Tax Changes In Very Different Economies

Jeffrey Condon

Follow this and additional works at: http://scholarworks.gsu.edu/econ_diss

Recommended Citation
http://scholarworks.gsu.edu/econ_diss/103

This Dissertation is brought to you for free and open access by the Department of Economics at ScholarWorks @ Georgia State University. It has been accepted for inclusion in Economics Dissertations by an authorized administrator of ScholarWorks @ Georgia State University. For more information, please contact scholarworks@gsu.edu.
ABSTRACT

TAX CHANGES IN VERY DIFFERENT ECONOMIES

By

JEFFREY THOMAS CONDON

August 2014

Committee Chair: Dr. Andrew Feltenstein

Major Department: Economics

Despite the prevalence of computable general equilibrium (CGE) models applied to tax changes of varying types, little work has been done focusing on state level comprehensive tax reform or on tax reform in countries undergoing a regime change. This research develops and applies methodologies for analyzing fiscal policy changes under these two very different economic scenarios. The findings for each application are relevant to policy makers as they weigh the effects of tax reform. The models developed for the two scenarios offer guidance to future modelers in studying similar economies and the contrast of the two provides a framework for thinking about model design and application. Finally, the results, when compared to each other, allow us to see the relative effectiveness of the two tax reform policies given their very different economies.

A method for extending Lofgren’s 2002 standard CGE model for developing countries is developed to analyze state personal and corporate income taxes, sales taxes, and taxes on intermediate goods. This extension is then used to study comprehensive state level tax reform in Georgia. The model is run in GAMS using 2010 IMPLAN data with industries aggregated
specifically for the tax reforms. The tax reforms analyzed include and shift from the income tax to the sales tax as considered by the Georgia legislature in 2011 as well as an extension of that policy which totally replaces the income tax with a sales tax. Results are reported for short and long run effects on gross state product, consumer income and equivalent variation, industrial output, and the state’s budget.

A model containing tax evasion and tax avoidance behavior is developed and applied to Egypt in which the economic effects of the regime change are simulated within the duration of the dynamic model. The model is run using 2008 data from the Egyptian Central Bank and includes an exogenous shift in foreign demand for Egyptian exports to simulate the effects of the regime change. Results are presented for the growth paths and end states for consumer income and welfare, gross domestic product, inflation, and tax evasion.
TAX CHANGES IN VERY DIFFERENT ECONOMIES

BY

JEFFREY THOMAS CONDON

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy in the
Andrew Young School of Policy Studies of
Georgia State University
ACCEPTANCE

This dissertation was prepared under the direction of the candidate’s Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

Dissertation Chair: Dr. Andrew Feltenstein

Committee:
- Dr. Sally Wallace
- Dr. Jorge Martinez-Vazquez
- Dr. Florenz Plassmann

Electronic Version Approved By:

Dr. Mary Beth Walker, Dean
Andrew Young School of Policy Studies
Georgia State University
August 2014
DEDICATION

This dissertation is dedicated to my wife who deserves this dedication more than anyone, my family who have been supportive my entire life, and my friends who threatened to call me ‘Doctor’ whether I finished this or not. It is also dedicated to everyone who, while watching a race, yells “Looking good…. Keep it up…. You can do it!” rather than “Is everything ok? Why are you taking so long? When are you going to finish?”
ACKNOWLEDGMENTS

I would like to thank my dissertation committee members and readers, Sally Wallace, Jorge Martinez-Vazquez, Florenz Plassmann, Mark Rider, Dave Sjoquist, and Felix Rioja for their advice and patience. I would like to thank Melissa Rockwood for her hard work proof reading. I would like to thank Nour Abdul-Razzak for her early work on Egyptian tax evasion. I would like to thank my late colleague and friend Manal Metwaly for her hard work gathering data in the middle of a revolution and for being such a gracious host. I would like to thank Georgia State’s International Center for Public Policy, the director Jorge Martinez-Vazquez, and the entire staff for generously providing funds and logistical support for trips to Kenya and Egypt. I would like to thank the Andrew Young School for funding my studies. I would like to thank all of the professors who have taught me something during these fascinating years. Finally, I would like to thank my advisor Andrew Feltenstein for encouraging me when I struggled, pointing me in the right direction when I got confused, always having an open door, and for showing me the pyramids.
# TABLE OF CONTENTS

**CHAPTER ONE: COMPARISON OF METHODOLOGIES** ................................................................. 1

I. INTRODUCTION.......................................................................................................................... 1

II. CONTRASTING MODEL DESIGNS.......................................................................................... 3

   A. Fiscal and Monetary Policy Control....................................................................................... 5
   B. Trade.................................................................................................................................... 6
   C. Economic Stability .............................................................................................................. 8
   D. Closure Rules .................................................................................................................... 10

III. EMPIRICAL LITERATURE ...................................................................................................... 13

   A. State Level Literature ........................................................................................................ 13
   B. Event Literature ................................................................................................................. 16

**CHAPTER TWO: THE EFFECTS OF TAX REFORM IN GEORGIA.** ............................................. 19

I. INTRODUCTION.......................................................................................................................... 19

II. GEORGIA’S TAX STRUCTURE AND REFORMS ................................................................... 20

III. SOCIAL ACCOUNTING MATRIX ............................................................................................. 21

IV. GENERAL EQUILIBRIUM SPECIFICATION ......................................................................... 23

   A. Consumption ..................................................................................................................... 24
   B. Production ........................................................................................................................ 26
   C. Taxes .................................................................................................................................. 31
   D. Trade .................................................................................................................................. 36

V. CALIBRATION............................................................................................................................ 37
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Tax Revenue</td>
<td>37</td>
</tr>
<tr>
<td>B. Parameters</td>
<td>38</td>
</tr>
<tr>
<td>VI. SPECIAL COUNCIL SIMULATIONS</td>
<td>39</td>
</tr>
<tr>
<td>VII. SPECIAL COUNCIL SIMULATION RESULTS</td>
<td>43</td>
</tr>
<tr>
<td>A. State Results</td>
<td>43</td>
</tr>
<tr>
<td>B. Household Results</td>
<td>45</td>
</tr>
<tr>
<td>C. Industry Results</td>
<td>47</td>
</tr>
<tr>
<td>VIII. INCOME TAX ELIMINATION SIMULATIONS</td>
<td>50</td>
</tr>
<tr>
<td>IX. INCOME TAX ELIMINATION RESULTS</td>
<td>53</td>
</tr>
<tr>
<td>A. State Results</td>
<td>53</td>
</tr>
<tr>
<td>B. Household Results</td>
<td>55</td>
</tr>
<tr>
<td>C. Industry Results</td>
<td>59</td>
</tr>
<tr>
<td>X. CONCLUSIONS</td>
<td>62</td>
</tr>
<tr>
<td>CHAPTER THREE: A SIMULATED FUTURE OF EGYPT</td>
<td>65</td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>65</td>
</tr>
<tr>
<td>II. EGYPT BEFORE AND AFTER THE REVOLUTION</td>
<td>66</td>
</tr>
<tr>
<td>III. EGYPTIAN TAX EVASION AND INFORMAL SECTOR</td>
<td>71</td>
</tr>
<tr>
<td>A. Tax Evasion</td>
<td>71</td>
</tr>
<tr>
<td>B. Egyptian Informal Sector</td>
<td>74</td>
</tr>
<tr>
<td>IV. GENERAL EQUILIBRIUM SPECIFICATION</td>
<td>76</td>
</tr>
<tr>
<td>A. Dynamics</td>
<td>77</td>
</tr>
<tr>
<td>B. Production</td>
<td>77</td>
</tr>
</tbody>
</table>
LIST OF TABLES

