty cost-benefit analysis accompanying the recommendations. The Beacon Hill Institute (BHI) has identified an additional problem with the analysis presented by CCS in these climate action plans. CECAC recommends enacting many of the same policies in South Carolina that they have recommended in other states.

In fact, BHI found over 20 policy recommendations in the CECAC report that are, in fact, "carbon" copies of recommendations found in state GHG emission mitigation reports that involved CCS. The problem herein lies with the fact that CCS recommends the same policies for states that have vastly different geographic, economic, climate, cultural and population characteristics. In its cost/benefit analysis, CECAC utilizes outcomes from policies and studies in other state and local areas, such as California, the Back Bay section of Boston or the nation as whole.

For example, the CECAC report recommends the adoption and implementation of Clean Car Standards very similar to those enacted in California. CCS supports their claims about the net benefits of this policy largely with documentation that pertains solely to California, a state which has demographic and geographical characteristics that in no way compare to South Carolina. Understandably, California is the only state that has provided detailed analyses of the vehicle fleets and the potential emissions reduction from enacting Clean Car Standards. However, CCS makes no substantial attempt to adapt the analysis of this policy to the differing circumstances prevailing in South Carolina, such as population density. Instead, CCS merely reproduces the same analysis that has been trotted out in other states where they have facilitated GHG mitigation planning.

In another example, for TLU-2 Transportation System Management, CECAC uses reports from several different states to determine the benefit of coordinating traffic signal timing. They use examples from other locations "to estimate the level of benefits South Carolina's communities can expect, including Boston, Massachusetts, Toronto, Canada, and the state of California."[9] Moreover, the Boston study focuses on the results from the unique "Back Bay" neighborhood, which includes an unusual mix of dense residential and commuter populations served by an extensive public transportation network of subway and bus lines. It is unlikely this urban mix is replicated in the cities of Greenville, Columbia, and Charleston South Carolina. Yet, there is no indication that CECAC has made an accommodation for the differences in the composition of the

[9] Final Report, I-16.

cities used in the studies they reference. They simply state that the policy will realize net benefits without attempting to quantify them.

However, South Carolina is much different than states like California, the most common state used for comparison, which leads to inappropriate assumptions about the effectiveness of the proposals, reducing their use as a policy tool. South Carolina is less densely populated than California, with 133.7 persons per square mile, compared to 217.2 persons per square mile in California.[10] The population of South Carolina is also less concentrated in large urban areas, which contain only a fraction of the population that the large cities in California and the northeastern Unites States have. Other differences include the energy, transportation fuel and housing markets as well as climate and culture. These differences cast doubt on cost and benefit calculations performed by CECAC, since they fail to consider South Carolina's unique local factors.

Transportation

CECAC estimates that the transportation sector is directly responsible for 11% of GHG emissions in South Carolina. Its recommendations for the transportation sector are predicted to reduce emissions by 47.56 $MMtCO_2e$ by 2020. BHI simulated four CECAC transportation proposals that CECAC estimates will reduce GHG emissions by 25.8 $MMtCO_2e$ that are projected to cost South Carolinians from -$60 million to $5,117 million in 2005 NPV dollars.

TLU-1: Adopt South Carolina Clean Car Standards

CECAC recommends that South Carolina adopt California Clean Car standards. The California standards would require that all new cars sold in South Carolina reduce GHG emissions by 30% as part of a regional clean car initiative. In hopes of reaping economies of scale, the standard would be implemented "if and when other states in the region adopt similar standards."[11] CECAC estimates that the tax credits would reduce GHG emissions by 7.04 $MMtCO_2e$ and estimate costs that range from -$323 million (net cost savings) to $1,598 million from 2008 to 2020.

[10] U.S. Census Bureau, State and Local Quick Facts; Internet; available at http://quickfacts.census.gov/qfd/index.html.
[11] CECAC, *Final Report*, 1-3.

The recommendation would force automobile manufacturers to make upgrades that would increase the cost of the new cars. Consumers would benefit from the increase in the gas mileage performance of the upgraded cars. The analysis seeks to determine if the gas savings outweigh the higher manufacturing cost of new automobiles within the timeframe of the STAMP model.

The calculation is further complicated by the new Corporate Average Fuel Economy (CAFE) standards adopted by the federal government as part of the Energy Independence and Security Act of 2007, which mandates higher average fuel efficiency for the United States. The Act mandates average fleet wide fuel efficiency of 35 miles per gallon by 2020 for all passenger vehicles and light trucks.[12] However, it does not mandate the path or timing of any increases prior to 2020.

An example of CECAC comparing South Carolina to California without considering basic differences in the states is with the CAFE standards. The CECAC analysis is based on a California Attorney General's Office report entitled "A Comparison of California GHG Standards and the Senate CAFE Targets."[13] One example of the difference is that SC citizens used 0.15972 gallons of regular grade gasoline per day in April 2008 vs. a national average of 0.15768 gallons per day and a CA average of 0.17338 gallons per day.[14] Due to the increased fuel usage in CA, there is a much larger amount to be gained from "low hanging fruit" in CA, leading to higher overall costs in SC with lower GHG reductions.

Interestingly, in a footnote on the transportation document from CECAC, the authors observe that 13 states have already adopted the California standards which "have about one-third of the nation's registered automobiles," and that "these states are such a large portion of the auto industry sales, that automotive manufacturers would most likely improve technologies for all vehicles, rather than utilize inefficient two-tier production lines."[15] If this last statement were true, South Carolina would not need to adopt the standard since the automobile manufacturers would make the improvements in the absence of the policy change. However, if manufacturers

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[12] "Fact Sheet: The Energy Independence and Security Act of 2007," The White House, Internet; available at http://www.whitehouse.gov/news/releases/2007/12/20071219-1.html.
[13] California Attorney General's Office. "A Comparison of California GHG Standards and the Senate CAFE Target." November 9, 2007. Internet, available at: http://ag.ca.gov/cms_attachments/press/pdfs/n1493_energybill_attachment.pdf.
[14] http://tonto.eia.doe.gov/dnav/pet/pet_cons_refmg_d_nus_VTR_mgalpd_m.htm
[15] CECAC, *Final Report*, I-5.

do maintain separate production lines, then South Carolina consumers would have a choice to pay for the vehicles with better emissions or not, in the absence of the proposal.

Nevertheless, CECAC provides a low cost (-$323 million) and a high cost ($1,598 million) estimate for the policy in NPV terms. BHI used the CECAC cost estimates to derive our inputs for the SC-STAMP model. First, we factored in a rebound effect of 15%, assuming that the GHG reduction would be achieved through higher fuel efficiency. The higher fuel efficiency under the policy would provide an incentive for drivers to use their vehicles more and thus eliminate a portion of the gain in efficiency.

Next we calculated the annual cost of each scenario in constant 2008 dollar payments for the entire 12 year period for each scenario (-$30.54 million for the low cost and $204.04 million for the high cost). We then calculated the mean of the two scenarios ($86.75 million) and the price increase that it would represent in the transportation sector in the STAMP model, or 0.98%. This price increase would average $81 for South Carolina households.

TLU-3: Tax Credits for Efficient Vehicles

South Carolina currently offers a sales tax rebate up to $300 on the purchase of low GHG vehicles and $500 for conversion of conventional vehicles to alternative fuel vehicles. In addition, taxpayers also enjoy a state income tax credit of $2,000 for the purchase of plug-in vehicles. However, the state caps the sales tax credits at $4.15 million per year and the income tax credit at $200,000 per year. CECAC recommends lifting the caps for these programs. CECAC estimates that the tax credits would reduce GHG emissions by 0.68 $MMtCO_2e$ and cost $244 million from 2008 to 2020.[16]

In general, lifting caps for these tax credits would represent a tax cut for some motor vehicle buyers in South Carolina. The tax cut should produce positive effects on the South Carolina economy as those consumers that would choose to purchase these vehicles or pay for the conversion would save money against the baseline of no change. Although lifting the cap will provide a tax break for the individuals that choose to buy the vehicles, the higher cost of the

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[16] Ibid, I-18.

vehicles will reduce the income available for other purchases. The question is whether the credit offsets the higher cost.

Lifting of the caps would also represent a negative impact on the fiscal position of the state government, since the state would lose sales and income tax revenue. The magnitude of these impacts would depend on behavior of South Carolina's automobile owners.

CECAC estimates that TLU-3 would cost the state $7.83 million in the fiscal year ending 2010 and $9.18 million in the year ending 2011.[17] We input the change into the SC-STAMP model as an income tax cut.

The tax incentives will induce some consumers in South Carolina to purchase alternative fuel vehicles, which cost more than their conventional counterparts. In a 2001 study, The American Council for an Energy Efficient Economy (ACEEE) estimates the additional cost to apply four different technology upgrades (moderate, advanced, mild hybrid and advanced hybrid) to improve fuel efficiency and safety for six model types in 2000 dollars.[18] BHI calculated the percentage cost increase for each technological upgrade and model type and averaged them across all model types. We then reduced the price increases by 15% to reflect a productivity increase of 1.6% per year between 2000 and 2009.

Table I-7 in the CECAC report presents estimates for sales of alternative fueled vehicles by technology type (flex fuel, hybrid, fuel cell, 30+ miles per gallon for non-hybrid cars) for the fiscal year ending 2010 through 2014. We mapped the technology types from the ACEEE report to the CECAC report as follows: CECAC Flex fuel to ACEEE moderate, CECAC fuel cell to ACEEE advanced, CECAC hybrid/plug in to ACEEE hybrid, CECAC 30+ mpg non-hybrid to ACEEE moderate, CECAC plug in and propane to ACEEE advance hybrid.

We then calculated the weighted average percentage increase for each CECAC technology type using the ratio of the sales for that technology type to total sales of all five technologies, resulting in a 7.8% price increase. This increase was adjusted to reflect the predicted penetration rate for

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[17] Ibid, I-24.
[18] American Council for an Energy-Efficient America, "Technical Options for Improving the Fuel Economy of U.S. Cars and Light Trucks by 2010-2015;" (June 2001); Internet; available at http://www.aceee.org/pubs/t012.htm (accessed June, 2008).

these technologies as a percentage of total vehicles sales and total transportation purchases in the SC-STAMP model and entered as a price increase. As a result, the transportation prices were increased by 0.287% in the STAMP model, which represents an increase of $24 dollars per household.

TLU-5: Transit & Bike-Pedestrian [Incorporates TLU-11]

CECAC proposes TLU-5 in order to "enable personal trip-making to move from Single-Occupancy Vehicles (SOVs) to lower GHG emitting options," including bicycles, carpools, mass transit and on foot.[19] To accomplish the goal of reducing SOV trips, CECAC proposes to increase government funding for mass transit, and improve pedestrian and bicycle infrastructure. The new spending would be funded through a $0.0175 increase in the gasoline tax, on conventional motor fuels. CECAC expects the programs would reduce GHG emissions by 0.22 $MMtCO_2e$ and cost $1 million from 2008 to 2020.[20]

This policy provides another example of the Center for Climate Strategies comparing predicted outcomes of policies in California and the nation to South Carolina. However, they fail to account for local factors in designing their policy recommendation and subsequent analysis. As described above, South Carolina has a lower population density than California, and enjoys lower gasoline prices ($2.923 per gallon compared to $3.146 in California excluding taxes as of April 2008).[21] These factors contribute to a low utilization rate for public transportation and a high use of motor vehicles in South Carolina compared to the rest of the country. A low population density makes public transportation systems much less efficient and impractical in South Carolina. Nationally, 4.6% of workers use public transportation, while Californians use it 4.8% of the time, but SC workers use it only 0.5%. As a result, 82.6% of South Carolina commuters drive to work while only 75.4% of CA workers do, which is slightly less then the national average of 77.7 %.[22]

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[19] CECAC, *Final Draft Report*, I-36.
[20] Ibid, I-18.
[21] U.S. Department of Energy, Energy Information Agency; Comprehensive State Energy Profiles with detailed data for each State; Internet; available at http://tonto.eia.doe.gov/state/.
[22] Statistical Abstract of the United States: 2007. U.S. Census Bureau. Section 23, Transportation. Internet, available at http://www.census.gov/prod/2006pubs/07statab/trans.pdf.

The proposed tax increase will exert negative effects on the state economy and have the greatest impact on lower income residents. The proposed use of the new revenue would likely temper some of the negative impacts. Infrastructure spending produces efficiencies in the transportation sector of the economy through effects such as the mitigation of traffic congestion and other spending.

BHI simulated the proposal in the STAMP model by increasing the state gasoline tax by $0.0175 and allocating the funds to the state infrastructure spending within the state Department of Transportation fund.

TLU-12: Low-GHG Fuels Standard

TLU-12 seeks to reduce the carbon intensity of motor vehicle fuels by 10% no later than 2020 through increasing biofuel sales in the state's gasoline and diesel markets. Biofuels are produced from either a starch or cellulosic ethanol base, procured from plants. CECAC also wants South Carolina to continue its financial commitment to develop hydrogen in fuel cell technology and "hasten its practical use as a transportation fuel."[23]

This is a case of the government attempting to pick and subsidize a technology, a task that is better suited for entrepreneurs who risk their own money. Also, the technology may never be practical. Auto executives have expressed concerns that fuel cell vehicles are still far too expensive. Toyota President Katsuaki Watanabe said, "It will be difficult to see the spread of fuel cells in 10 years' time." Watanabe also cited the high cost of fuel cells and the lack of a hydrogen-fueling infrastructure.[24] The speculative nature of the fuel cell technology research efforts raises doubts about the State's financial commitment of taxpayer money to develop fuel cell technology.

CECAC sets no interim timeframe or goals to achieve other than reaching the 10% reduction by 2020. It is possible that technological innovation, spurred by elevated petroleum prices and more research, will help make progress toward achieving this goal. However, with the currently available fuel alternatives listed above (ethanol and biodiesel), even attempting to achieve tiny

[23] CECAC, *Final Report*, 70.
[24] Hybridcars.com, "Giving Up on Hydrogen?" (March 7, 2008), Internet: available at, http://www.hybridcars.com/news/giving-hydrogen.html. (accessed June, 2008).

incremental progress toward the goals would prove problematic and expensive. CECAC expects programs would reduce GHG emissions by 17.89 $MMtCO_2e$ and cost \$20 to \$3,276 million from 2008 to 2020.[25]

These estimates also apply national numbers to a specific region. The CECAC analysis of TLU-12 is based on national fuel price forecasts from Energy Information Agency's, *Annual Energy Outlook 2008: With Projections for 2030.* [26] Yet more specific information for the South Atlantic regions is available in the "Supplemental Tables to the Annual Energy Outlook 2008," published by the same department.[27] The difference between the two projections in 2030 is 11 cents, which could have easily been included in the CECAC cost benefit report, had the group looked at more accurate, relevant information.

BHI modeled small reductions in the carbon intensity of vehicle fuels assuming that a portion of gasoline is replaced by ethanol and diesel is replaced with biodiesel. Ethanol and biodiesel are less expensive than gasoline or diesel fuel on a per gallon basis, but ethanol and biodiesel produce less energy than gasoline and diesel. This lower energy concentration translates into a lower driving mileage per gallon for ethanol and biodiesel relative to gasoline and diesel. As a result ethanol becomes more expensive to use than gasoline or diesel, since you need larger quantities of them to drive the same distance.

Ethanol produces less GHG than gasoline, although the quantity of the reduction is the subject of intense debate. Even using very generous estimates of the per gallon carbon concentrations of ethanol compared to gasoline (50%), very small carbon reductions would require very large increases in the percentage of ethanol use in motor fuels.[28] As a result fuel prices would have to increase sharply to achieve even a single percentage point reduction in the GHG emissions from motor vehicle fuels.

[25] Ibid, I-18.
[26] Ibid, 71.
[27] Supplemental Tables to the Annual Energy Outlook 2008. Energy Information Administration. http://www.eia.doe.gov/oiaf/aeo/supplement/supref.html. (accessed June 17, 2008).
[28]U.S. Department of Energy; Energy Information Administration, "Carbon Emissions Factors (1980-2006)", www.eia.doe.gov/oiaf/1605/ggrpt/excel/CO2_coeff.xls, (accessed June 17, 2008).

The use of biodiesel presents an even greater challenge for lowering GHG emissions. The carbon concentration of biodiesel is only 20% lower than conventional diesel, on a per gallon basis.[29] Therefore, attempting to reduce the carbon concentration of motor fuel by replacing diesel with biodiesel would run into the same problem as using ethanol, as outlined above, but on a much larger scale. Large quantities of biodiesel would be necessary to achieve very small emission reductions, resulting in consumers facing large fuel price increases in order to drive the same distances as using conventional diesel.

CECAC states "secondary costs, such as impacts on the cost of food, are not included in the analysis."[30] CECAC relegates the impact of the use of biofuels, especially ethanol, to a secondary consideration. Apparently the CECAC members have discounted news reports of food riots in Mexico, the surge in food stamp usage in the United States, or of international aid organizations struggling to feed hungry people in places such as the Darfur region of Sudan and other conflict areas. Otherwise, how could the Commission consider the impact of burning food crops as automobile fuel as a secondary cost?

Unfortunately people, especially at the lower end of the income scale, will feel the pain of these "secondary effects" for the policy would likely divert agricultural production from food to fuel. The policy would encourage the burning of food crops and could contribute to further substantial increases in food prices, especially on corn based products. CECAC's apparent disregard of this negative effect is insensitive to the suffering of the poor, especially in a time of rising food prices.

For South Carolina, we used data from the U.S. Bureau of Transportation Statistics (BTS) and the U.S. Energy Information Agency (EIA). We begin with the BTS estimate of motor fuel use for each state for 2005.[31] We inflate this figure through 2011 using the annual percentage change in the EIA estimate for U.S. energy consumption for motor fuels.[32] We then estimate the amount of ethanol consumption in South Carolina for 2008-2011 by inflating the EIA estimate for 2005 by

[29] Ibid.
[30] CECAC, *Final Report*, 73.
[31] U.S. Department of Transportation, Bureau of Transportation Statistics, "State Transportation Statistics 2006, in "Table 7-4: Motor Fuel Use: 2005," http://www.bts.gov/publications/state_transportation_statistics/state_transportation_statistics_2006/html/table_07_04.html (accessed April 17, 2008).
[32] U.S. Department of Energy; Energy Information Administration, "Energy Consumption by Sector and Source," in "Table 2: Energy Price and Expenditure Estimates by Source, 1970-2005, South Carolina," http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_2.xls (accessed April 17, 2008).

the estimated increase in U.S. ethanol consumption for 2006 to 2011.[33] The ethanol projection is subtracted from the gasoline projection for each year, since the gasoline figure includes ethanol, according to a note in the EIA table. We calculate the total British Thermal Units (BTUs) that our predicted consumption of gasoline and ethanol combined would produce for each year, using the BTU per gallon figures from the EIA.[34] We calculate the total emissions produced by the current consumption of gasoline and ethanol.

We calculate the number of additional gallons of ethanol that would need to be consumed in South Carolina in order to reduce total vehicle emissions by very small percentages: 0.25% in 2008, 0.5% in 2009 and 0.75% in 2010. This is not straightforward, since every new gallon of ethanol produces fewer BTUs than the gallon of gasoline it replaces. Thus, if we were simply to replace gasoline, gallon for gallon, with ethanol, drivers would not be able to travel the same distance as before. To complete the calculation we utilize the Microsoft EXCEL "Solver" utility. Solver allows us to compute the number of gallons of ethanol and gasoline that would satisfy the emissions reduction percentage listed above, while keeping the total number of BTUs generated from both, unchanged from the initial calculation. This process was repeated for replacing diesel with biodiesel.

The TLU proposals outlined above would increase prices and taxes in the transportation sector of the economy, and ultimately families in South Carolina would bear the burden. Using household expenditure data from the U.S. Bureau of Labor Statistics for the Southern region, we estimate that the policies would cost South Carolina households an average of over $1,400 annually.

Energy Demand and Supply

ES-1: Develop Efficiency and Renewable Portfolio Standards and Statement of Support for New Nuclear Energy

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[33] U.S. Department of Energy; Energy Information Administration in "Table C4: Estimated Consumption of Alternative Fuels by State and Fuel Type, 2005," http://www.eia.doe.gov/cneaf/alternate/page/atftables/afvtransfuel_II.html (accessed April 17, 2008).
[34]U.S. Department of Energy; Energy Information Administration, "Forecasts and Analysis, Alternative Fuels: Ethanol," http://www.eia.doe.gov/oiaf/ethanol3.html. See also the calculator at "Energy Kids Page," http://www.eia.doe.gov/kids/energyfacts/science/energy_calculator.html#mogascalc. (accessed April 17, 2008).

The first recommendation by the Energy Supply Technical Work Group is a combination of three different policies. In one breath the group recommends mandates requiring future energy demand be reduced by 5% through energy efficiency (EE) programs, 5% of future demand be supplied by new renewable power sources and at least 6% of future energy demand be met with new nuclear power plants. To implement these recommendations, the current South Carolina Energy Efficiency Act would be amended to require the first two parts, while state policy would be adjusted to encourage investment in nuclear power.

To reduce future energy demand, CECAC proposes implementing Demand Side Management (DSM) programs to reduce energy demand by 5% from the base case. CECAC estimates that this policy would save the state, in NPV terms, \$586 million between 2008 and 2020 and would "minimize the cost impacts to customers, while ensuring cost recovery for utilities."[35] It seems that these cost savings, according to the work group, are incurred by taking the difference between the cost of EE and the future cost of energy. As the cost of EE is less than the retail cost of energy, there is an apparent savings.

This first glance approach does not take into account the cost to producers or overall dynamic effects on the economy as a whole. The reduction of future earnings for electric power companies would have a ripple effect on every part of the economy that uses power, in other words the economy as a whole. Since the recommendation wants to minimize costs to the end consumer, and cost recovery to the utilities, somehow the bills will have to be paid. Through decoupling of rates, an annual adjustment charge or a millage tax, the final cost of electricity will be higher then the base case scenario. BHI looked at these two opposite effects on rates, as well as the overall dynamic economic effects of rate changes, supplying a detailed comparison between the policy change case and the base case.

A RPS in South Carolina would require that 5% of future energy generation be produced from newly built renewable energy sources, including but not limited to hydro, wind, biomass or solar. In the base case, the market would decide the most financially viable type of power, be it coal, natural gas, nuclear or a renewable. The RPS would replace 5% of the generation power from these sources with renewable power plants built since December 31, 2003. Again the work group

[35]CECAC, *Final Report*.

states that RPS "will minimize the cost impacts to retail customers, while ensuring cost recovery for utilities."[36]

The working group's preliminary report estimates that the RPS will cost the state $489 million in NPV terms between 2008 and 2020. Since the RPS would replace economically efficient power sources with previously more expensive sources, the total cost of power would also increase.

The working group recommends that nuclear power should account for at least 6% of the state's total power needs by 2020. The goal would not be legislated, but would be encouraged via "policy and goals supporting the development of new nuclear power."[37]

ES –2: Technology Research and Development

This policy recommendation focuses not on presenting actual policy tools, but instead suggests researching and completing a "roadmap." This roadmap would enable "South Carolina to focus on efforts that have the greatest potential for achieving reduced GHG emissions, economic development opportunities, national security, and energy independence for the state."[38] The research would involve a detailed investigation into offshore wind turbines and ways to make hydrogen supply infrastructure accessible to the majority of residents. The roadmap also creates an additional advisor position in the Governor's office.

After identifying the areas with the most potential to reduce GHG, the government would provide funding for renewable or advanced power generating technologies (including nuclear), as well as entrepreneurs to develop commercial applications. In effect the state government would play the role of a venture capitalist in the market thus exposing public funds to risk. The one announced goal with measurable costs is a plan to supply $20 million in state funding to research and development in clean energy. This funding would have to be raised by increasing taxes on the state's constituents or cutting other public expenditures.

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[36] Ibid, H-3.
[37] Ibid, H-4
[38] Ibid, H-16

CECAC declines to project GHG reductions or costs for this program due to the large amount of uncertainty involved, the lack of goals and a timeline for implementation.

ES–3: Renewable Energy Financing, Tax Incentives, Loans

ES-3 focuses on increasing demand for smaller renewable energy systems through a "suite of financial and regulatory redresses, as well as thorough information and public education campaigns."[39] More precisely, it would expand current tax incentives, including income tax credits, a subsidy to renewable power generated outside of RPS mandates and low interest loans.

The energy technical working group estimated that this policy would be responsible for a 7.1 $MMtCO_2e$ reduction by 2020 at a cost of $600 million in net present value terms. These numbers are incomplete since the CECAC only qualified two out of the five goals contained in the recommendation, while labeling the others as "Not Quantifiable."

The three goals that were not quantified are quite ambitious and would likely increase the overall cost of this recommendation. The first goal would remove legislative caps on tax incentives for renewable fuels reducing the overall tax burden on residents, leading to an overall economic improvement in the state. The second goal plans to subsidize all renewable energy production that is not used to meet state or federal renewable energy standards. The third goal would provide low interest loans in the field of biomass generation, with partial loan forgiveness if equipment fails. These last two goals would certainly alter the state's fiscal position and require tax increases or spending cuts elsewhere in the budget.

The two goals that CECAC quantified would also produce distorting effects on South Carolina's energy markets. The first would expand the current 25% income tax credit to include not only solar and biomass power production but also micro-hydro and wind power. The second would provide a government guaranteed price for new renewable energy plants in stepped increments. The first 100MWs of capacity would receive 15 cents per kWh of power, decreasing incrementally up to 500MWs, which would receive 8 cents per kWh.

[39] Ibid, H-19.

The CECAC report states that the policy would produce "no additional cost to the state" and "no net cost to the state" while other portions of the report state that "costs will be borne by the state's General Fund" or "ultimately paid for by ratepayers" without attempting to quantify the actual effect.[40] As all of the components of this policy are, in short, subsidies, the funding will need to be raised through additional taxation.

ES-4: Investments in Energy Efficiency

CECAC describes ES-4 as an attempt to help utility companies invest in distributed generation and energy efficient generation technologies. This would be achieved by regulating the price that the utility can charge to allow for the timely recovery of the investment made by the utility, as well as to compensate the utility for the loss incurred because of Demand-Side Management programs (See below).

CECAC implies that there would be financial incentives made available to the utilities for implementing DSM/Energy Efficiency (EE) programs, but the incentives are unrealistic. For example, CECAC states that the DSM/EE programs would achieve savings in energy consumption, which, in turn, would lower utility sales and revenue. The program also calls for the utilities to be compensated for this loss of revenue by allowing them to increase the regulated price of energy. If the investments and reduction in energy consumption are balanced out by the increase in energy price, where are the savings?

Is CECAC assuming that the savings derive from the utility themselves? If the savings were to compensate the investment on such programs, why would there be any need to create this program and ensure that the price of energy goes up high enough so that utilities are motivated to invest?

ES-6: Green Power Purchases and Marketing

ES-6 would give consumers the option to purchase green energy through a voluntary program. The CECAC estimated that this policy would be responsible for a 1.7 $MMtCO_2e$ reduction by 2020 at a cost of $46 million in net present value terms.

[40] Ibid, H-20

The vehicle behind green power purchases is Palmetto Clean Energy (PaCE), which is a program aimed at encouraging the development of renewable energy resources, with the goal of reducing GHG emissions. Consumers are able to purchase the green power through South Carolina investor-owned electrical utilities.

There are three goals associated with the ES-6 proposal. The first goal requires consumers to have the necessary information regarding the power sources and emissions their energy consumption involves. To be workable, the second goal needs to be accomplished, which is the establishment of a Voluntary Green Power Utility Program. CECAC estimates that these goals would be operational with consumer involvement by 2012. Also by 2012, the state's green power initiatives are called upon to fund the necessary marketing and development for the voluntary green power programs.

The costs of this program are twofold. First, if consumers choose to purchase the more expensive Green Power then they will have less to spend in other sectors of the economy. Second, the marketing and development costs to achieve the goals must be paid by someone. CECAC suggests that these costs be funded "through state funded green power initiatives coordinated by the SC Energy Office."[41]

ES-8: Distributed Renewable Energy

According to CECAC, ES-8 refers to the production of renewable resources at or near the sites of consumption. In the past, there have been many barriers preventing this distribution generation. Some of these barriers include high transaction costs, high financing costs, community barriers, etc. Many of these barriers have already been addressed, while the rest are currently being reviewed. CECAC estimates this policy would be responsible for a 0.81 $MMtCO_2e$ reduction by 2020 at a cost of $41 million in net present value terms.

The goal of ES-8 is to provide options of distributed renewable energy to residences and commercial and industrial facilities. Before this can be accomplished, all renewable energy sources need to be identified and deemed to have the potential to be a distributed generation

[41] Ibid, H-25.

source. The plan is to have three MW per year of distributed renewable generations from 2009 to 2020.

Distributed generation systems produce energy at a higher cost per kilowatt than conventional sources.[42] This program would increase the cost of generating energy, which would directly increase the price of energy that the utilities have to charge. Moreover, ES-4 would regulate energy prices, through a rate rider, to compensate utilities for the loss in energy consumption due to the energy efficient systems. This will increase the price of energy even further.

The ES proposals outlined would increase prices and taxes in the utility sector of the economy, which, in turn, would be passed on to the state's energy consumers. We estimate that the policies would cost South Carolina households an average of over $157 annually.

Residential, Commercial and Industrial

RCI-1: Demand Side Management / Energy Efficiency Programs, Funds or Goals for Electricity & RCI-2: Demand Side Management / Energy Efficiency Programs, Funds or Goals for Natural Gas, Propane, and Fuel Oil

The first two policy recommendations for the Residential, Commercial and Industrial sectors are designed to complement each other with each having similar implementation designs and outcomes. RCI-1 focuses on Demand Side Management (DSM) programs concerning end use of electricity, while RCI-2 centers on DSM policies regarding combustion fuels. The RCI technical work group set a goal of a 0.25% decrease in demand for the first year, 2009, with increases to a 1% reduction by 2015. RCI-1 would then increase to 1.5% by 2020, with a total benefit of $1.127 billion in NPV terms, while RCI-2 would hold constant at a 1% reduction, with total estimated benefits of $379 million.