TABLE 1 – AGGREGATED INDUSTRY LABELING KEY ........................................................................................................ 26
TABLE 2 – DATA EXTRACT AND BUDGET COMPARISON .............................................................................................. 37
TABLE 3 – PARAMETER VALUES .................................................................................................................................. 38
TABLE 4 – HOUSEHOLD TAX RATES AND INCOME PER CAPITA .................................................................................. 41
TABLE 5 – BASELINE AND SIMULATED STATE GDP ......................................................................................................... 44
TABLE 6 – BASELINE AND SIMULATION TAX REVENUE BY SOURCE ...................................................................................... 45
TABLE 7 – BASELINE AND SIMULATION UTILITY BY HOUSEHOLD ..................................................................................... 46
TABLE 8 – EQUIVALENT VARIATION BY HOUSEHOLD SOURCE .......................................................................................... 46
TABLE 9 – AGGREGATED INDUSTRY LABELING KEY ........................................................................................................ 47
TABLE 10 – OUTPUT BY COMMODITY .......................................................................................................................... 49
TABLE 11 – OUTPUT BY ACTIVITY .................................................................................................................................. 49
TABLE 12 – SALES TAX REVENUE BY TREATMENT ............................................................................................................. 51
TABLE 13 – BASELINE AND SIMULATED STATE GDP ......................................................................................................... 53
TABLE 14 – BASELINE AND SIMULATION TAX REVENUE BY SOURCE ...................................................................................... 54
TABLE 15 – BASELINE AND SIMULATION UTILITY BY HOUSEHOLD ..................................................................................... 56
TABLE 16 – EQUIVALENT VARIATION BY HOUSEHOLD ........................................................................................................ 57
TABLE 17 – AGGREGATED INDUSTRY LABELING KEY ........................................................................................................ 59
TABLE 18 – OUTPUT BY COMMODITY .......................................................................................................................... 60
TABLE 19 – OUTPUT BY ACTIVITY .................................................................................................................................. 61
TABLE 20 – AVERAGE PRIVATE SECTOR GROWTH RATE OF COMMODITIES AND ACTIVITIES ........................................ 62
LIST OF EQUATIONS AND FIGURES

EQ 1 – HOUSEHOLD CONSUMPTION OF MARKET COMMODITIES .......................................................... 25
EQ 2 – VALUED ADDED .......................................................................................................................... 27
EQ 3 – INTERMEDIATE INPUTS .............................................................................................................. 27
EQ 4 – CES FUNCTION .......................................................................................................................... 28
EQ 5 – MARKETABLE COMMODITIES PRODUCED BY ACTIVITY ....................................................... 29
EQ 6 – DOMESTIC COMMODITY OUTPUT AGGREGATION FUNCTION ...................................................... 29
EQ 7 – FIRST-ORDER CONDITION OF DOMESTIC COMMODITY AGGREGATION FUNCTION .................. 30
EQ 8 – HOUSEHOLD DIRECT TAX RATE ............................................................................................. 32
EQ 9 – TAX RATE ON CAPITAL .............................................................................................................. 33
EQ 10 – HOUSEHOLD CONSUMPTION OF MARKET COMMODITIES .................................................... 34
EQ 11 – INTERMEDIATE USE OF COMMODITY BY ACTIVITY .................................................................. 35
EQ 12 – TRADE CALCULATION FOR CURRENT ACCOUNT BALANCE ..................................................... 36
EQ 13 – HOUSEHOLD DIRECT TAX RATE ............................................................................................. 40
EQ 14 – VALUE ADDED .......................................................................................................................... 78
EQ 15 – COST OF BORROWING AND PRESENT VALUE OF RETURN TO NEW CAPITAL EQUALITY .................. 79
EQ 16 – INTEREST RATE .......................................................................................................................... 80
EQ 17 – PRESENT VALUE OF RETURN TO NEW CAPITAL INEQUALITY ................................................... 80
EQ 18 – PRESENT VALUE OF RETURN TO NEW CAPITAL INEQUALITY ................................................... 80
EQ 19 – TAX RATE OF THE FIRM ........................................................................................................... 81
EQ 20 – REAL VALUE OF CAPITAL ......................................................................................................... 82
EQ 21 – DEMONSTRABLE VALUE OF CAPITAL ...................................................................................... 83
CHAPTER ONE: COMPARISON OF METHODOLOGIES

I. INTRODUCTION

Since the advent of Computable General Equilibrium (CGE), the models have been modified and adapted to study numerous alternative policy treatments. In addition to the expanded capabilities of the models themselves, there has been a dramatic increase in the amount of resources given to the collection of data required for these models. With increasingly detailed datasets and new and interesting applications created each year, there are many opportunities for previously unexplored policy analyses. This dissertation considers the use of CGE models to analyze fiscal policy changes in two regions with very different economies.

Focusing on fiscal policy, we have a wide spectrum of regional or policy applications available to us. Taxation and government expenditure analyses using CGE have been conducted across the globe for years. In each case, the model’s general design must be modified according to the level of regional fiscal control, monetary control, and trading partners, calibrated to the state of the economy, and must take into account any exogenous factors that are essential to the model. In this research, we look at two extreme ends of the spectrum: the state of Georgia within the United States of American (USA) and the nation of Egypt.

These two economies present an interesting contrast of CGE application as they are so drastically different in a few interesting ways. Georgia operates within the USA’s currency while
Egypt, as a sovereign nation, controls its monetary policy. The USA--and as a result Georgia--has free trade within the nation and federal control of its policies regarding trade are above Georgia’s level of control, while Egypt has unilateral control of its trade policy. Georgia’s tax structure represents a relatively modest portion of the total fiscal picture, as federal and local taxes are not under its control, while Egypt is a single fiscal zone. Georgia’s economy is stable within the business cycle, while Egypt has suffered the consequences of a political revolution and regime change with dramatic impacts on its trade, currency, and largest industries.

The purpose of this research is to explore the application of CGE methodology in fiscal policy analysis as applied to the subtle changes resulting from modest revenue neutral changes of a currency within a region and a free trade zone, and then compare that approach to a model that assumes a large exogenous change to a country. This chapter will look at the contrasting specifications required in the Georgia and Egypt models. Because we are focusing on fiscal policy in a CGE framework, this chapter will begin by comparing and contrasting the complexities of CGE modeling in these two different economies. Chapter Two of this dissertation will present a subnational model of tax reform for the state of Georgia. Chapter Three will present a national model for Egypt, evaluating alternative fiscal policies to address the exogenous effects of the revolution. Chapter Four contains conclusions.
II. CONTRASTING MODEL DESIGNS

Chapters Two and Three detail each model’s specifications and the methodology used for evaluating the treatments. They also present background information about the status of the economies and supporting empirical literature for similar models. Before presenting the methodology in its entirety we address the two models generally, to note important differences in what is required in each case, and provide some useful background.

The Georgia analysis is a static simulation of a tax reform package for which the defining characteristic is a decrease in the income tax, with a corresponding expansion of the sales tax to previously untaxed sectors, thus maintaining revenue neutrality. In Georgia, the purpose of the analysis is to predict the effects of the policy on welfare and output. In Egypt, the analysis is sequentially dynamic, incorporating an informal sector, with an exogenous shift of foreign demand to simulate the political revolution, and the treatment is a hypothetical fiscal policy response. The purpose of the Egyptian analysis is not to predict the future state of the Egyptian economy or of the Egyptian people, but rather to compare the relative effects of alternative policies in the extreme conditions of the post-revolution economy.

In any model, the designer must consider the relevant policy levers available to policy makers, the important economic indicators used for policy evaluation, as well as the direct effects of any exogenous changes in the model. Regarding policy levers in Georgia, we first consider the initial tax structure and proposed reforms. The initial tax structure varies from the reformed tax structure only with regard to the rates and their application in untaxed sectors, so this implementation is limited only by the availability of industry and household data.
Furthermore, Georgia does not have control of its trade or monetary policy, so those policy levers are not of interest in this instance. Regarding Egypt, the nation has complete control of its fiscal, monetary, and trade policies, as long as its trading partners and lenders are modeled realistically so as to avoid corner solutions. In Egypt’s case, we will have to pay close attention to each decision, allowing the model to simulate the widest array of fiscal policy changes and monetary shifts, as well as consequences of the revolution.

In Georgia, we are interested in the economic indicators affected by tax reform. Thus, we maintain endogeneity for variables of interest such as household utility, industry output, gross domestic output of the state, and prices. To keep to a square system of equations, some conditions must be imposed on any model. In Georgia, for example, we maintain a balanced budget so that government expenditures are allocated according to the previously observed shares of the budget and exactly equal to the tax revenue generated by the model. In Egypt, we are interested in macroeconomic indicators for purposes of policy evaluation, but we also consider which variables are exogenously shifted to simulate the revolution. In this case we look at indicators such as the budget deficit, currency flows, GDP, household utility, and prices. We will look at endogenous macroeconomic variables after we exogenously adjust taxes. We also can maintain control of variables hit hardest by the revolution, including foreign demand for Egyptian exports such as tourism, or foreign direct investment, or the interest rate on government debt.
A. Fiscal and Monetary Policy Control

CGE models are powerful tools for analyzing policy changes under the weakest *ceteris paribus* conditions. However, when designing the model, we must isolate the policy instruments available to policy makers according to their level of control. Generally, we can separate these into three different classifications: control of both fiscal and monetary policy; control only of fiscal policy; and control only of monetary policy. All countries with their own currency fall into the first category where they control both fiscal and monetary policy. Subnational regions that wield fiscal authority have control of their regional fiscal policy, with some constraints, but do not have control of their monetary policy. Examples include states or cities within the United States, or countries within the Economic and Monetary Union of Europe, or countries that have dollarized, such as Panama. The final of the three categories applies only to the European Monetary Union, as it has control of monetary policy for its region, but no direct control of the fiscal policy of its members. The structure of the CGE model varies greatly depending on the level of fiscal and monetary control.

For regions with control of their monetary policy, the model’s design must align with the currency policy of the region. For countries with a floating exchange rate, we allow relative values of currency to adjust endogenously, so that we can monitor the effects on the currency in the simulation. For countries with a fixed exchange rate, we can hold constant the relative values of currency, and see the effects on reserves in the central banks. In the case of Egypt, where the exchange rate floats within a narrow range, we have chosen to maintain a fixed exchange rate so that we can control it both before and after the regime change. Had the
exchange rate encountered drastic swings during the revolution, adjustment of this variable would have been possible. Regardless, this approach allows us to allocate foreign aid to simulate the Egyptian Central Bank’s defense of the currency.

Within the USA, and in the state of Georgia, we maintain the same currency for all goods by allowing borrowing and savings between states to adjust and account for terms of trade between the states. This procedure essentially gives us a fixed exchange rate between Georgia and the rest of the USA. A similar procedure is done regarding the borrowing and savings from the foreign sector as the effect of the revenue neutral tax change in Georgia has a negligible effect on the value of the US dollar.

Regarding tax changes, Egypt is the simpler of the two as it is a single fiscal zone. Changes within the Egyptian model are simply introduced for the country and applied using constraints. Georgia, however, requires separation of the federal and local taxes in the social accounting matrix (SAM), so that state level tax changes are not applied to federal or local tax codes. This is a straightforward procedure that is considered when the structure of the SAM is established.

B. Trade

Computable general equilibrium (CGE) models are frequently used for analysis of unilateral trade reforms, multilateral tariff and quota reforms, and regional free trade agreements. CGE models are capable of identifying the subsets of each regional economy that
will be helped or hurt by trade reform. As with production technology and consumption preferences, trade data is retrieved from the social accounting matrix (SAM). Trade specific models, depending on the structure, require trading partner specific data on import and export tariffs and quotas, freight-on-board prices, transportation costs, and economic distance. When regional SAM data is denominated in different currencies, nominal exchange rates are required. This nominal rate is used to calculate the real exchange rate, which is the ratio of the prices of traded goods to non-traded goods. The nominal rate can be flexible, fixed, or stochastic, depending upon the context. In models that incorporate trade but for which trade is not the primary point of interest, the nominal exchange rate is flexible and allowed to fluctuate to permit for a fixed current account balance. This closure rule, an exogenous current account and endogenous nominal exchange rate, applies to most countries, but this too can be adjusted depending upon the context.