There would be two main implementation methods for DSM focused on electricity. The first would apply to the Commercial, Industrial and Institutional Sector, where energy audits would be completed for firms. The audits would identify improvements that would save energy, help the

[42] W. Liss et. al, Development of Innovative Distributive Power Interconnection and Control Systems. et al. Internet; available at http://www.nrel.gov/docs/fy03osti/32864.pdf.

firm design a project to implement these improvements and then help find financing for the projects themselves. The Energy Service Company "guarantees that the improvements will generate savings sufficient to pay for the project."[43]

The second implementation method would be geared towards all electricity consumers, not just firms. This package includes another recommendation for an RPS, a Public Benefit Charges to fund state agencies and other "efficiency utilities" as well as financial incentives for specific "green" technologies.

Policy recommendation RCI-2 is designed to complement RCI-1, so many of the policies and expected outcomes are similar. It advocates a DSM program for combustion fuels, including natural gas, propane and fuel oil. The stated goal, to reduce fuel use by 1%, would be reached using two methods. It would set goals and incentives for households, and conduct a consumer education program. CECAC expects RCI-2 would reduce GHG emissions by 4.5 $MMtCO_2e$ and incur benefits of $379 million from 2008 to 2020.

RCI–6: Incentives and Policies for Improving Building Efficiency, Including Building Energy Codes

Since CECAC attributes a large portion of GHG emissions to the residential, commercial and industrial building sectors, the RCI targets this sector through new and stricter building codes. Most houses built in South Carolina are subject to the most recent International Energy Conservation Code (IECC), which sets minimum energy efficiency, but manufactured housing is exempt. The work group states that "a significant percentage of South Carolinians reside in manufactured housing," with a total of 378,366 manufactured homes existing, or about 23% of all homes[44]. The goals of this policy would require that 100% of SC municipalities adopt IECC by 2015 and that ENERGY-STAR labeled manufactured homes reach 25% market penetration by 2010 and 75% by 2020.

These mandates would be enforced through legislative changes to the current South Carolina Code of Laws, as well as the implementation of new building and inspection codes. The "carrot" to offset these requirements would be reduced permitting fees for retrofitting of buildings as well

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[43] CECAC, *Final Report*, G-3.
[44] Number of manufactured homes according to the work group (378,366) divided by occupied housing units (1,656,978) from the U.S. Census.

as a reward system for "'beyond code' energy efficiency and emission reduction improvements, including 'green mortgages'."[45] All told, this recommendation is purported to save the state $665 million in NPV terms and reduce GHG emissions by 40.4 $MMtCO_2e$ from 2008 to 2020.

RCI-7: Improved State and Local Govt. Buildings

RCI-7 is allowing state and local governments to "lead by example." The policy dictates that all state and local government facilities operate using clean energy technologies. This includes, but is not limited to, the use of only energy efficient appliances, audits of all energy performance and operations in existing, renovated and new buildings and financial assistance for energy-saving projects. According to CECAC, RCI-7 would provide a 24.6 reduction in $MMtCO_2e$ by 2020 at a net cost savings of $800 million in net present value terms.

Under the policy, government facilities would derive 20% of the electricity from in-state renewable sources by 2018. The government would purchase energy efficient appliances for all of its existing, renovated and newly designed buildings, and create a program to audit all energy consumption. The state would also provide the funding for the energy saving projects for existing buildings and the goals would also be applied to public schools in South Carolina.

The RCI proposals outlined would increase prices and taxes in the residential and industrial buildings sector of the economy, which, in turn, would be passed on the state's consumers. We estimate that the policies would cost South Carolina households an average of over $265 annually.

BHI Analysis of the Energy and Residential, Commercial and Industrial Recommendations

In this section we present our estimations of the costs or cost savings that the RCI and ES proposals and present the results of the SC-STAMP simulation of the changes that these proposals would impose on the economy of South Carolina. Before presenting the different proposals and the costs/benefits that they imply, however, we must consider ES-4 for a moment.

[45]CECAC, *Final Report*, G-48.

ES-4 aims to compensate utilities for any loss in profit that they may incur due to the implementation of the EE, DSM and distributed generation programs. CECAC states that the policy goal

> "is to implement a regulatory model that equalizes the incentive for utilities to invest in cost-effective EE and renewable DG with the incentive to invest in new supply resources. By equalizing utility … (DSM) and EE programs with earnings on traditional power supply, utilities will consider investment in EE in parity with investment in new conventional capacity."[46]

The policy design section specifically provides utilities with recovery of all costs associated with the implementation of DSM and EE programs including program costs and lost margins. In addition, the policy would allow utilities to recover lost revenues (net of costs to produce the saved energy) experienced by the utility as a result of the implementation of DSM/EE programs through the annual rate rider.[47]

For example, suppose a consumer, encouraged by a utility rebate program, were to install a new energy efficient hot water heater and, as a result, enjoyed lower energy consumption and presumably a lower utility bill. Under ES-4, however, the utility would be able to recover the cost of the rebate and the loss of revenue (net of costs to produce the saved energy) resulting from the consumer's lower energy consumption. Utilities would be allowed to impose a rate rider that raises the rates consumers pay for energy. Thus the benefits attributable to the consumer at one end are recovered by the utility through the higher price at the other end. Thus the only change due to the policy is lower energy consumption at higher prices.

The profound implication of ES-4 is that most cost savings that derive from the EE and DSM programs and result in lower energy consumption would be eliminated, since the gain derived by energy consumers in the form of lower consumption would be compensated to the utilities through the utility rate rider and higher prices for energy consumers in South Carolina.

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[46] Ibid, H-25.
[47] Ibid..

Since ES-4 erases the vast majority of the benefits in other proposals, we estimate, using CECAC's figure, the net present value figures of the different projects excluding the benefits they attributed to energy efficiency and demand side management programs. The only other cost (that is not estimated in the proposals) is the amount it would cost to compensate utilities under ES-4 because of higher costs related to new energy efficient generation capacity.

Table 4: Cost Estimates of CECAC's Energy Recommendations

Recommendation	CECAC NPV ($ million)	BHI NPV ($ million)	Annual Cost ($ million)	Price Change (%)	2009 Tax Revenue Increase ($ million)
Energy Demand					
RCI-1	-1,127	987	113.43	NA	113.43
RCI-2	-379	115	13.22	NA	13.22
RCI-6	-665	1,362	156.53	1.18	NA
RCI-7	-800	372	42.75	NA	42.75
Energy Supply					
ES-1b	489	1,788	205.49	1.58	NA
ES-2	NQ	20	2.30	NA	2.30
ES-3	600	600	68.96	NA	68.96
ES-4	NQ			1.52	NA
ES-6	46	223	25.62	0.20	NA
ES-8	41	41	4.71	NA	4.71
Transportation					
TLU-1	-323 – 1,598	179.09	251.73	0.98	NA
TLU-3	244	326.73	29.70	0.29	-7.83
TLU-5	-1	NQ	71.47	NA	69.25
TLU-12	20 -3,276	5,945	832.69	15.0	NA
Total	**-1,865- 3,322**	**11,959**	**1,818.60**	**20.17**	**237.56**

Table 4 presents BHI's costs estimates of the different recommendations we analyzed in net present value terms for the 12-year span, as well as the annual cost in constant 2008 dollars. As indicated in the table, CECAC estimates that all 14 policies will provide, at most, net costs of $3,322 million in NPV between 2008 and 2020, with the possibility that the policies would provide net cost savings of $1,865 million. However, BHI estimates that the same policies would cost $11,959 million in net present value over the same period. The policies that provide the greatest differences between the CECAC and BHI estimates are RCI-1, RCI-6, RCI-7 and TLU-12. Table 4 also presents our estimates of the effects in the respective economic variables that each recommendation implies. These changes are input into the SC-STAMP to simulate the effects of the recommendations.

The total NPV of all the proposals is $11,959 million, which translates into an annual cost of $1,818.60 million. We categorize each proposal as either a new regulation that induces a price increase within the utility, transportation or construction sectors or as a tax increase if the proposal involves a tax or expenditure by state and local governments. We translate the annual NPV of seven proposals into price increases for South Carolina. ES-1, ES-4, and ES-6 increase prices in the utility sector by a total of 3.29%. RCI-6 increases prices in the construction sector by 1.18% and TLU-1, TLU-3 and TLU-15 inflate prices in the transportation sector by 15.69%. For the other six proposals (RCI-1, RCI-2, RCI-7, RS-2 ES-3 and ES-8), we translate their annual NPV costs directly into a tax increase that also serves to raise the price of products in the respective sector. The price increases faced by government agencies would require the state to make changes to the general fund, as programs become costlier to administer.

BHI Estimates and Results

Each of these proposals consists of either a tax or a fee added to the purchase of a product, such as a vehicle surcharge, or seeks to increase the purchase and use of products, such as biofuels, that emit fewer greenhouse gases. BHI used the SC-STAMP model to measure the changes to the South Carolina economy that would take place as a result of the CECAC recommendations. Each estimate represents the change that would take place in the indicated variable against a "baseline" assumption about the value that variable would take in the indicated year.

Energy, Residential, Commercial and Industrial

Table 5 presents the results from the SC-STAMP to the policy changes specified above. The private sector would shed 5,580 jobs in 2009, a consequence of the higher prices that consumers face both in the utility and construction sectors, which will cause them to reduce their consumption in those sectors. The increase in state government revenue would allow the public sector to add 2,610 jobs in 2009. In total, the measures would extinguish an estimated 2,970 jobs in South Carolina.

Although South Carolina would lose jobs, the wage rate would remain essentially steady. South Carolinians would face higher utility prices and taxes, which in turn would increase their cost of living. The cost of living increase would, in turn, put upward pressure on household's wage demands, since people would need more money to cover their basic needs. The higher wage demands would add to the already higher energy costs, leading producers to reduce their demand for labor, which would act to temper the original increase in wage demands. These opposing forces balance out, with wages remaining unchanged compared to the baseline.

Table 5: Economic and Fiscal Impacts of Energy Sector Recommendations

Economic Variable	2009
Total Employment (Jobs)	(2,970)
Private (Jobs)	(5,580)
Government (Jobs)	2,610
Gross Wage Rate ($)	(2.50)
Investment ($ millions)	(56.59)
Nominal Personal Income ($ millions)	(239.00)
Real Disposable Income ($millions)	(306.00)
Real DI per Capita ($)	(56.50)
Real Gross State Product ($millions)	(331.38)
State Funds ($ millions)	**362.91**
State individual income tax	(9.99)
State sales tax	403.35
State motor fuel taxes	(0.82)
State corporation income tax	(0.77)
State alcohol tax	(0.16)
State motor vehicle fees	(0.20)
State bank tax	(0.08)
State corporation license fees	(1.03)
State beer and wine tax	(0.29)
State insurance tax	(0.36)
State business license tax	(0.09)
State deed recording tax	-
State other taxes	(6.57)
State unemployment compensation fees	(1.51)
State other fees and revenues	(18.60)
Local Funds ($ millions)	**(62.85)**
Local tax on residential property	(0.01)
Local tax on business property	(37.17)
Local sales and use taxes	(1.68)
Local other taxes and fees	(24.00)
Total Funds ($ millions)	**300.06**

The combination of higher energy prices and lower employment under the CECAC proposals would reduce incomes in South Carolina. Real disposable income would fall by $306 million in 2009. This translates into a loss of $57 in real disposable income per capita.

The higher cost of energy would hurt firms' profit margins, causing them to reduce investment in South Carolina. We estimate that investment would drop by $56.59 million in 2009, with the utility sector accounting for three-quarters of the decrease. The lower investment, employment and incomes would shave $331.4 million off of real GDP in South Carolina in 2009.

State government revenues increase due to our treatment of CECAC proposals as taxes on the utility sector. As a result, state tax revenue would increase by $362.9 million in 2009. However, the negative economic effects of the proposals reduce local tax revenues by $62.9 million for a combined net gain of $300 million to government in South Carolina.

Transportation

Table 6 presents the results from the SC-STAMP to the changes specific to the TLU recommendations. In this case, both the government and the private sector lose jobs. The total job loss is 11,334 jobs in 2009. The increase in transportation prices are large enough to cause consumption to contract in all sectors, which forces both the government and the private sector to hire fewer people than they would have otherwise. This decrease in labor demand causes the annual wage rate to drop by $263 in 2009.

The reduction in jobs and lower wages combine to shrink real disposable income by $909.5 million, implying a loss of $162 real dollars per South Carolinian in 2009.

The price increases also hurts investment in South Carolina by $147.99 million. The lower investment, employment and incomes would reduce real GDP in South Carolina by $1,442 million in 2009.

Table 6: Economic and Fiscal Impacts of Transportation Sector Recommendations

Economic Variable	2009
Total Employment (Jobs)	(11,334)
Private (Jobs)	(11,019)
Government (Jobs)	(315)
Gross Wage Rate ($)	(263.00)
Investment ($ millions)	(147.99)
Nominal Personal Income ($ millions)	(1,425.50)
Real Disposable Income ($millions)	(909.50)
Real DI per Capita ($)	(162.00)
Real Gross State Product ($millions)	(1,442.01)
State Funds ($ millions)	**(44.45)**
State individual income tax	(55.83)
State sales tax	(25.07)
State motor fuel taxes	72.80
State corporation income tax	(2.51)
State alcohol tax	(0.38)
State motor vehicle fees	1.41
State bank tax	(0.20)
State corporation license fees	(2.06)
State beer and wine tax	(0.68)
State insurance tax	(1.05)
State business license tax	(0.20)
State deed recording tax	-
State other taxes	(1.87)
State unemployment compensation fees	(5.72)
State other fees and revenues	(23.11)
Local Funds ($ millions)	**(84.21)**
Local tax on residential property	(0.02)
Local tax on business property	(66.56)
Local sales and use taxes	(2.16)
Local other taxes and fees	(15.48)
Total Funds ($ millions)	**(128.66)**

The proposed transportation policies would damage the South Carolina economy, but they also encroach on the ability of state and local governments to provide goods and services. The negative effect on income and employment shrink the state's personal income tax collections by $55.8 million in 2009 and the state's sales tax revenue by $25.07 million. These losses alone nearly cancel out the extra revenue generated from the increase in the state's motor fuels tax. Local governments also would suffer revenue losses under the proposals of $84.21 million in 2009.

Note that this loss in government revenue, at both the state and local levels, would not result from a drop in the taxes paid by the individuals or businesses in South Carolina. The harm to the economy brought about by promoting the use of more costly production methods, as well as the increase in the tax, would translate into lower revenues for other taxes, while also causing South Carolina residents to lose jobs and purchasing power.