An additional factor to consider when looking at trade is the relative importance of the trading regions. If a region is of insufficient size to impact global prices, modelers usually allow world prices to remain fixed regardless of changes in the small country. However, if trade is modeled using an Armington import function, each country is a monopoly provider of its goods. If Armington elasticities are set incorrectly, unrealistically large swings in prices and exchange rates can occur regardless of the size of the country. Furthermore, if the substitutability of goods is parameterized incorrectly, these price swings can generate unrealistic production or consumption decisions.

In our Georgia model, we allow the state of Georgia to be the monopoly provider of differentiated goods and services to its trading partners: the rest of the United States (RUS) and
the rest of the world (ROW). For both the RUS and the ROW, we maintain a stable currency and allow foreign savings and investment and the current account to fluctuate. This is appropriate in Georgia, as the fluctuations have a negligible effect. Its largest trading partner is the RUS, which uses the dollar, and that dollar is nearly unaltered by the new flow of goods and services in response to the tax change in Georgia.

In Egypt, we model a single trading partner—the ROW—in a simple export equation in which aggregate demand for exports is determined by domestic and foreign price indices as well as world income. Thus, the combination of the export equation and domestic supply responses determines aggregate exports. Demand for imports is endogenous and is derived from the domestic consumers' maximization problems. Foreign lending is assumed to be exogenous. Thus, gross capital inflows are exogenous, but the overall change in reserves is endogenous with a fixed exchange rate.

C. Economic Stability

We say the economy is stable when there are no fundamental changes in the nature of the economy during the time period covered by the calibration and simulations. Descriptions of the Georgian and Egyptian economies as well as the calibration and simulation of the models are explained in detail in Chapters Two and Three. For now, suffice it to say that the fundamental structure of the economy as represented by Georgia’s SAM is unchanged for the duration of the simulation, while Egypt’s SAM is fundamentally altered within the model’s duration by the regime change.
In the case of the stable Georgia economy, we are interested in the effects of the tax change, so that change in Georgia is the cause of the effects we are interested in studying. Thus, we calibrate the model of Georgia to the pre-change equilibrium, institute the change, and then look at the differences. This is the most common application of CGE models.

In Egypt, the revolution is a known confounding change we must account for in the calibration. In this situation, we calibrate our model using a pre-revolution SAM so that it simulates the pre-revolution economy. Without an exogenous intervention, the model would simply simulate the economy as it would have existed in the absence of the revolution. To avoid this, we use a sequentially dynamic model calibrated to the economy as it existed when the SAM was established, and then adjust exogenous variables to simulate the macroeconomic effects of the regime change. This calibration is considerably more difficult than the case of Georgia, as we are calibrating the model, first to the economy that spawned the SAM, but then again to a similar yet new post-revolution economy. Finally, with a fully calibrated model, we then simulate treatments for comparison.

Another alternative is available and is used by modelers who do not know the stability of the economy with certainty. A modeler may allow for stochastic changes to parameters. This application of CGE models, first used by Kydland and Prescott, is called dynamic stochastic general equilibrium (DSGE) modeling (1982). In a DSGE, the modeler addresses the Lucas critique by allowing some parameters such as technology, prices, preferences, or government policies to adjust randomly (1976). This approach can incorporate more sophisticated assumptions about the rationality of institutions. For example, a consumer’s consumption and savings decisions in the present depend upon his/her rational expectations about the real
interest rate, and that real interest rate is heavily affected by the stochastically determined future nominal interest rate. In this example, we see the relationship between the expectations of the consumer, the volatility of interest rates, and economic performance. This inclusion of expectations has led many central banks to use DSGE models to study monetary policy. Another feature of this approach is that it can incorporate stickiness in parameter adjustments. For example, one might use a DSGE model to study the different effects of volatile inflation on industries whose prices vary with respect to their flexibility or stickiness.

D. Closure Rules

Closure rules refer to the modeler’s decisions about which variables are endogenous and which variables are exogenous. This is necessary to maintain a square system in which the number of unknowns does not exceed the number of equations thus allowing for mathematical techniques to solve the system of equations. Closure rules are generally divided into two categories: micro and macro. Micro closure rules refer to the mechanisms by which individual markets adjust to reach equilibrium. Sen (1963) notes that the system of equations is over-determined if we impose the following: fixed investment, consumption is determined by income; prices equal their marginal product; and factor supply equals factor demand. To avoid the over-determined system, we must make some assumptions about the mechanisms. To illustrate micro closure rules, it is useful to look at a single market. In the labor market, for example, two common closure rules are neoclassical and Keynesian. Under a neoclassical
closure rule, labor supply is the exogenous variable, while the endogenous wage variable adjusts until supply and demand equal. Under the Keynesian closure rule, the (sticky) wage is the exogenous variable, and the endogenous labor supply variable adjusts until supply and demand equal. In this example, it is easy to see that the choice of closure rule can have a significant effect on the results of the model. There are other configurations of labor market closure rules such as Kaldorian, which allows the wage rate to deviate from the marginal product of labor, and Johansen, which adjusts residual consumption to obtain labor market equilibrium. One should choose the closure rule based on the economy and the market structures being modeled because each of these may alter the resulting equilibrium depending upon regional and sectoral factor mobility, the relationship between savings and investment, or other factor market traits (Dewatripont and Michel, 1987).

In addition to the micro closure rules of the factor markets, a modeler must choose macro closure rules. Macro closure rules refer to the savings-investment balance, the government budget balance, and the trade balance. In each case a modeler must assign exogeneity or endogeneity. For example, investments are either endogenous and savings driven or savings can accommodate an exogenously fixed level of investments. Models frequently have balanced budget conditions on government so that expenditure equals revenue, but an alternative to that approach allows for the government to access capital markets to cover a deficit. Yet another way to approach the government balance is to allow some tax instrument to adjust endogenously to maintain an exogenous government budget. Regarding trade closure in a multiregional model, the trading partners each have their own SAM, so their behavior is modeled with their own micro closure rules. In a model with a single
region we use that region’s SAM with import and export flows to complete the model. In either case, one must accommodate for changes in the relative value of currencies and foreign savings such that one adjusts to clear the current account of the balance of payments. This is frequently done with the ROW reacting to the regions with SAMs to borrow or loan, consume or provide, and appreciate or depreciate as needed to close the model. There is no ‘correct’ closure rule: a structuralist may use Keynesian rules, while a neoclassical economist may use a price-adjusting closure rule. The choice is up to the modeler’s judgment as to what most accurately represents the economy (see Robinson and Lofgren, 2005).

In Georgia we vary the closure rules to simulate the effects of the policy change depending upon the treatment of factors. This approach allows us to use a static model to draw conclusions about the long run and the short run. We vary labor market and capital market closures by adjusting the supply of either factor and the specificity of capital. In the variation simulating the shortest run, we set capital to be activity specific with a fixed supply, and set a fixed supply of labor. In the short run simulation, the supply of both factors remains fixed, but capital is mobile. In the long run simulation, both capital and labor are mobile and the supply of each is variable. Regarding macro closures, we let the government expenditure equal government revenue with an exogenous tax structure, investment adjusts to accommodate savings, and both the RUS and ROW savings adjust to accommodate a fixed exchange rate. The first macro closure is crucial as it allows us to control the tax rates. The remaining two rules have little impact on the simulation results, as the effect of the policy change on these variables is minimal.
In the Egyptian model, capital is sector specific while labor is mobile between sectors and thus the supply is variable. The supply of sector capital in period two is determined by sector savings in period one. This calculation of the endogenous savings variable is explained in Chapter Three. Egypt’s government may run a deficit which is financed through monetary expansion or borrowing. The ROW is modeled as a single trading partner whose consumption of Egyptian goods adjusts to accommodate domestic supply and whose supply of foreign goods to Egypt adjusts to accommodate domestic consumption. The balance of payments is kept through adjustments to the endogenous central bank reserves.

III. EMPIRICAL LITERATURE

A. State Level Literature

For the first time, both state level data and software capable of computing the numerical solutions of CGE models were widely available in the late 1980s. IMPLAN, a private data provider, began publishing I-O matrices in 1988, and General Algebraic Modeling Software (GAMS) made programming and solving these problems possible outside of the base programming languages such as Fortran or COBAL. This led to early models of Oklahoma (Koh, 1991), Southern California (Robinson, Subramanian, and Geoghegan, 1993), and Ohio (Kraybill and Pai, 1995). Koh’s model looked at the Oklahoma’s ‘boom and bust’ cycle from 1977 to 1986. Robinson, Subramanian, and Geoghegan looked at air pollution in the LA basin. Kraybill
and Pai developed the model to look at infrastructure, but their two-factor model served as a platform for follow-up papers on tax incentives and public goods (see Seung and Kraybill, 1999, 2001). Another early model is the Oklahoma model by Vargas, Eliecer, and Schreiner (1999) which treats the factor market for wood as a monopsony. This extensively documented model has been used in numerous follow-up papers on such topics as oligopsonies and sport fishing.

In 2002, Lofgren, Harris, and Robinson, through the International Food Policy Research Institute (IFPRI), published a standard model along with a detailed model description and its accompanying code in GAMS. Lofgren also developed a series of CGE exercises in GAMS to familiarize new modelers with GAMS. As a result of Lofgren’s extensive documentation and GAMS coding exercises, numerous researchers use this as a base. The IFPRI model has been modified and used for hundreds of CGE applications. For example, the IFPRI model was adapted for regional modeling by Holland, Stodick, and Devadoss and applied to the economic effects of Mad Cow Disease in Washington (2004). In this iteration, the code modifications and additional details regarding the new model design were published for others to build on. This process of modifying the existing model for other purposes and publishing the documentation continues today (See Watson et al., 2012). The Lofgren model, while the most popular, is not unique. Similar detailed documentation and code is available for more than 40 different models within GAMS alone. The wide distribution of so many resources has made CGE models significantly more accessible for researchers. The result is that their use has spread, and today it is used to model almost anything that can be modeled, from fisheries in Alaska (Seung and Waters, 2010) to the economic impacts of forest bioenergy in Florida (Huang et al., 2012).
Despite their increased use for various academic purposes, academics represent a small portion of the state analysis that takes place when proposed policies are being evaluated.

Berck, Golan, and Smith (1996) built the California Dynamic Revenue Analysis Model (DRAM) to fulfill the state government’s requirement that all tax changes be dynamically scored. The model ran three hypothetical scenarios, found relatively modest deviations from static methods, was defunded in 2000 without having simulated any real policies, and is now used by California’s Air Resource Board to study the environment (Vasche, 2006). Massachusetts also developed a sophisticated model in cooperation with REMI, a private company. REMI operates it today and has numerous states and cities as clients. IMPLAN, the provider of the I-O matrices in every state-level paper mentioned above, does policy evaluation for every level of regional aggregation down to the single county. These private firms conduct a significant share of the modeling for which there is funding available.

Despite their small market share, academics continue to apply CGE models to study state tax issues. Morgan, Mutti, and Partridge (1989) studied the long-run impact of local, state, and federal taxes on factor allocation. They found that unilateral removal of distorting taxes led to higher growth in the region and inflows of capital and labor. Waters, Holland, and Weber (1997) examined the impact of Oregon’s “Measure 5,” a property tax limit passed in 1990. They find that output and income increased after the limitation was passed, and high income households benefited more than low income households while state and local government

---

1 To illustrate the repeated modifications to existing models: the Waters, Holland, and Weber model was built using some early GAMS code by Krybill and Pai. The Julia-Wise, Cooke, and Holland model was built using the Waters, Holland, and Weber model’s treatment of the property tax. The Faulk, Thaiprasert, and Hicks model was built using the Holland, Stodick, and Devadoss model.
expenditures and revenues decreased substantially. Julia-Wise, Cooke, and Holland also looked at property taxes by modeling a 50% cut to property taxes in Idaho (2002). Their study found that $2 of tax revenue would be lost for every $3 of property tax reduction, with a significantly regressive distribution of the benefits. Edmiston (2002) used a CGE model to simulate the strategic apportionment of state corporate income taxes. She finds that the first mover has significant budgetary gains by strategic apportionment, but after neighboring states respond, the effects are diminished. However, the economic development gains remain. Dakhlia and Strauss (2003) looked at sales and use taxes in e-commerce between Washington and Oregon. They find the classic beggar-thy-neighbor results. Faulk, Thaiprasert, and Hicks (2013) simulated a cap on Indiana’s property tax and a corresponding revenue increase in sales taxes. In their study, they find long run increases in employment, income, and investment.²

B. Event Literature

There is a large body of literature using CGE models to simulate the effects of exogenous events. For our purposes, we exclude events with a stochastic component. In 1997, the News South Wales treasury partnered with the Center for Regional Economic Analysis to look at the state and national economies for the 6 years prior to and the 6 years after the 2000