Distributional Effects: The Poor Are Hurt More

The policy recommendations suggested by CECAC have the potential to mitigate GHG emissions in the state of South Carolina. However, from a fiscal standpoint, the majority of the various policy proposals become less attractive when subjected to a cost-benefit analysis more rigorous than that provided by CECAC. Overestimation of potential benefits in addition to an underestimation, if not outright neglect, of significant costs associated with these proposals casts serious doubts on the merits of such a fundamental transformation of the local economy in South Carolina.

The CECAC analysis particularly neglects a thoughtful and thorough analysis of the likely distributional impacts of the various legislative, administrative and regulatory policies that will alter the patterns of energy use in South Carolina. Most of the benefits that will accrue to the economy of South Carolina primarily in the form of reduced GHG emissions, but also in the form of more efficient energy use from fossil fuels and promotion of alternative energy sources, remain uncertain as to their likelihood of occurrence and effectiveness. Moreover, these benefits often are only quantifiable over the long run, while the costs associated with their implementation begin immediately and extend throughout the time horizon of the analysis.

A cursory examination of the potential benefits of GHG mitigation in light of the recent worry concerning climate change lends credence to the notion that policymakers ought to intervene and induce more responsible energy consumption. However, a more detailed examination reveals the detrimental effects of many of the policy proposals on the well-being of the low income citizens of South Carolina.

Although the CECAC report rarely exhibits an explicit recognition of the power of price changes in the realignment of incentives and disincentives for energy consumption, such price changes abound in the report outlining the policy recommendations. In most cases, the end result of the policy proposals raises the price of energy consumption in the short run. Proposals to increase gasoline taxes or to mandate low-GHG fuel standards, for instance, arbitrarily increase the price of fuel as well as reduce the energy potential by diluting a gallon of gasoline with less efficient fuels. Increasing energy prices disproportionately impact low income consumers, whose income is already devoted mainly to the acquisition of the basic necessities of life.

Other proposals such as mandating stricter building codes to promote greater energy efficiency also disproportionately impact citizens with lower incomes by increasing the price of housing. South Carolina also has a high percentage of citizens residing in manufactured housing. Even though promulgation of standards for manufactured housing falls under the purview of the United States Department of Housing and Urban Development, the CECAC report proposes that the state of South Carolina lobby the federal government for stricter building codes and energy efficiency standards for manufactured housing. If these efforts are implemented and successful, increased housing prices for low income citizens in manufactured housing could be a long run consequence.

While many of the proposals concerning energy consumption contain disincentives designed to discourage additional energy consumption through increasing prices, some proposals attempt to provide positive incentives for investment in energy efficiency in the form of tax credits. Many of these tax credits are targeted at large-scale energy producers to induce investment in alternative energy sources.

In some cases, these tax credits are contingent upon compliance with mandates for use of renewable energy sources or the purchase of expensive hybrid vehicles that are generally beyond the means of lower income families, even with the tax breaks. While such proposals may produce benefits in the form of reduced GHG emissions, the likely result will be to increase the costs of energy production in the short run. Inevitably, those higher costs will be passed on to consumers in the form of higher prices, which will again disproportionately impact low income citizens of South Carolina.

BHI measures the progressivity of the CECAC proposals by estimating the cost increase that households in different income groups would face. In order to measure the progressivity of the different proposals, we first constructed a data set that includes information from a sample of households on both expenditure and income. The next step was to apply the price or tax increase attributable to the CECAC proposals to the total dollar value of total expenditures in each spending category for each household group. For example, for TLU-12 we applied the 15% price increase to the total spending on transportation for each income group to determine that group's increase in transportation expenditures. This process was all completed for the fourteen CECAC proposals that involved a price increase.

Table 7 displays households sorted into specific income brackets, taken from the Consumer Expenditure Survey from the U.S. Bureau of Labor Statistics.[48] When our data set is sorted into income groups, the CECAC proposals appear highly regressive, as the burden of the price and tax increases represent a higher percentage of income for those individuals in the lower groups and a lower percentage of the income of those in the higher income groups. The price increases would represent over 8.1% of the income of a household earning between $5,000 and $10,000 annually, while only 2.6% of the income of a household earning more than $70,000. On average, the proposals would inflate expenditures for South Carolina households by nearly $1,800 per year, or by 3.5% of their annual income.

However, income fails to capture the true lifetime earnings of individuals that find themselves temporarily in each income group, which is clearly evident by the discrepancy between income and expenditures experienced at the bottom of the income scale. Households in the first six income categories are spending more than their incomes, as they are in the process of acquiring houses, cars, and other "big ticket" items in anticipation of higher incomes in the future. Other household earners, namely sole proprietors, individuals in partnerships, and contract workers, have very erratic and unpredictable income patterns which can result in negative incomes over the course of a year. Both situations push average income levels down, relative to average expenditure, at the lower end of the scale, especially the bottom three income groups in Table 7.

[48] U.S. Department of Labor, Bureau of Economic Analysis, Consumer Expenditure Survey, 2005-2006; "Table 33: Southern region by income before taxes: Average annual expenditures and characteristics:" Internet; available at ftp://ftp.bls.gov/pub/special.requests/ce/crosstabs/y0506/regbyinc/xregns.txt.

Table 7: Distributional Effects of the CECAC Recommendations

Household Income Categories	Average Annual Disposable Income ($)	Average Annual Expenditures ($)	Expenditure Increase ($)	Percentage of Income	Percentage of Expenditure
Less than 5,000	1,374	19,343	937	68.2	4.8
5,000 to 9,999	8,089	15,364	658	8.1	4.3
10,000 to 14,999	12,730	19,297	861	6.8	4.5
15,000 to 19,999	17,469	22,752	1,095	6.3	4.8
20,000 to 29,999	24,701	27,928	1,321	5.3	4.7
30,000 to 39,999	34,067	34,539	1,608	4.7	4.7
40,000 to 49,999	43,297	38,248	1,712	4.0	4.5
50,000 to 69,999	57,071	47,415	2,076	3.6	4.4
70,000 and more	114,720	77,128	2,997	2.6	3.9
Average	52,599	43,513	1,836	3.5	4.2

As a result, when we measure households by average annual expenditures, the difference between the income groups narrows significantly, the price increase represents between 4.8% and 3.9% of expenditure. Nevertheless, the distribution of the burden remains intact: households in the highest three income groups suffer the least burden, between 4.5% and 3.9%, while households in that warn between $15,000 and 39,999 in annual income face a higher burden of between 4.7% and 4.8% of their annual expenditures. Irrespective of our measure of income, the CECAC proposals will be a greater liability for South Carolina's low income households than for its higher income households.

Not only do South Carolina's lower income households bear a higher burden of costs of the CECAC proposals, but these costs will be borne in the near term. However, any benefits that may accrue to these households will materialize over a period of ten or more years, if at all. Thus, poor households will experience a negative shock to their economic well being that, given their already limited financial means and the economic damage produced by the proposals, may well inhibit their ability to fully recover the lost ground in the medium term.

Conclusion

In its draft final report, CECAC offered 51 recommendations for reducing GHG emissions covering four sectors of the state economy. CECAC proposes the use of less efficient and more expensive renewable energy sources and public funding for untested programs to promote energy efficiency.

Consistent with CECAC assertions, the implementation of these measures would increase costs in the energy, transportation and building sectors.[49] The programs would "entail consumer costs" and increases in prices that consumers and businesses in South Carolina pay for energy, transportation and construction.[50] Increasing energy prices disproportionately fall on low income consumers, whose income is already devoted mainly to the acquisition of the basic necessities of life. It is, at the same time, unlikely that these new programs would lead to improvements in efficiency that would offset the increased prices at some undetermined date in the future. Meanwhile, the South Carolina business community would see a reduction in its competitive advantage over other states that resist the pressure to adopt similar legislation. Real State GDP would be one percentage point below baseline by 2009.

The CECAC report estimates that South Carolina will emit a total of 87.8 million metric tons (MMt) of carbon dioxide in the year 2000.[51] In this same year, the World Resources Institute estimated that worldwide global carbon dioxide emissions to be 31,640 MMt and U.S. emissions to be 5,364 MMt. Accordingly, South Carolina accounts for just 1.6% of U.S. emissions and a minuscule 0.28% of worldwide emissions.[52]

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[49] CECAC, *Final Report*, ES-2.
[50] Ibid, EX-7.
[51] Ibid, EX-8.
[52] Kevin A Baumert, Tim Herzog, Jonathan Pershing, "Navigating the Numbers: Greenhouse Gas Data and International Climate Policy," The World Resources Institute; December, 2005; Internet; http://www.wri.org/publication/navigating-the-numbers; accessed August 8, 2008.

The CECAC study suggests that its recommendations would result in a 46% reduction in South Carolina emissions by 2020 (64.3 vs. 119.7 MMt), which amounts to a net decrease of 0.012% in projected 2025 global emissions. Because South Carolina's GHG emissions are so small relative to the rest of the world's emissions, it is quite apparent that no policy adopted by South Carolina would have any discernable impact on global climate change and thus no measurable benefit.

If the South Carolina legislature is to consider the CECAC proposals, it should give considerable thought to their likely economic consequences. It should understand that, whatever the benefits of those proposals, the proposals will exert measurable, negative effects on the state economy. To assert that it is possible to adapt sweeping greenhouse gas legislation without exerting such effects is to ignore sound economic analysis.

Appendix A: SC-STAMP

SC-STAMP is a comprehensive model of the state of South Carolina, designed to capture the principal effects of city tax changes on that economy. SC-STAMP is a five-year dynamic computable general equilibrium (CGE) tax model. As such, it provides a mathematical description of the economic relationships among producers, households, government and the rest of the world. It is *general* in the sense that it takes all the important markets and flows into account. It is an *equilibrium* model because it assumes that demand equals supply in every market (goods and services, labor and capital); this is achieved by allowing prices to adjust within the model (i.e., prices are endogenous). The model is *computable* because it can be used to generate numeric solutions to concrete policy and tax changes, with the help of a computer. And it is a tax model because it pays particular attention to identifying the role played by different taxes.[53]

We begin by distinguishing between producers and consumers. Consumers/households earn income by supplying labor (wages and salaries) and capital (dividends and interest); they also receive transfer payments such as pensions. They are assumed to maximize their utility, which they do by using income to buy goods and services, pay taxes and save. Their spending decisions are strongly influenced by the structure of prices they face. Their spending decisions are also influenced by the amount of labor that they are willing to provide given on the wage rates offered to them..

Producers/firms buy inputs (labor, capital and intermediate goods that are produced by other firms) and transform them into outputs. Producers are assumed to maximize profits and are likely to change their decisions about how much to buy or produce depending on the prices they face for inputs and outputs.

In addition, there is a government sector that collects taxes and fees and provides services and transfers. The rest-of-the world sector consists of the entire world outside of South Carolina. The relationships between these components are set out in the circular flow diagram shown in Figure

[53] Shoven and Whalley, "Applied General-Equilibrium Models."

1.[54] The arrows in the diagram represent flows of money (for instance, households purchase goods and services), and flows of goods and services (for instance, households supply their labor to firms). The separate box for government shows the flows of funds to government in the form of taxes, as well as government purchases of goods and services and government hiring of labor and capital.

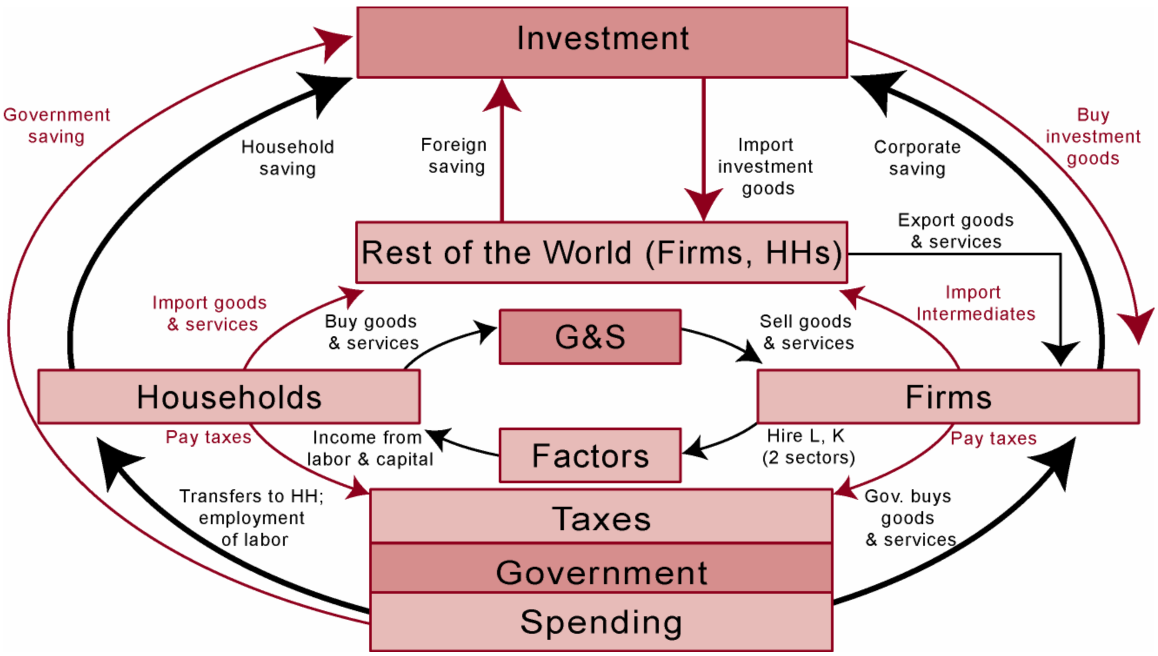

Figure 1. Circular Flow Diagram

Complex as it may seem, the diagram in Figure 1 is still too simple, because it lumps all households into one group, and all firms into another. To provide further detail it is necessary to create *sectors*. SC-STAMP includes 81 economic sectors. Each sector is an aggregate that groups together segments of the economy. We separate households into seven income classes and firms into 27 industrial sectors. In addition, we distinguish between 30 types of taxes and funds (four at the federal level, 14 at the state level, and 12 at the city level) and 13 categories of government spending (two at the federal level, six at the state level, and five at the city level). To complete the model, there are two factor sectors (labor, capital), an investment sector and a sector that

[54] Based on a similar diagram in Peter Berck, Elise Golan and B. Smith, with John Barnhart and Andrew Dabalen. "Dynamic Revenue Analysis for California," Summer 1996. University of California at Berkeley and California Department of Finance. Available at http://www.dof.ca.gov:8080/html/fs%5Fdata/dyna%2Drev/dynrev.htm; Internet: accessed 23 January 2007.

represents the rest of the world. The choice of sectors is dictated by the availability of suitably disaggregated data (for households and firms), and the purposes of the model.