² No additional scientific literature was found on CGE models studying state level tax reforms. However, there are numerous policy evaluations done by REMI, IMPLAN, TRAIN (Tax and Revenue Analysis in Nebraska), STAMP (State Tax Analysis Modeling Program) out of Suffolk University, and others. With each of these organizations, the model description is to some degree publically available, but the applications are not peer reviewed.
Sydney Olympic Games (Madden and Crowe). They predicted that the significant gains would go, almost exclusively, to New South Wales, the Australian state where Sydney is located. Similar studies have been conducted for every Olympics going back Los Angeles in 1984. Kasimati (2003) evaluates ex-ante studies for every summer Olympics from 1984 until 2000 and kindly notes their predictions were ‘optimistic’. Porter and Fletcher (2008) look back and evaluated models simulating the 1996 summer and the 2002 winter Olympic Games in Atlanta and Salt Lake City. They concluded that because the I-O models used constant factor prices and technical coefficients, they overstated the effects. Madden (2006), who had previously employed I-O models for this purpose, responded to the criticism, “I would contend, however, that the problems with I-O analysis are of such a fundamental nature that it should no longer be used for mega events of the scale of the Olympic Games... However, I-O is not the only method available for undertaking economic impact analysis. A more modern and much more sophisticated method, namely computable general equilibrium (CGE) modeling, is available.” CGE has largely replaced I-O analysis as a result of the I-O models’ public failures. For a recent meta-analysis of impact studies on a variety of major sporting events see Li and Jago (2012).

There are also many examples of negative events being modeled. Pambudi, McCaughey, and Smyth (2009) used the Indonesian version of TERM, called EMERALD, to construct a static model of Indonesia’s 26 provinces. In this paper, Pambudi et al. simulated the effects of the 2002 bombing in Bali that killed 202 people. The authors exogenously “shift the export demand schedule for tourism commodities uniformly by 50% to the left.” This exogenous shift to the tourism industry, of which Bali was the largest producer, had effects throughout the provinces and on the country’s terms of trade and exchange rates.
Looking at Australia and using a Monash University model, Horridge et al. (2005) used TERM to study the 44 regional effects of the 2002-03 drought, which was the worst drought in two decades. They find that effects on some statistical divisions are extreme, with income losses of up to 20%. Despite the relatively small share of agriculture in Australian GDP, the drought reduces GDP by 1.6%, and contributes to a decline in unemployment and to a worsening of the balance of trade.”

Kawai and Zhai (2009) built a custom model in GAMS with 17 regions focusing on the Asian block. Their model simulated integration and economic interactions of the export driven Asian economies during the “evaporation” of US consumption. They find that “a combination of domestic reform aimed at boosting service sector productivity and external liberalization aimed at fostering broader economic integration” will be critical as the Asian economies rebalance after an end to the export-driven growth period of the past few decades.

Additional topics studied using this methodology in CGE include the impact of El Niño on Mexican agriculture (Harris and Robinson, 2001); the effect of remittance shocks on El Salvador (Morley, Piñeiro, and Robinson, 2011); the effect of changes in the international prices of tobacco and petroleum products on Malawi (Löfgren et al., 2001); the economic impact of AIDS in Cameroon (Kambou, Devarajan, and Over, 1992); and the effect of coups in Fiji (Narayan and Prasad, 2007). In addition to these economic impact studies of real exogenous events, numerous papers used this method for estimating resilience to disasters such as an earthquake, terrorist attack, or water disruption (Rose and Liao, 2005). For an overview, refer to the work of Dwyer, Forsyth, and Spurr titled, “Assessing the Economic Impacts of Events: A Computable General Equilibrium Approach” (2006).
CHAPTER TWO: THE EFFECTS OF TAX REFORM IN GEORGIA

I. INTRODUCTION

Georgia tax reform is a fresh topic. Georgia’s Special Council on Tax Reform and Fairness for Georgians (Special Council) issued its final report on January 7, 2011. This final report outlined a revenue neutral tax reform policy with specific tax rate adjustments, exemptions, and inclusions. These changes followed the basic premise that the tax structure should be broad based with low rates. They recommended expanded application of the sales tax to personal and household services and household food consumption; a reduced personal income tax rate with less deductions; a lower corporate income tax rate; the elimination of sales tax exemptions on inputs for the education, health, and movie industries; and a new exemption on energy used in the agriculture, mining, and manufacturing industries. These approaches for reforming the tax code in Georgia were in keeping with the Special Council’s stated ‘guiding principles’ and represented a shift away from the income tax and towards consumption-based or use taxes.

This research will simulate the Special Council’s approach using a subnational CGE model of Georgia. The simulations will include an expansion of sales tax to previously untaxed sectors, proposed tax exemptions, proposed eliminations of exclusions, and the reduction of the personal and corporate income taxes. In addition to the simulation of the Special Council’s proposals, this paper will also simulate the elimination of the personal and corporate income
taxes, which are replaced with an expanded sales tax so that the tax change is revenue neutral. The effects of each of these tax policy changes are evaluated using total economic output of the state, state tax revenue, industry output, and household utility.

II. GEORGIA’S TAX STRUCTURE AND REFORMS

Georgia’s tax structure, as is the case in many states, is complicated. Georgia collects revenue from a combination of personal and corporate income taxes, sales tax, and taxes on motor fuel, tobacco, alcohol, and insurance. Property taxes are used at the local level. While combining a number of taxes for revenue collection is common, the implementation of the tax code in Georgia is confounded by exemptions, deductions, rate schedules, and tax holidays.

The personal income tax (PIT) in Georgia has a top marginal rate of 6% since the 1955 elimination of the 7% rate. With the exception of that change, the income schedule and associated tax rates have remained unchanged since 1937. Income tax is levied on incomes as low as $750 at a rate of 1%, and the top marginal rate of 6% is reached for a single filer at $7000. Standard deductions in Georgia are significantly lower than the federal deductions, at $2700 for filers and $3000 for dependents. There are also 28 additions or subtractions necessary to get the Georgia adjusted gross income (AGI) from the federal AGI. The PIT accounts for almost half of the total tax revenue for the state government. The corporate income tax (CIT) has changed significantly over the years. There have been numerous deductions and credits implemented to stimulate various sectors. The current rate is 6%. The
CIT raises less than 5% of the state’s total tax revenue. The sales and use taxes in Georgia raises approximately 33% of total state revenue. The state sales tax rate is 4%, although with local option sales taxes used throughout the state, the rate can reach as high as 8%. Georgia also offers a sales tax holiday lasting three days which applies to school items, clothing, and energy or water efficient products.

The Special Council proposed reforms to address each of the aforementioned taxes as well as a number of others including taxes on cigarettes, insurance premiums, E-commerce, etc. They did so under their own established ‘guiding principles’ that the tax structure should be growth enhancing, efficient, stable, clear, fair and equitable, properly developed, and have an avenue for resolution of disputes. Their final report was considerably more detailed than is summarized here, but from a broader perspective it constituted a shift from the income tax toward the sales and use tax as the primary vehicle of revenue generation for the state. They recommended a lowering of the PIT ultimately to 4% which would be applied as a flat rate. The CIT would also fall along with the PIT to 4%. To make up for the lost revenue, they also recommended an expansion of sales and use taxes on services, food, and inputs for health, education, and movies.

III. SOCIAL ACCOUNTING MATRIX

A social accounting matrix is a framework of economic data for a geographic region in which each cell represents a payment from the account of its column to the account of its row resulting in a square matrix of data in which expenditures are in the column and incomes in the
row.\(^3\) Within the SAM framework, because of double entry accounting, the sum of an account row equals the sum of its account column. Columns and rows are similarly labeled according to whatever the desired disaggregation of activities, commodities, factors, institutions, and both foreign and domestic trade.

The SAM for this paper was extracted from IMPLAN using 2010 data and aggregated in GAMS\(^4\). The extracted data originally included 440 activities and 440 commodities. These were aggregated to 15 of each. The three factors include labor, capital, and indirect taxes. There are 16 institutions: nine households organized by income; three federal government institutions for non-defense, defense, and investment; three state government institutions for non-education, education, and investment; and one aggregation of enterprises, investment, and inventory deletions. The last two rows and columns include foreign trade and domestic trade. The final aggregated SAM is 51 rows x 51 columns. Individuals and firms are aggregated according to their income group or industry, respectively, and these aggregations are modeled as if the entire income group was a single representative consumer or the entire industry was a single representative firm. It is important to note that a commodity’s production is not limited to that corresponding industrial activity; for example, the mining activity can produce a manufacturing commodity. Aggregation is necessary so that the solution algorithm is capable of finding a convergent solution.

\(^3\) When referencing a specific cell in the SAM, we will refer to it using matrix notation so \(\text{SAM}(i,j)\) will refer to the cell in the SAM in the row \(i\) and column \(j\).

\(^4\) See Appendix D for information regarding the Georgia SAM.
IV. GENERAL EQUILIBRIUM SPECIFICATION

The model used here is based on the International Food Policy Research Institute (IFPRI) CGE model described in Lofgren et al. (2002). It was later adapted for regional modeling purposes by Holland, Stodick, and Devadoss in their Washington-Idaho model (2004) to include domestic and foreign trade. This model was developed in General Algebraic Modeling System (GAMS) and thus adaptable for alternative purposes. Because the CGE model is a system of linear and nonlinear equations in which the number of equations is equal to the number of endogenous variables in the model, the PATH solver, which is a generalized variation of Newton’s method, is used to calculate the solution.

When accounting for each individual commodity, activity, factor, household, government unit, and foreign sector, the model contains 839 individual equations and 839 individual variables. These equations and variables are divided into four blocks: a production and trade block, an institution block, a price block, and a constraints block. The production and trade block refers to the equations that reveal the endogenous equilibrium quantities. The institution block governs the behavior of the institutions which include households, government, and enterprises and investment. The price block refers to the system of equations that reveals the endogenous equilibrium prices. The constraint block ensures a square system of equations by enforcing constraints such as the factor demand equals the factor supply.

This model does not contain an objective function. Its equations define the behavior of factors in the economy such that their behavior is subject to first order optimality conditions.
The model assumes that producers and consumers will maximize profit and utility, given prices, endowments, and technology. The maximization is subject to constraints for the behavior of markets and governmental units as well as macroeconomic flows such as savings, investment, or foreign demand. Households provide the factors—labor and capital—to firms that use these factors as well as intermediate inputs to produce the final output. Intermediate goods are an Armington composite of domestic and imported goods.

Trading partners include the RUS and foreign trade. The final output generated is allocated to domestic consumption and exports. Households consume final goods and public services, and either save or borrow the remainder of final output. The government consumes intermediate goods, produces public services, and distributes money in the form of transfers to institutions. The government tax revenue includes all transfers from institutions and all revenue generated by taxes on intermediate and final goods. In any CGE model, there are more equations than are possible to detail in an applied paper. However, because this paper looks at the effects of tax reform on households, firms, and the government, it is important to consider the utility-maximizing households, profit-maximizing producers, and the treatment of taxes and government within the model.

A. Consumption

Consumers are divided into nine households according to income level. Households receive income from factor endowments and from transfers from other households, government, and enterprises. Household income is used to pay taxes, to fund transfers to
other households, to consume domestic market commodities and foreign goods, and to save.

Household income available for consumption is the income received from factors and transfers net of taxes, transfers to other institutions, and savings. Household consumption of market commodities is governed by:

\[
Q_{H,c,h} = Y_{c,h} + \beta_{c,h} \left( E_{H} - \sum_{c} P_{C,c} (1 + t_{q,c}) Y_{c,h} \right) \ast \left( P_{C,c} (1 + t_{q,c}) \right)^{-1}
\]  

(1)

where,

\[
Q_{H,c,h} = \text{the quantity consumed of commodity } c \text{ by household } h,
\]

\[
Y_{c,h} = \text{the subsistence level of consumption of market commodity } c \text{ for household } h,
\]

\[
\beta_{c,h} = \text{the marginal share of consumption spent on market commodity } c \text{ for household } h,
\]

\[
E_{H} = \text{net income of taxes, savings, and transfers},
\]

\[
P_{C,c} = \text{the composite price of commodity } c,
\]

\[
t_{q,c} = \text{the sales tax on commodity } c.
\]

This is a linear expenditure system function and the first-order condition for a Stone-Geary utility function, which governs the utility-maximizing consumers. Multiplying both sides of the equation by the relevant prices would derive the total household spending on marketed commodities. Note that activities are not included in this equation as there is no home consumption at the cost of production in the SAM. Also, the prices are those paid by consumers for the composite good of domestic and imported commodities.
B. Production

The SAM is aggregated to 15 industries for both activities and commodities. There are two factors: labor and capital. A producer is represented as an activity and is modeled to maximize the difference between revenue earned and the cost of factors of production and intermediate inputs. Revenue is earned by selling the commodities produced by an activity. This profit maximization is subject to the technology. All participants in the market are price takers. Table 1 lists the 15 industrial commodity and activity aggregations.