Sub-national models, such as SC-STAMP, are similar in many ways to national and international CGE models. However, they differ in a number of important respects, which are as follows:

a. In a national model, most saving goes toward domestic investment; however, this need not be true at the regional level. If citizens save more than they spend, then the excess saving will leak out of the state.
b. The smaller the unit under consideration, the greater the importance of trade with the rest of the world. This is an important consideration for state models.
c. Migration is likely to be larger and more responsive across cities and states than across nations.
d. In sub-national models, taxes are interdependent. So, for instance, the amount of revenue collected by the Federal personal income tax depends significantly on whether there is a state or local income tax (which may be deducted from income before computing the Federal tax).
e. Data are less available at the sub-national than national level. This explains why scores of national CGE models have been built, but relatively few sub-national models.

Constructing a CGE model

The construction of a CGE model involves several steps. First, one needs to organize the data needed by the model. SC-STAMP starts with data for a single FY, 2004, which we use as the basis to develop a steady state path through FY 2010 in the model. This steady state path is attained by applying growth rates for investment, population, employment and inflation throughout the time frame of the model. In SC-STAMP, the investment growth rate is assumed to be 1.31%.[55] The growth rate for population is assumed to be 1.7%.[56] The inflation growth rate is assumed to be 3.00%[57]. To attain a reasonable steady state path, the data for the base year, FY 2004, must be very detailed. Most of the data are organized into a *Social Accounting Matrix*

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[55] This figure is derived from taking the average nominal US gross domestic investment for the period 1929-2004, as published by the Bureau of Economic Analysis.
[56] This figure is the Census projection for South Carolina for the period 2005-2010.
[57] This figure is based on data obtained from the U.S. Bureau of Labor Statistics.

(SAM), which in this case consists of an 81 by 81 matrix that accounts for the main economic and fiscal flows in the state.

The model also requires some additional information – for instance, data on employment and on the structure of the Federal income tax – which are put in separate files. And the model requires information on "elasticities;" these are the parameters, typically taken from the academic literature, that measure the responsiveness of households to changes in prices and wages, and of firms to changes in input costs and output prices. These are set out in detail in Section 4 of this report. The economy is assumed to be competitive, and to run at full employment (by which we mean that there is no involuntary unemployment).

Second, the model needs to be specified in detail; the next section of this report sets out details of the model that we constructed for South Carolina, along with some comments explaining the choices made at each step.

The third step is to program the model. For this we use the specialized GAMS (General Algebraic Modeling System) software. In order to make the model easier to use, we also developed an interface in Microsoft Excel. This allows the user to enter tax changes on an Excel spreadsheet, click the "Estimate CGE" button, and read the key output on the same spreadsheet; the heavy-duty computing occurs in the background.

Before we can use it, the model must be calibrated. Calibration consists of running the model – i.e., asking it to solve for all the variables in such a way as to maximize (and minimize!) total personal income.[58] The results for the base year are checked to see that they correspond with the actual values of the variables in the SAM. Once the model reproduces the base year values, it is considered calibrated. Calibration is an important step, as it is essentially a way of checking that the model is working properly.

After it has been calibrated, the model is ready to be used to quantify tax change effects. The procedure is straightforward: specify a new tax rate (or change in the tax), run the model, and compare the new results with the steady state ones. At this point it is also possible to test the

[58] The choice of variable to maximize has no substantive importance and serves as a device for getting the model to solve.

sensitivity of the results to different assumptions – such as the values of elasticities – that are incorporated into the model. *It is worth stressing that SC-STAMP is a policy model and not a forecasting model; in other words it is designed to answer "what if?" questions, not to estimate what is actually expected to occur in coming years.*

Organizing the Data

The starting point in building a CGE model is to determine the degree of detail that is desired and to organize the collected data into the useful format of a Social Accounting Matrix (SAM) for the base year. The SAM that we developed for STAMP is an 81 by 81 matrix. Each of the 5,929 cells in the matrix represents the dollar value of a flow from one sector of the economy to another – for instance, purchases of business services by the utilities sector, or labor earnings flowing to middle-income households. Reading along a row, one finds the payments received by that sector; reading down a column, one sees the payments made by that sector. The SAM is balanced, which means that the sum of the entries in any given row equals the sum of the entries in the corresponding column. Thus, for instance, the revenue received by utilities must equal spending by that sector, so that all incoming and outgoing funds are completely accounted for.

For SC-STAMP, we distinguish 27 industrial sectors, two factors (labor and capital), seven household categories, an investment sector, 43 government sectors (26 for taxes, 13 for spending, four government funds) and a sector for the rest of the world. In dividing the economy into sectors, we sought to strike a balance between providing a high level of detail (especially on the tax side) and keeping the model to a manageable size. An additional limitation is that the lack of finely disaggregated data limits the degree of detail that is possible. Data availability also determined some of the choices we made; for instance, it is possible to get a breakdown of households into seven income categories (see below for further details), and while we might have preferred a different set of categories, we were constrained by the nature of the data available.

Industrial sectors

Although data for 49 sectors were available from the Bureau of Economic Analysis, SC-STAMP contains only 27 industrial sectors. This is because some sectors were too small to merit separate attention. In these cases, we combined some industries, such as textiles and apparel. In other cases, there were no matching employment figures, and so it was easier to work with aggregates.

Factor Sectors

We distinguish between two factors, labor and capital (which include land). Businesses pay wages and salaries to labor, and they generate profits. These are then distributed to household owners as factor income.

Household Sectors

In SC-STAMP, households receive wages, capital income and transfers and they use this income to buy goods and services, to pay taxes and to save. We distinguish seven household sectors, which group households by their levels of income. Expenditure data are available for households in each of these categories, which make it relatively straightforward to work with this structure. One purpose of this disaggregation of households is to allow one to trace the distributive effect of tax changes and another one is to allow different groups to have different levels of sensitivity to labor market conditions.

Investment Sector

There is one investment/savings sector. Households save, both directly out of their cash incomes, and indirectly because they own shares in businesses that save and reinvest profits. The government also saves and invests. Information is available from the Bureau of Economic Analysis (BEA) on the pattern of gross investment by destination (i.e., how much gross investment went into adding to the stock of capital in utilities, in industry, and so on). We have constructed measures of the capital stock in each sector, and by applying published depreciation rates and adding gross investment, arrived at the capital stock in the subsequent period. This permits the model to track the expansion of the economy over time. The BEA has also produced a matrix, built for the U.S. for 1997, which maps investment by destination with investment by source. This mapping allows one to determine, for example, how much of the investment destined for utilities is spent on purchasing goods and services from the construction sector and the transport sector. Thus if investment rises, it is possible to identify which sectors would face an expansion in the demand for their output.

Government Sectors

SC-STAMP was designed primarily to analyze the effects of major changes in the structure of state taxes, and so we have paid particular attention to providing sufficient detail for government transactions. The sectoring is summarized below in Table 7.

Table 8: Government Sectors

Federal Government Receipts		
USSSTX	Social Security (OASDI and MEDICARE)	Receives payments from employers and households; pays out transfers to households.
USPITX	Federal Personal Income Tax	Receives payments from households, which are put into the Federal normal spending account.
USCITX	Federal Corporation Income Tax	Receives payments from corporations and channels them into the Federal normal spending account.
USOTTX	Other Federal Taxes	Includes excises on motor fuel, alcohol, and tobacco; estate and gift taxes. Also funneled into the Federal normal spending account.
Federal Government Expenditure		
USNOND	Federal Normal Spending	Federal government purchases goods and services, hires labor, and transfers money to SC and to Federal defense fund.
USDEFF	Federal Defense Spending	Purchases goods and services, and pays labor for military purposes.
SC State Government Receipts		
STPITX	State Personal Income Tax	Revenues go into State general fund.
STCBTX	State Corporate Income Tax	Revenues go into State general fund.
STSATX	State Sales Tax	Revenues go into State general fund.
STESTX	State Estate Tax	Revenues go into State general fund.
STINTX	State Insurance Tax	Revenues go into State general fund.
STHCPT	State Healthcare Provider Tax	Revenues go into State general fund.
STTPPT	State Telecommunication Personal Property	Revenues go into State general fund.
STFUTX	State Taxes on Motor Fuels	Revenues go into State special fund and highway fund.
STPUTX	State Public Utility Tax	Revenues go into State general fund.
STRETT	State Real Estate Transfer Tax	Revenues go into State general fund.
STALTX	State Alcohol Beverage Taxes	Revenues go into State general fund.
STTCTX	State Tax on Cigarettes and Tobacco	Revenues go into State general fund.
STPTTX	State Property Transfer Tax	Revenues go into State general fund.
STOTTX	State Other Taxes	Revenues go into State general fund and Other funds.
STMOTX	State Motor Vehicle Tax	Revenues go into State general fund.

STWKTX	State Worker Compensation Tax	Sector combines workers compensation and unemployment funds. Receipts go into proprietary fund.
STFEES	State Fees, License Permits and Other Revenue	Revenues go into all funds.
STGENF	State General Fund	An accounting device. Tax revenue is channeled into this fund before being distributed to other uses.
STFSCF	State Special Fund	An accounting device. Tax revenue is channeled into this fund before being distributed to other uses.
STHIWF	Highway Fund	
STSPCF	State Other Special Fund (Healthy Fund)	
State Government Expenditure		
STGGSP	State General Spending	General government spending.
STEDUC	State Spending on Education	Mainly purchases of goods and services and labor in the higher education sector.
STHELT	State Spending on Health & Welfare	Buys some services; mainly transfers funds to local health spending fund.
STPBSF	Public Safety	Public safety and fire departments spending.
STTRAN	State Spending on Transport	Mainly buys engineering services and construction.
STOTHS	State Other Spending	Miscellaneous other spending by the state on labor, goods and services.
Local Government Receipts		
LOPRTX	Local Tax on Residential Property	Revenues go into the local general fund.
LOPBTX	Local Tax on Business Property	Revenues go into the local general fund.
LOTCTX	Local Tax on Cigarettes and Tobacco	Revenues go to the local general fund.
LOOTRE	Local Taxes Other	Revenues go to the local general fund.
LOCHAR	Local Public Service Charge and Fees	Revenues go to all three funds (general, capital projects and other)
Local Government Expenditure		
LOEDUC	Local Spending on Education	Purchases goods and services and (mainly) pays teacher salaries.
LOHELT	Local Spending on Health & Welfare	Purchases goods and services and pays labor; large transfers to the poorest category of households.
LOPBSF	Local Public Safety	Public safety and fire departments local spending.
LOTRAN	Local Spending on Local Transportation	Mainly buys engineering services and construction.
LOOTHS	Local Other Spending	Includes spending on police and firefighters, road repair, and miscellaneous local government services.

South Carolina's state government collects revenue from taxes and fees. Specific tax categories at the state level included in the model are: sales and use, cigarettes and tobacco, mortgage recording, corporate and personal incomes, and taxes both on residential and commercial properties. The rest of the state taxes are grouped into a residual category (other local taxes).

The revenues from the taxes go to either the South Carolina general fund, the South Carolina capital projects fund or to other funds, or a combination of them. Funds then allocate the money into the five spending categories: education, health and welfare, transportation, public safety or others.

Rest of the World

To complete the model, we have included a sector for the rest of the world (ROWSCT). This refers to the world outside of the state, i.e., the rest of the United States and other countries. Information on flows between the state and the rest of the world is difficult to piece together, and is an area where considerable professional judgment was required.

SC-STAMP: The Model in Detail

This section of the report explains the SC-STAMP model in detail. First, we introduce each equation, providing some context and a short description. Then we present each equation in mathematical form, provide information on the sources of data used, and summarize the elasticity assumptions used in the model.

Detailed Equations for South Carolina STAMP

SC-STAMP is a dynamic CGE model which assumes a steady state growth path. Absent from any "shocks", the economy is assumed to remain on this path. If the economy experiences a shock, such as a tax change, the economy will diverge from this steady state path and eventually turn onto a new path. The size and length of the divergence will depend on the size of the shock to the economy. Below we set out the equations used in SC-STAMP and the assumptions inherent in them.

Household Demand

Households are assumed to maximize their well being ("utility") by picking baskets of goods and services, subject to their budget constraints. The key set of equations in this section is labeled *Private Consumption*, and consists of a set of demand functions. These demand functions, based on a Cobb-Douglas utility function, take on the simple form,

$$X_{t,i} = \lambda_i * \frac{I_t}{P_{t,i}}, \quad i = 1,...,n; t = 1,...n,$$

where $X_{t,i}$ is the quantity demanded of good i at time t, $P_{t,i}$ is the price of good i at time t, I_t is income at time t, and λ_i are parameters that measure the share of income that is devoted to good i. This is the simplest specification that is theoretically satisfactory: it is additive (so spending equals income less taxes less saving), has downward-sloping demand (ensuring that when the price of a good rises, the quantity demanded falls), is zero degree homogeneous in prices and income (so that if prices and incomes were to double, the quantity demanded would not change), and meets the technical requirement of symmetry of the Slutsky matrix. More complex formulations are possible, but there is a lack of reliable data on the elasticity parameters that would be needed in such cases.

Household Gross Factor Income

Comments: The gross income of households in each of the seven groups (indexed by h in the set H) is found by first summing factor income (y_f) from labor and capital, subtracting the social security contributions paid by employees, and then allocating the total to each group on the basis of fixed shares. Factor payments are allocated to each household group using the same fixed shares as were found in the base year.

Eq. 1.

$$y_{t,h} = \sum_{f \in F} \frac{\alpha_{h,f} a^w_{t,h}}{\sum_{h \in H} \alpha_{h,f} a^w_{t,h}} y_{t,f} (1 - FFP_f) \left(1 - \sum_{g \in GF} \tau^{fh}_{t,g,f}\right) \qquad \forall t \in T, h \in H, f \in F$$

Description: Household income is the sum of income from each factor (labor and capital) less factor taxes, distributed by household groups according to their share of total.

Data: The information on earnings for each household group comes from SC (South Carolina) IMPLAN (an economic impact modeling system which allows users to perform in-depth regional analysis).[59]

Household Disposable Income

Comments: Disposable household income is gross income, less taxes on household income and property (mainly personal income tax (USPITX, STPITX) and residential property tax (LOPRTX)), plus transfer payments (such as social security and unemployment benefits).

Eq. 2.

$$y_{t,h}^{d} = y_{t,h} - \sum_{g \in GI} t_{t,g,h} a_{t,h}^{hh} - \sum_{g \in GH} \tau_{t,g,h}^{h} a_{t,h}^{hh} + \sum_{g \in G} w_{hg} a_{t,h}^{n} \tau_{t,h,g}^{pc} \quad \forall h \in H, t \in T$$

Description: Disposable household income is the household income less income taxes and other household taxes (property taxes etc), plus the government transfer payments.

Private Consumption Expenditure

Comments: This is the simplest demand system that is consistent with theoretical first principles, and it requires only a limited number of parameters.

Eq. 3.

$$c_{t,i,h} = \bar{c}_{t,i,h} \left(\frac{y_{t,h}^{d}}{\bar{y}_{t,h}^{d}} \div \frac{p_{t,h}}{\bar{p}_{t,h}} \right)^{\beta_{ih}} \prod_{i' \in I} \left[\frac{p_{t,i'}}{p_{t,i'}} \frac{\left(1 + \sum_{g \in GS} \tau_{t,g,i'}^{c}\right)}{\left(1 + \sum_{g \in GS} \tau_{t,g,i'}^{q}\right)} \right]^{\lambda_{i'i}} \quad \forall i \in I, h \in H, t \in T$$

[59] For more details see Minnesota IMPLAN Group at http://www.implan.com..

Description: Consumption is a function of baseline consumption, adjusted to reflect the change in household disposable income (in constant prices), and the change in after-tax prices.

Data: By construction, this equation has zero cross price elasticities. In the absence of adequate estimates of demand elasticities we follow the approach taken by Berck et al., setting all income and own-price elasticities equal to unity.

Direct Household Purchases of Imports

Comments: Some household spending goes directly to buy goods and services outside South Carolina.

Eq. 4.
$$m_{t,h} = \overline{m_{t,h}} \left(\frac{y^d_{t,h}}{\overline{\overline{y^d_{t,h}}}} \div \frac{p_{t,h}}{\overline{\overline{p_{t,h}}}} \right)^{\eta^m_h} \quad \forall h \in H, t \in T$$

Description: Household imports will increase with the increase in disposable income, in constant prices.

Household Savings

Comments: In SC-STAMP, household savings is the residual after spending and taxes have been subtracted from income. Thus savings are seen as occurring passively.

Eq. 5.
$$s_{t,h} = y^d_{t,h} - \sum_{i \in I} c_{t,i,h} p_{t,i} \left(1 + \sum_{g \in GS} \tau^c_{t,g,i} \right) \text{-} m_{t,h} \quad \forall h \in H, t \in T$$

Description: See comments above.

Data: The savings rates for households at each income level were adjusted based on professional judgement, to account for the imputed savings by corporations (which indirectly represents savings by the owners of the corporations).

Consumer Price Index

Comments: The price index in the reference period is set equal to 1. There is a separate price index for each household group. This allows one to compute the real (rather than nominal) income for each household group. For instance, a tax on foodstuffs would tend to hit poor households relatively hard, and the CPI for poor households would pick up this effect.

Eq. 6.

$$p_{t,h} = \frac{\sum_{i \in I} p_{t,i} \left(1 + \sum_{g \in GS} \tau^{c}_{t,g,i}\right) c_{t,i,h}}{\sum_{i \in I} \overline{p}_{t,i} \left(1 + \sum_{g \in GS} \tau^{q}_{t,g,i}\right) c_{t,i,h}} \qquad \forall\, h \in H, t \in T$$

Description: Price index by household group is a function of the baseline price index, adjusted by the change in after-tax prices by industry, according to their corresponding share of consumption.

Data: The consumption of each good by each household group (c_{ih}) is derived from reports published by State and Federal agencies. The model also generates some of its own values.

Labor Supply

Comments: In the SC-STAMP we model the labor participation rate, defined as the proportion of households in any given income category that work. The participation rate is assumed to rise if wage rates rise, if the taxes levied on earnings fall, or if the transfer payments paid out per non-working household fall. The participation rate for low-income households is assumed to be highly sensitive to the level of transfer payments, but relatively insensitive to changes in taxes or the wage rate. On the other hand, high-income households are assumed to respond substantially to changes in the taxes and wage rates they face.

Eq. 7.

$$a_{t,h}^{w} = \bar{a}_{t,h}^{w} \frac{a_{t,h}^{hh}}{\bar{a}_{t,h}^{hh}} \left(\frac{r_{t,L}^{a}}{\bar{r}_{t,L}^{a}} \div \frac{p_{t,h}}{\bar{p}_{t,h}} \right)^{\eta_h^{ls}} \left[\prod_{g \in GI} \left(\frac{t_{t,g,h}^{pi}}{\bar{t}_{t,g,h}^{pi}} \div \frac{p_{t,h}}{\bar{p}_{t,h}} \right)^{\eta_{h,g}^{PIT}} \right]^{1/GINUM} \left(\frac{\sum_{g \in G} \frac{w_{t,h,g}}{p_{t,h}}}{\sum_{g \in G} \frac{\bar{w}_{t,h,g}}{\bar{p}_{t,h}}} \right)^{\eta_h^{tp}} \quad \forall t \in T, h \in H$$

Description: The supply of labor is a function of the baseline supply of labor adjusted by population growth, the net change in wages, income taxes, and government transfer payments. We used professional judgment in determining the proper elasticities for each household group.

Data: The data on working households by income class came from SC-IMPLAN.

Population

Comments: The number of households in each income group depends first and foremost on the initial number of households. To this we add the natural growth of the population and net in-migration. Migration in turn depends on the level of after-tax income, and the proportion of households that are not working (which reflects the employment prospects facing new migrants). This formulation is in the spirit of the migration model popularized by Harris and Todaro.[60]

Eq. 8.

$$a_{t,h}^{hh} = \bar{a}_{t,h}^{hh} + \bar{a}_{t,h}^{i} \left(\frac{y_{t,h}^{d}}{a_{t,h}^{hh}} \div \frac{\bar{y}_{t,h}^{d}}{\bar{a}_{t,h}^{hh}} \div \frac{p_{t,h}}{\bar{p}_{t,h}} \right)^{\eta_h^{yd}} \left(\frac{a_{t,h}^{n}}{a_{t,h}^{hh}} \div \frac{\bar{a}_{t,h}^{n}}{\bar{a}_{t,h}^{hh}} \right)^{\eta_h^{u}}$$
$$- \bar{a}_h^{o} \left(\frac{\bar{y}_{t,h}^{d}}{\bar{a}_{t,h}^{hh}} \div \frac{y_{t,h}^{d}}{a_{t,h}^{hh}} \div \frac{\bar{p}_{t,h}}{p_{t,h}} \right)^{\eta_h^{yd}} \left(\frac{\bar{a}_{t,h}^{n}}{\bar{a}_{t,h}^{hh}} \div \frac{a_{t,h}^{n}}{a_{t,h}^{hh}} \right)^{\eta_h^{u}}, \quad \forall h \in H, t \in T$$

Description: See comments above.

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[60] John R. Harris and Michael P. Todaro, "Migration, Unemployment and Development: A Two-Sector Analysis," *American Economic Review* 60, no. 1 (1970): 126-142.

Data: The elasticities used in this equation are the same as those used for California by Berck et al., and "reflect the middle ground found in the literature about migration."[61]

Number of Non-Working Households

Comments: This is a simple accounting equation; the number of non-working households is the total number of households, less the number that are working.

Eq. 9. $$a^{n}_{t,h} = a^{hh}_{t,h} - a^{w}_{t,h} \qquad \forall h \in H, t \in T$$

Description: See comments above.

The Behavior of Producers/Firms

Producers are assumed to maximize profit. Combining intermediate inputs with labor and capital produces output. The amount of intermediate inputs required per unit of output is fixed, but firms have considerable leeway to vary the amounts of capital and labor that they use in production. The value of output less intermediate inputs is value added, and it is useful to compute a price for this value added; it is this price that determines factor demand – i.e. drives firms to hire more or less labor and capital. The amounts of labor and capital inputs, in turn, drive the total value of output via the production function.

Intermediate Demand

Comments: Intermediate goods constitute a fixed share of the value of production.

Eq. 10. $$v_{t,i} = \sum_{i' \in I} \alpha_{t,i,i'} q_{t,i'} \qquad \forall i \in I, t \in T$$

Description: See comments above.

[61] Berck, et. al.,117.

Data: From the South Carolina input-output table, derived from data from IMPLAN, which in turn are based on data from by the Bureau of Economic Analysis.

Production Function

Comments: Output is determined by the quantities of labor and capital used in production; it is assumed that enough intermediate goods will be available. We use a Constant Elasticity of Substitution (CES) production function, which allows a degree of substitution between labor and capital; in other words, if the price of labor rises, firms will cut back on the number of workers they hire, and use more capital instead.

Eq. 11.

$$q_{t,i} = \gamma_{t,i} \left[\sum_{f \in F} \alpha_{t,f,i} \left(u^{d}_{t,f,i} \right)^{-\rho_i} + g\alpha_{t,i} \left(gk_t \right)^{-\rho_i} \right]^{-1/\rho_i} \quad \forall\, i \in I, t \in T$$

Description: In addition to labor and capital used in production, we account for infrastructure.

Data: We use values for the elasticity of substitution that are close to, but slightly lower than, one. This is relatively standard in CGE models. Information on the shares of labor and capital in production come from the Bureau of Economic Analysis.

Price of Value Added

Comments: Define value-added as the value of output less the cost of intermediate inputs. One may then define a "price" of value added, which we then use below in the factor demand (i.e. labor demand, capital demand) equations.

Eq. 12.

$$p^{va}_{t,i} = p^{d}_{t,i} - \sum_{i' \in I} \alpha_{t,i',i}\, p_{t,i'} \left(1 + \sum_{g \in GS} \tau^{v}_{t,g,i'} \right) \quad \forall\, i \in I, t \in T$$

Description: Price of value-added by industry is the domestic price by industry minus the production prices by industry according to their share in domestic supply, including taxes on intermediates, if any.

Data: Prices are set equal to unit in the baseline case.

Factor Demand

Comments: It is possible to construct a profit function that expresses profits as a function of factor inputs. Microeconomic theory shows that the partial first derivative of the profit function, with respect to a given factor demand variable, gives the demand equation for that factor. The left hand side of the equation shows payments to labor (including the cost of factor taxes such as the employer share of social security contributions). The right hand side gives the amount of value added attributable to the factor. There are separate equations for labor and for capital, for each of the 27 industrial sectors.

Eq. 13.

$$r_{t,f,i} r^{a}_{t,f} \left(1+\sum_{g \in GF} \tau^{x}_{t,f,g,i}\right) u^{d}_{t,f,i} = p^{va}_{t,i} q_{t,i} \alpha_{t,f,i} \quad \forall i \in I, f \in F, t \in T$$

Description: The factor demand at the current intra-industry rental rate (for labor and capital) times the overall rental rate, including factor taxes is a function of the price of value-added times the industry domestic supply.

Data: Information on the wage bills comes from the Bureau of Economic Analysis. The total wage bill is divided by the number of workers (from the Bureau of Labor Statistics) to get measures of wage rates by industry. The intersectoral wage differentials are not allowed to vary within the model. The cost of capital was derived as property-type income divided by the capital stock. The capital stock was constructed by disaggregating the national aggregate level of capital using a series of proxy measures; further details of the methodology are provided in Appendix 2 of the *Texas State Tax Analysis Modeling Program: Texas-STAMP* (1999) and although this refers to Texas, the same approach was taken in computing the capital stock for South Carolina.[62]

[62] David G. Tuerck, Jonathan Haughton, In-Mee Baek, James Connolly and Scott Fontaine, "Texas State Tax Analysis Modeling Program Methodology and Applications," The Beacon Hill Institute at Suffolk University, (February 1999, Revised); Internet; available from http://www.beaconhill.org/BHIStudies/TexasSTAMPFinal19Feb99.pdf.

Factor Income

Comments: The total income accruing to factors – i.e. to labor and capital – is computed here.

Eq. 14. $$y_{t,f} = \sum_{i \in I} r_{t,f,i} r^{a}_{t,f} u^{d}_{t,f,i} + \sum_{g \in G} r_{t,f,g} r^{a}_{t,f} u^{d}_{t,f,g} \qquad \forall f \in F, t \in T$$

Description: The factor income is the sum of factor demand multiplied by rental rates, for all industries and government sectors.

Trade with other States and Countries

From a state perspective, the "rest of the world" consists of other states and U.S. territories as well as the world outside the United States. Goods produced in the state are assumed to be close, but not perfect, substitutes for goods produced elsewhere. Thus if prices rise in South Carolina, the state's exports will fall and its imports will rise, but the adjustment need not be very large. There is no need for trade to be balanced; capital flows simply adjust to cover the gap between exports and imports. In this section we also develop a measure of the average price faced by domestic households and firms for goods and services produced by each industry, the price is a weighted average of the price of locally produced and imported goods.

Demand for Exports

Comments: Exports depend on the price of goods within the state relative to the price outside the state. If the domestic price rises relative to the foreign price, exports will fall. Note that the elasticity here is negative.

Eq. 15. $$e_{t,i} = \overline{e}_{t,i} \left[\frac{p^{d}_{t,i} \div \overline{p}^{w}_{t,i}}{1 + \sum_{g \in G} \tau^{m}_{t,g,i}} \right]^{\eta^{e}_{i}} \qquad \forall i \in I, t \in T$$

Description: Current exports are a function of baseline exports adjusted by the change in domestic prices versus fixed world prices.

Data: The trade data for the state are not particularly reliable; we have used our judgement, combined with BEA data, to arrive at sensible estimates. The elasticities we use are similar to those employed by Berck et al.

Domestic Share of Domestic Consumption

Comments: The demand for imports is handled indirectly, by modeling the share of domestic consumption that is supplied by domestic firms (*d*), following the approach pioneered by Armington.[63] This share depends on the domestic price relative to the price of the same goods in the rest of the world. We ignore import tariffs on the grounds that they are a tiny fraction (less than 1%) of the value of goods imported into South Carolina.

Eq. 16.
$$d_{t,i} = \bar{d}_{t,i} \left[\frac{p^d_{t,i} \div \bar{p}^w_{t,i}}{1 + \sum_{g \in G} \tau^m_{t,g,i}} \right]^{\eta^d_i} \qquad \forall i \in I, t \in T$$

Description: See comments above.

Data: As with export demand we have used our judgement, combined with BEA data, to arrive at sensible estimates.

Intermediate Demand for Imports

Comments: Imports consist of the share of domestic consumption that is not supplied by domestic production.

Eq. 17.
$$m_{t,i} = \left(1 - d_{t,i}\right) x_{t,i} \qquad \forall i \in I, t \in T$$

Description: See comments above.

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[63] Paul S. Armington, "A Theory of Demand for Products Distinguished by Place of Production," *IMF Staff Papers* 16, (1969): 159-176.

Average Prices by Industry

Comments: These aggregated prices are computed for each industry, and are weighted averages of the domestic price and the import price, with the weights consisting of the respective shares in consumption. The price is set to unity in the baseline situation.

Eq. 18. $$p_{t,i} = d_{t,i} p_{t,i}^{d} + \left(1 - d_{t,i}\right) \overline{p}_{t,i}^{w} \qquad \forall\, i \in I, t \in T$$

Investment

We first constructed a measure of the capital stock for each industrial sector for 2003. This stock, less depreciation and plus gross investment gives the capital stock for 2004. Gross investment is determined, sector-by-sector, based on the net of tax rate of return (relative to the return in the base period). For instance, once investment by the agricultural sector has been determined, it is transformed with the help of the capital coefficient matrix into the demand for goods and services for each sector in the economy.[64]

Capital Stock

Comments: The capital stock in time *t* is the capital stock from the previous period adjusted for depreciation, and augmented by gross investment.

Eq. 19. $$u_{t,K,i} = u_{t-1,K,i}\left(1 - \delta_i\right) + n_{t,i} \qquad \forall i \in I, t \in T$$

Description: See comments above.

[64] The Capital Coefficient Matrix is a matrix of investments by use by industries. It contains distribution ratios of new structures and equipment to using industries from the 1992 BEA capital flow tables.

Data: A complete discussion of the construction of capital stock figures is given in Texas *State Tax Modeling Program: Texas-STAMP* (1999); the same approach and the same data sources are used for South Carolina.[65]

Gross Investment by Sector of Destination

Comments: The amount of gross investment in any given sector depends on the after-tax rate of return in that sector relative to the return in the base period. The terminology here can be confusing; investment destined for agriculture, for instance, consists of the purchases of goods that will add to the capital stock in the agricultural sector; the goods themselves will mainly come from other sectors (the sectors of source).

Eq. 20.

$$n_{t,i} = \overline{n}_{t,i} \left[\frac{r_{t,K,i} \left(1 - \sum_{g \in GK} \tau^{x}_{t,g,K,i} \right) u_{t,K,i}}{\overline{r}_{t,K,i} \left(1 - \sum_{g \in GK} \tau_{t,g,K,i} \right) \overline{u}_{t,K,i}} \right]^{\eta^{i}} \qquad \forall i \in I, t \in T$$

Description: Gross investment is the baseline gross investment by industry adjusted to the change in after-tax capital rental rates.

Data: The rate of return is computed as the property-type income for each sector (from BEA) divided by the capital stock (authors' computations). Based on the econometric results from STAMP models estimated for this state and elsewhere, we estimated the investment demand elasticity to be about 0.3.

Gross Investment by Sector of Source

Comments: Given that investment has been determined for each sector of destination, this equation allows one to determine who will actually produce the investment goods. This is done with the help of a capital coefficient matrix.

[65] Tuerck, Haughton, et. al, Texas-STAMP.

Eq. 21. $$p_{t,i}\left(1+\sum_{g\in GS}\tau^{n}_{t,g,i}\right)cn_{t,i}=\sum_{i'\in I}\beta_{i,i'}n_{t,i'}\qquad \forall i\in I, t\in T$$

Description: The gross investment by source in after-tax prices is a function of investment by destination according to the capital coefficient matrix.

Data: Based on the 1992 capital coefficient matrix for the United States from the BEA/Department of Commerce.

Government

Government derives income from a wide range of taxes. It purchases goods and services and makes transfers (such as pensions) to individuals. Some government spending is assumed to remain unchanged even if tax revenues vary; the rest of spending is endogenous, in that it responds to the availability of funds. Notionally, most revenues flow into the State General Fund; they are then used in part to buy goods and services, but some are also transferred to local government units.

Government Income

Comments: This equation adds up government income from multiple sources, including indirect taxes (sales, motor fuels) and direct taxes (income, franchise tax).

Eq. 22.

$$y_{t,g}=\sum_{i\in I}\tau^{v}_{t,g,i}v_{t,i}p_{t,i}+\sum_{i\in I}\tau^{m}_{t,g,i}m_{t,i}pw^{0}_{t,i}+\sum_{h\in H}\sum_{i\in I}\tau^{c}_{t,g,i}c_{t,i,h}p_{t,i}+\sum_{i\in I}\tau^{n}_{t,g,i}cn_{t,i,n}p_{t,i}+\sum_{i\in I}\sum_{g'\in G}\tau^{g}_{t,g,i}c_{t,i,g'}p_{t,i}$$
$$+\sum_{i\in I}\sum_{f\in F}\tau^{x}_{t,g,f,i}r_{t,f,i}r^{a}_{t,f}u^{d}_{t,f,i}+\sum_{g'\in G}\sum_{f\in F}\tau^{x}_{t,g,f,g'}r_{t,f,g'}r^{a}_{t,f}u^{d}_{t,f,g'}+\sum_{f\in F}\tau^{fh}_{t,g,f}y_{t,f}+\sum_{h\in H}\tau^{pi}_{t,h,g}a^{hh}_{t,h}+\sum_{h\in H}\tau^{h}_{t,h,g}a^{hh}_{h}$$
$$\forall g\in G, t\in T$$

Description: Income by government sector is the sum of taxes on intermediates, imports, consumption, investment, government consumption, factors, income taxes and other household taxes.

Government Endogenous Purchases of Goods and Services

Comments: Spending on these items is assumed to take a fixed fraction of total government receipts (from taxes and net intergovernmental transfers, less government savings). The endogenous sectors are state spending on education, health, safety, transport and "other," and local spending on education and health.

Eq. 23.

$$p_{t,i}\left(1+\sum_{g\in GS}\tau^{g}_{t,g,i}\right)cg_{t,i,g}=\alpha_{i,g}\left(y_{t,g}+\sum_{g'\in G}b_{t,g,g'}-\sum_{g'\in G}b_{t,g',g}+b_{t,ussstx,g}-\sum_{h\in H}w_{t,h,g}a^{n}_{t,h}\tau^{pc}_{t,h,g}-\overline{s}_{t,g}\right)$$

$$\forall i\in I, g\in GN, t\in T$$

Description: The government spending in after-tax prices computed according to their share of government income plus net inter-government transfers less government savings and transfer payments. Note that only state and local governments are endogenous in the model.

Data: The shares of spending going to these sectors are based on a careful analysis of State government budget and financial reports.

Government Endogenous Rental of Factors

Comments: As in the case of goods and services, government is also assumed to devote a fixed share of its total spending to the purchase of labor and capital services for those sectors considered to be endogenous.

Eq. 24**.**

$$u^{d}_{t,f,g} r^{a}_{t,f} r_{t,f,g} = \alpha_{f,g} \left(y_{t,g} + \sum_{g' \in G} b_{t,g,g'} - \sum_{g' \in G} b_{t,g',g} + b_{t,ussstx,g} - \sum_{h \in H} w_{t,h,g} a^{n}_{t,h} \tau^{pc}_{t,h,g} - \overline{s}_{t,g} \right) \quad \forall f \in F, g \in GN, t \in T$$

Description: The government factor demand is computed according to the share of each government in total government spending, including net inter-government transfers, less savings and transfer payments.

Government Infrastructure Capital Stock

Comments: The government adds to its infrastructure capital stock through its spending on the government transportation sector, STTRAN.

Eq. 25.

$$gk_{t+1} = gk_t(1-\delta) + \sum_{g\in G} b_{t+1,STTRAN,g} - \sum_{g\in G} b_{t+1,g,STTRAN} + \sum_{g\in G} b_{t+1,LOTRAN,g} \quad \forall t \in T$$

Description: The infrastructure capital stock for the current year is the infrastructure for the previous year, less depreciation plus the net spending on transportation by state and local governments.

Data: The data for government infrastructure capital stock is based on national data from the BEA.

Government Savings

Comments: Government saving is a residual, consisting of revenue less spending.

Eq. 26.

$$s_{t,g} = y_{t,g} - \sum_{i\in I} cg_{t,i,g}\, p_{t,i}\left(1 + \sum_{g\in GS} \tau^{g}_{t,g,i}\right) - \sum_{f\in F} u^{d}_{t,f,g}\, r_{t,f,g}\, r^{a}_{t,f}\left(1 + \sum_{g'\in GF} \tau^{x}_{t,f,g',g}\right) - \left(\sum_{h\in H} w_{t,h,g}\, a^{n}_{t,h}\, \tau^{pc}_{hg}\right) - \sum_{g'\in G} b_{t,g',g} + b_{t,ussstx,g} + \sum_{g'\in G} b_{t,g,g'} \quad \forall g \in G, t \in T$$

Description: Government savings is the residual from government income, after spending and factor rental, transfer payments, plus net inter-governmental transfers.

Distribution of Taxes to Spending and Transfers

Comments: Tax units, in this case those sectors collecting revenue, distribute some of their receipts to spending units, and others directly in the form of transfers to households. The matrix IGTD (in the miscellaneous input file) identifies which units pass on their revenues to other spending units, and the flows are recorded in this equation.

Eq. 27. $$b_{t,g',g} = \mu_{t,g',g}\left(y_{t,g} - \left(\sum_{h \in H} w_{t,h,g} a^{n}_{t,h} \tau^{pc}_{t,h,g} - \overline{s}_{t,g} \right)\right) \quad \forall g, g' \in G$$

Description: The intra-fund accounting to distribute the government income, less transfer payments and savings.

Data: This equation is based on institutional arrangements in place in SC.

Endogenous Distribution of SC Funds

Comments: This equation details the flows from state funds to state spending sectors and from state spending sectors to local spending sectors.

Eq. 28. $$b_{t,g,g'} = \mu_{t,g,g'}\left(\sum_{g''} b_{t,g',g''} + w_{g',INVEST} + w_{g',ROWSCT} \right) \quad \forall g, g' \in G$$

Description: Some funds are fixed to the original share.

Data: Based on an analysis of the current pattern of spending in SC.

State Personal Income

Comments: This equation defines state personal income as earnings (from labor and capital) plus transfer payments.

Eq.29. $$y^{s}_{t} = \sum_{h \in H} y_{t,h} + \sum_{h \in H}\sum_{g \in G} w_{t,h,g} a^{n}_{t,h} \tau^{pc}_{h,g} \quad \forall t \in T$$

Description: State personal income is the sum of household income and government transfer payments.

Model Closure

Labor Market Clearing

Comments: Labor supply equals labor demand. For this to occur, the wage rate must adjust to bring about this market clearing.

Eq. 30. $$\sum_{h \in H} a^{w}_{t,h} = \left(\sum_{z \in Z} u^{d}_{t,L,z} \right) \varepsilon_t \quad \forall t \in T$$

Description: Total working households equals the sum of private employment and government employment.

Capital Market Clearing

Comments: Capital markets also clear for each sector. In other words, demand for capital by industries equals supply of capital.

Eq. 31. $$u^{s}_{t,K,i} = u^{d}_{t,K,i} \qquad \forall i \in I, t \in T$$

Description: See comments above.

Goods Market Clearing

Comments: Domestic demand (intermediate, consumer, government and investment demand) plus exports less imports must equal domestic supply.

Eq. 32. $$q_{t,i} = x_{t,i} + e_{t,i} - m_{t,i} \qquad \forall i \in I, t \in T$$

Description: See comments above.

Domestic Demand Defined

Comments: These equations define domestic demand for each sector.

Eq.33. $$x_{t,i} = v_{t,i} + \sum_{h \in H} c_{t,i,h} + \sum_{g \in G} cg_{t,i,g} + cn_{t,i} \qquad \forall i \in I, t \in T$$

Description: Domestic demand is the sum of intermediate demand, household consumption, government consumption and investments.

PIT for Non Income Tax Units

Comments: This equation sets the personal income tax for non-income tax units to zero; this is a technicality that ensures the solution to the model does not create income tax revenue in an inappropriate place.

Eq.34. $$t_{t,g,h} = 0 \qquad \forall h \in H, g \notin GI, t \in T$$

Set Intergovernmental Transfers to Zero if Not in Original SAM

Comments: This is another housekeeping equation that ensures the solution to the model does not create inter-governmental transfers where they should not occur.

Eq.35. $$b_{t,g,g'} = 0 \qquad \forall g, g' \in G, t \in T \qquad \text{where } \overline{b}_{gg'} = 0$$

Federal Social Security Transfers to SC

Comments: Transfers paid to South Carolina households from the Federal social security system are assumed to be mainly determined by the number of households in the state.

Eq.36. $$b_{\mathrm{t,h,USSSTX}} = \overline{b}_{\mathrm{t,h,USSSTX}} \times \left(\frac{\overline{a^{n}_{t,h}}}{a_{t,h}} \right)$$

Description: Transfer payments are adjusted by the change in nonworking households.

Fix Exogenous Federal Transfers to Households

Comments: Federal transfers to households are assumed to vary with the number of households in the state.

Eq.37. $$b_{\mathrm{t,h,USNOND}} = \overline{b}_{\mathrm{t,h,USNOND}} \times \left(\frac{a_{t,h}^{n}}{\overline{a}_{t,h}^{n}} \right)$$

Description: Transfer payments are adjusted by the change in nonworking households.

Fix Goods and Services Demand by Exogenous Government Units

Comments: The purchases of goods and services by some government sectors are considered to be exogenous to the model. This equation fixes these values.

Eq. 38. $$cg_{t,i,g} = \overline{cg}_{t,i,g} \qquad \forall i \in I, g \in GX, t \in T$$

Fix Factor Rentals Paid by Exogenous Government Units

Comments: The purchases of the services of labor and capital are considered to be exogenous to the model. This equation fixes these values.

Eq. 39. $$u_{t,f,g}^{d} = \overline{u}_{t,f,g}^{d} \qquad \forall f \in F, g \in GX, t \in T$$

Fix Intersectoral Wage Differentials

Comments: Although wage rates differ from sector to sector, these differentials are assumed to remain fixed, as set by this equation. Household labor supply responds to overall wage rates, and not to the wage rates in any particular sector.

Eq. 40. $$r_{t,L,i} = \overline{r}_{t,L,i} \qquad \forall i \in I, t \in T$$

Fix Government Rental Rate for Capital to Initial Level

Comments: For SC-STAMP, we have set these rental rates to zero, in the absence of viable information about the rental rates paid by government on the capital that it uses. However, the relevant equations are included, and so government rental rates could be incorporated in a future version of the model.

Eq. 41. $$r_{t,K,g} = \overline{r}_{t,K,g} \qquad \forall g \in G, t \in T$$

Fix Economy Wide Scalar for Capital

Comments: The model allows both for an overall cost of capital, and sector-specific returns. This equation sets the overall scalar to its original level, so that only the sector-specific returns vary endogenously.

Eq. 42. $$r^{a}_{t,K} = \overline{r}^{a}_{t,K} \qquad \forall f \in F, t \in T$$

Set Transfer Payments to Zero

Comments: This equation ensures that if transfer payments to households were zero in the original social accounting matrix, they remain at zero.

Eq. 43. $$w_{t,h,g} = 0 \qquad \forall\ h \in H, g \in GWX, t \in T \quad \text{where } \overline{w}_{t,h,g} = 0$$

Objective Function

Comments: This equation measures utility over the entire period of the dynamic model as measured by the sum of state personal income discounted. The variable is of interest in its own right. However, it also provides a convenient variable for GAMS to maximize (or minimize), because it is an unrestricted variable without a subscript.

Eq. 44. $$U = \sum_{t \in T} \beta_t statey_t \qquad t \in T$$

Description: Utility is defined as the net present value of future state personal income levels.

Elasticity Assumptions for SC-STAMP

For the model to work, one must introduce values for the relevant elasticities. These are drawn from the existing literature, as follows:

ETAM: Import elasticity with respect to domestic price for producers' purchase of intermediates. Most of the data on elasticities are taken from Reinert, Roland-Holst, and Shiells. The two most recent are Reinert and Roland-Holst[66] and Roland-Holst, Reinert and Shiells[67].

In the first study, the authors estimate an Armington model for 163 mining and manufacturing sectors. Two-thirds of the elasticities were positive and statistically significant, ranging from a low of 0.13 for chocolate to 3.49 for wine, brandy and brandy spirits. The second study looked at the impact of NAFTA. In this study many of the aggregate industries had an elasticity of 1.50. Since import data for goods between states is almost impossible to obtain, we made some assumptions and used 1.50 for most industries and a slightly lower elasticity of 0.50 for a handful of less traded industries such as service industries.

While these elasticities are slightly higher than the literature on national trade, we believe that goods in a state are more price-sensitive to goods in the Rest of the World (including other states) than national goods. Therefore, we converted the elasticities to a domestic share elasticity for each industry using the following equation. ETAD = ETAM * IMPORT / (DOM. DEMAND * DOM. SUPPLY SHARE OF DOM. DEMAND). The estimates for this elasticity were taken from the literature.

[66] Kenneth.A. Reinert and Donald.W. Roland-Holst. "Armington Elasticities for United States Manufacturing Sectors," *Journal of Policy Modeling* 14, no.5 (1992): 631-639.
[67] Donald.W. Roland-Holst, Kenneth A. Reinert and Clinton.R. Shiells. "A General Equilibrium Analysis of North American Economic Integration," *Modeling Trade Policy: Applied General Equilibrium Assessments of North American Free Trade* (New York: Cambridge University Press, 1994): 47-82.

ETAE: Export elasticity with respect to domestic price for the sale producers' goods. Used in the export demand equation. The NAFTA study was also helpful with exports. We used an elasticity of 1.65 for industries which had an import elasticity of 1.50 and an export elasticity of 0.65 for those which had an import elasticity of 0.50.

SIGMA: Elasticity of substitution between capital and labor. Values in the literature range between 0.15 and 1.809 for industries with the majority close to 1, and we have used values of 0.90 for industries with substantial substitution and 0.8 in other cases (as shown in Table 8). This measurement is used to calculate RHO, which is the exponent in the production function. The equation is: RHO = (1- SIGMA)/SIGMA.

Table 9: Industry Elasticities

	ETAM	**ETAE**	**ETAY**	**ETAOP**	**SIGMA**
AGRICF	1.50	-1.65	1.00	-1.00	0.90
MINING	1.50	-1.65	1.00	-1.00	0.80
CONSTR	1.50	-1.65	1.00	-1.00	0.90
FOODPR	1.50	-1.65	1.00	-1.00	0.90
APPARL	1.50	-1.65	1.00	-1.00	0.90
MFRCON	1.50	-1.65	1.00	-1.00	0.80
PPAPER	1.50	-1.65	1.00	-1.00	0.80
CHEMIC	1.50	-1.65	1.00	-1.00	0.80
ELECTR	1.50	-1.65	1.00	-1.00	0.90
MVOTRA	1.50	-1.65	1.00	-1.00	0.90
METALS	1.50	-1.65	1.00	-1.00	0.80
MACHIN	1.50	-1.65	1.00	-1.00	0.80
INSTRU	1.50	-1.65	1.00	-1.00	0.90
MFROTH	1.50	-1.65	1.00	-1.00	0.90
TRANSP	1.50	-1.65	1.00	-1.00	0.90
COMMUN	1.50	-1.65	1.00	-1.00	0.90
UTILIT	1.50	-1.65	1.00	-1.00	0.80
WHOLSA	0.50	-0.65	1.00	-1.00	0.90
RETAIL	0.50	-0.65	1.00	-1.00	0.90
BANKNG	1.50	-1.65	1.00	-1.00	0.90
INSURS	1.50	-1.65	1.00	-1.00	0.90
REALST	1.50	-1.65	1.00	-1.00	0.90
REPSVC	1.50	-1.65	1.00	-1.00	0.80
BSVCES	1.50	-1.65	1.00	-1.00	0.80
ENTRHO	0.50	-0.65	1.00	-1.00	0.80
HEALTH	0.50	-0.65	1.00	-1.00	0.80
OTHSVC	0.50	-0.65	1.00	-1.00	0.80
USNOND	0	0	0	0	0
USDEFF	0	0	0	0	0

STGGSP	0	0	0	0	0
STEDUC	0	0	0	0	0
STHELT	0	0	0	0	0
STPBSF	0	0	0	0	0
STTRAN	0	0	0	0	0
STOTHS	0	0	0	0	0
LOEDUC	0	0	0	0	0
LOHELT	0	0	0	0	0
LOPBSF	0	0	0	0	0
LOTRAN	0	0	0	0	0
LOOTHS	0	0	0	0	0

The following elasticities are used in household-specific equations:

ETAPIT: Labor supply elasticity with respect to income taxes. This elasticity appears as an exponent in the labor supply equation. Measurements were based on estimates taken from the literature. The labor supply elasticities (ETARA) are widely divergent in the literature and suffer from a lack of disaggregation. They range from close to zero to 2.3 for net wages, with rather high positive values for women, particularly married woman. This means that the *tax* elasticities are negative. There is some evidence of greater (absolute) tax elasticities at higher income levels, which is why we assume a graduated scale from -0.15 for the lowest income category to -0.35 in the top category (see Table 9).[68]

ETATP: Household response to transfer payments. The transfer payment elasticities reflect a study by Robins (1985) on the effects of a negative income tax (NIT).[69] It is also a reflection of the observation that income received by upper income groups is on average largely unaffected by transfer payments.

ETAYD: Responsiveness of immigration to after tax income. Very little literature exists that ties migration to disposable income or unemployment. Studies by Bartik and Treyz et al. put the range of responses to a change in wage rates at between 0.835 and 2.39.[70] We used these as a basis for our after tax earnings elasticities. This elasticity appears in the population equation.

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[68] Note that ETAPIT = -ETARA (t/(1-t)), where t is the income tax rate.
[69] Philip K. Robins, "A Comparison of the Labor Supply Findings from the Four Negative Income Tax Experiments, *Journal of Human Resources*. 20, No. 4. (Autumn, 1985): 567-582.
[70] Timothy Bartik, *Who Benefits from State and Local Economic Development Policies?* (Kalamazoo, MI: W.E. Upjohn Institute, 1991). See also George I. Treyz; Dan S. Rickman; Gary L. Hunt; Michael J.

ETAU: Responsiveness of immigration to unemployment. We made some assumptions based on the responsiveness to employment elasticities in the literature.

ETAMH: Income elasticity of demand for imports by household. This elasticity appears in the household import equation.

Table 10: Household-Related Elasticities

	ETAPIT	ETATP	ETARA	ETAYD	ETAU	ETAMH
LESS10	-0.15	-0.05	0.17	1.30	-0.80	0.70
LESS25	-0.18	-0.05	0.17	1.50	-0.80	0.70
LESS50	-0.20	-0.04	0.20	1.60	-0.80	0.70
LESS75	-0.25	-0.04	0.30	1.80	-0.80	0.70
LES100	-0.25	-0.03	0.40	2.00	-0.80	0.70
LES150	-0.30	-0.03	0.50	2.10	-0.80	0.70
MOR150	-0.35	-0.02	0.50	2.30	-0.80	0.70

Definitions and Glossary

Summary of Set Names			
Sets	**Dimension**	**Math**	**GAMS**
Factors	2	$f \in F$	F
Governments – All	39	$g \in G$	G
Governments - Factor Taxes	6	$g \in GF$	GF
Governments - Per Household Taxes	8	$g \in GH$	GH
Governments - Income Taxes	2	$g \in GI$	GI
Governments - Capital Income Taxes	6	$g \in GK$	GK
Governments - Endogenous Spending	16	$g \in GN$	GN
Governments - Sales or Excise Taxes	11	$g \in GS$	GS
Governments - Endogenous Transfer Payments	1	$g \in GWN$	GWN
Governments - Exogenous Transfer Payments	4	$g \in GWX$	GWX
Governments - Exogenous Spending	6	$g \in GX$	GX
Households	7	$h \in H$	H
Industries	27	$i \in I$ or $j \in I$	I
All Social Accounting Matrix Accounts	77	$z \in Z$	Z

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Summary of Parameter Names			
Parameters	**Dimension**	**Math**	**GAMS**
Input Output Coefficients	77 x 77	-	A(Z,Z1)
Domestic Input Output Coefficients	27 x 27	α_{ij}	AD(Z,Z1)
Government Spending Shares of Net Income	39 x 39	α_{ig} ,α_{fg}	AG(Z,G)
Factor Share Exponents in Production Function	2 x 27	α_{fi}	ALPHA(F,I)
Initial Shares of Consumption	27 x 7	α_{ih}	ALPHA(I,H)
Deductibility of Taxes	3 x 3	$\alpha_{gg}{}^{t}$	ATAX(G,G1)
Income Elasticities of Demand	27 x 7	β_{ih}	BETA(I,H)
Capital Coefficient Matrix	27 x 27	β_{ij}	CCM(I,J)
Depreciation Rate	27	δ_{i}	DEPR(I)
Export Price Elasticities	27	$\eta_{i}{}^{e}$	ETAE(I)
Domestic Demand Elasticity	27	$\eta_{i}{}^{d}$	ETAD(I)
Investment Supply Elasticity	1	η_{i}	ETAI
L Supply Elasticity with respect to Average	7	$\eta_{h}{}^{ls}$	ETARA(H)
Labor Supply Elasticity with respect to TP's[71]	7	$\eta_{h}{}^{tp}$	ETATP(H)
Labor Supply Elasticity with respect to Taxes	7	$\eta_{h}{}^{PIT}$	ETAPIT(H)
Responsiveness of In-Migration to	7	$\eta_{h}{}^{u}$	ETAU(H)
Responsiveness of In-Migration to Disp.	7	$\eta_{h}{}^{yd}$	ETAYD(H)
Production Function Scale	27	γ_{i}	GAMMA(I)
Types of Inter-Government Transfers	39 x 39	-	IGTD(G,G1)
Correction Factor between Households and	1	ε	JOBCOR
Price Elasticities of Demand	27 x 27	$\lambda_{ii'}$	LAMBDA(I,J)
Miscellaneous Industry Parameters	27 x 10	-	MISC(Z,*)
Income Tax Table Data in Input File	7 x 8	-	MISCG(G,H,*)
Miscellaneous Household Parameters	7 x 8	-	MISCH(H,*)
Natural Rate of Population Growth	7	π_{h}	NRPG(H)
Substitution Exponent in Production Function	27	ρ_{i}	RHO(I)
Social Accounting Matrix	77 x 77	σ [illegible]	SAM(Z,Z1)
Consumption Sales and Excise Tax Rates	9 x 27	$\tau_{gi}{}^{c}$	TAUC(G,I)
Factor Tax Rates	5 x 2 x 77	τ_{gfz}	TAUF(G,F,Z)
Factor Taxes applied to Factors	5 x 2	-	TAUFF(GF,G)
Employee Portion of Factor Taxes	5 x 2	τ_{gf}	TAUFH(G,F)
Experimental Factor Tax Rates	5 x 2 x 77	$\tau_{gfz}{}^{x}$	TAUFX(G,F,Z)
Government Sales and Excise Tax Rates	9 x 27	$\tau_{gi}{}^{g}$	TAUG(G,I)
Household Taxes other than PIT	1 x 7	τ_{gh}	TAUH(G,H)
Investment Sales and Excise Tax Rates	9 x 27	$\tau_{gi}{}^{n}$	TAUN(G,I)
Sales and Excise Tax Rates	9 x 27	$\tau_{gi}{}^{q}$	TAUQ(G,I)
Intermediate Good Sales and Excise Tax Rates	9 x 27	$\tau_{gi}{}^{v}$	TAUV(G,I)
Tax Bracket Base Amount	2 x 7	$\tau_{gh}{}^{b}$	TAXBASE(G,H)
Tax Bracket Minimum Taxable Earnings	2 x 7	$\tau_{gh}{}^{d}$	TAXBM(G,H)
Tax Constant to Correct Calculated to	2 x 7	$\tau_{gh}{}^{c}$	TAXCVC(G,H)
Tax Deduction other than Standard and other	2 x 7	$\tau_{gh}{}^{o}$	TAXOD(G,H)
Percentage Itemizing	2 x 7	$\tau_{gh}{}^{i}$	TAXPI(G,H)
Tax Destination Shares	39 x 39	$\mu_{gg'}$	TAXS(G,G1)
Tax Deduction for Standard Deductions	2 x 7	$\tau_{gh}{}^{s}$	TAXSD(G,H)
Percent of Households Receiving TP’s	7 x 6	$\tau_{hg}{}^{pc}$	TPC(H,G)

[71] TP is abbreviation for transfer payments.

Summary of Parameter Names			
Variables	**Dimension**	**Math**	**GAMS**
Public Consumption	27 x 39	c_{ig}	CG(I,G)
Private Consumption	27 x 7	c_{ih}	CH(I,H)
Gross Investment by Sector of Source	27	c_{in}	CN(I)
Consumer Price Index	7	p_h	CPI(H)
Exports	27	e_i	CX(I)
Domestic Share of Domestic Consumption	27	d_i	D(I)
Domestic Demand	27	x_i	DD(I)
Domestic Supply	27	q_i	DS(I)
Sectoral Factor Demand	2 x 77	u_{fi}^d, u_{fg}^d	FD(F,Z)
Number of Households	7	a_h	HH(H)
Number of Non-Working Households	7	a_h^n	HN(H)
Number of Working Households	7	a_h^w	HW(H)
Household Out-Migration	7	a_h^o	MO(H)
Household In-Migration	7	a_h^i	MI(H)
Inter-Governmental Transfers	37 x 37	$B_{gg'}$	IGT(G,G1)
Capital Stock	27	u_{Ki}^s	KS(I)
Imports	27	m_i	M(I)
Gross Investment by Sector of Destination	27	n_i	N(I)
Net Capital Inflow	1	Z	NKI
Aggregate Price	27	p_i	P(I)
Aggregate Price including Sales/Excise Taxes	27	p_i^c	PC(I)
Domestic Producer Price	27	p_i^d	PD(I)
Per Household Personal Income Taxes	2 x 7	t_{gh}	PIT(G,H)
Producer Price Index	1	P	PPI
Value Added Price	27	p_i^{va}	PVA(I)
World Price (Rest of US and Rest of World)	27	p_i^w	PW(I)
Sectoral Factor Rental Rates	2 x 27	r_{fi}, r_{fg}	R(F,I)
Economy Wide Scalar for Factor Rental Rates	2	r_f^a	RA(F)
Government Savings	39	s_g	S(G)
Private Savings	7	s_h	S(H)
State Personal Income	1	Q	SPI
Transfer Payments	7 x 39	w_{hg}	TP(H,G)
Intermediate Goods	27	v_i	V(I)
Factor Income	2	y_f	Y(F)
Government Income	39	y_g	Y(G)
Household Income	7	y_h	Y(H)
Household after Tax Income including TP's	7	Y_h^d	YD(H)

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The Beacon Hill Institute at Suffolk University in Boston focuses on federal, state and local economic policies as they affect citizens and businesses. The institute conducts research and educational programs to provide timely, concise and readable analyses that help voters, policymakers and opinion leaders understand today's leading public policy issues.

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