<table>
<thead>
<tr>
<th>Aggregation Label</th>
<th>Aggregation Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFFH</td>
<td>Agriculture, forestry, fishing, and hunting</td>
</tr>
<tr>
<td>MIN</td>
<td>Mining</td>
</tr>
<tr>
<td>MANUF</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>MEDIMAN</td>
<td>Medical equipment manufacturing</td>
</tr>
<tr>
<td>UTIL</td>
<td>Utilities</td>
</tr>
<tr>
<td>FOOD</td>
<td>Groceries for home consumption</td>
</tr>
<tr>
<td>INFOSER</td>
<td>Information services</td>
</tr>
<tr>
<td>HEEDSER</td>
<td>Health and education services</td>
</tr>
<tr>
<td>OTHSER</td>
<td>All other services</td>
</tr>
<tr>
<td>CONST</td>
<td>Construction</td>
</tr>
<tr>
<td>WHOLTRAD</td>
<td>Wholesale trade</td>
</tr>
<tr>
<td>RETTRAD</td>
<td>Retail trade</td>
</tr>
<tr>
<td>TRAN</td>
<td>Transportation</td>
</tr>
<tr>
<td>MOVIE</td>
<td>Motion picture and music video production</td>
</tr>
<tr>
<td>GOVSPC</td>
<td>Government services</td>
</tr>
</tbody>
</table>

The technology is modeled by a nested function with constant elasticity of substitution (CES) and Leontief functional forms contained within. To produce output, the firms use factors and intermediate inputs. Using factors, we derive the value added using a CES function. Intermediate input of commodity $c$ used by activity $a$ is derived using a Leontief function. The
value added and intermediate inputs are then combined in the top level of the nested function using a CES functional form for the final activity level. Each representative firm chooses its optimal activity level by optimizing the combination of value added and intermediate inputs such that they are consumed until their marginal revenue product is equal to their price. This process reveals the activity level of the firms.

Valued added is derived in Equation 2:

$$QVA_a = \alpha_{va} \left( \sum_f \delta_{va} QF_{f,a}^{-\rho_{va}} \right)^{-\frac{1}{\rho_{va}-1}}$$

where,

- $QVA_a$ = quantity of aggregate value added by activity $a$,
- $\alpha$ = value added shift parameter,
- $\delta$ = value added share parameter,
- $QF_{f,a}$ = quantity demanded of factor $f$ for activity $a$,
- $\rho$ = transformation of the elasticity of factor substitution.

Here we see that the value added is derived from a CES function of disaggregated factor quantities.

Intermediate inputs are derived using Equation 3:

$$QINT_{a,c} = \phi_{a,c} QINT A_a$$

where,

- $QINT_{a,c}$ = intermediate demand for commodity $c$ from activity $a$,
\( \varphi \) = quantity of commodity \( c \) used as an intermediate good per unit of activity \( a \),

\[ QINT_a = \text{quantity of aggregate intermediate input for activity } a. \]

Here we see that firms’ demand for specific commodities as intermediate inputs for their activity is derived using a Leontief function with a fixed intermediate input coefficient.

Next in the production function we must combine the value added and intermediate inputs using a CES function:

\[
QA_a = \alpha_a \left( \delta_a QVA_a^{\rho_a} + (1 - \delta_a) QINT_a^{\rho_a} \right)^{-\frac{1}{\rho_a-1}} 
\]

where,

\( QA_a = \text{activity level for activity } a, \)

\( \alpha = \text{activity shift parameter}, \)

\( \delta = \text{activity share parameter}, \)

\( QVA_a = \text{quantity of aggregate value added for activity } a, \)

\( QINT_{a,c} = \text{intermediate demand for commodity } c \text{ from activity } a, \)

\( \rho = \text{is a transformation of the value added and inputs elasticity of substitution for activity } a. \)

Equation 4 is the CES function at the ‘top’ of the nested function. Below this are the CES value added function and the Leontief intermediate inputs function, Equations 2 and 3, respectively.

The optimal choices of value added and intermediate inputs, and thus factors and aggregate intermediate inputs, is derived by their relative prices. This is the primary mechanism by which industrial output is altered by policy simulations.
With all factors combined with all inputs to produce an activity level, we can determine the quantity of marketable commodities produced by the activity:

\[ Q_{X_{a,c}} = \phi_{a,c} Q_{A_{a,c}} \]  

(5)

Where,

- \( Q_{X_{a,c}} = \) marketed quantity of commodity \( c \) from activity \( a \),
- \( \phi_{a,c} = \) fixed yield coefficient for the quantity of commodity output \( c \) per unit of activity \( a \),
- \( Q_{A_{a,c}} = \) production of commodity \( c \) from activity \( a \).

This configuration allows each activity to produce any commodity and each commodity to be produced by any activity.

Equation 6 is the domestic commodity output aggregation function:

\[ Q_{X_{c}} = \alpha_{a,c} \left( \sum_{a}^{A} \delta_{a,c} Q_{X_{a,c}}^{-\rho_{a,c}} \right)^{-\frac{1}{\rho_{a,c}-1}} \]  

(6)

where,

- \( Q_{X_{c}} = \) aggregated marketed quantity of domestic output of commodity \( c \),
- \( \alpha = \) shift parameter,
- \( \delta = \) share parameter,
- \( Q_{X_{a,c}} = \) marketed quantity of commodity \( c \) from activity \( a \),
- \( \rho_{a,c} = \) domestic commodity aggregation function exponent of activity \( a \) for commodity \( c \).

In Equation 6 we see that the aggregate marketed quantity of a commodity is a CES aggregate of the marketed output of the activities producing the commodity.
The first-order condition of the domestic commodity aggregation function is:

\[ PP_{a,c} = PP_c QX_c \left( \sum_a \delta_{a,c} QX_{a,c}^{-\rho_{a,c}} \right)^{-1} * \delta_{a,c} QX_{a,c}^{\rho_{a,c}-1} \]  

(7)

where,

- \( PP_{a,c} \) = producer price of commodity \( c \) for activity \( a \),
- \( PP_c \) = aggregate producer price of commodity \( c \) produced from all activities,
- \( QX_c \) = aggregated marketed quantity of domestic output of commodity \( c \),
- \( \delta \) = share parameter,
- \( QX_{a,c} \) = marketed quantity of commodity \( c \) from activity \( a \),
- \( \rho_{a,c} \) = is a transformation of the elasticity of substitution of activity \( a \) for commodity \( c \).

In Equation 7 the marginal cost of commodity \( c \) from activity \( a \) equals the marginal revenue product of commodity \( c \) from activity \( a \).

Together Equations 6 and 7 are the first-order conditions for our profit-maximizing representative firms selling their optimized activity at the market price \( PC \) subject to the aggregation function and the disaggregated commodity producer price \( PP \). Regarding the prices in the consumption and production equations, note that \( PC_c \), the composite price of commodity \( c \); \( PP_a \), the aggregate producer price from all activities for commodity \( c \); and \( PP_{a,c} \), the producer price of commodity \( c \) for activity \( a \), can be different from one another and those differences may change as the model allows for trade and tariffs, as well as taxes according to activity or
commodity. Demonstrated here are three of the 10 prices included in the model. Relationships between the 10 different modeled prices are contained in the 10 equations of the price block.

C. Taxes

Government revenue in a generic SAM format and the model can be derived from numerous sources: direct taxes on institutions (households and enterprises), direct taxes on factors, value added taxes, activity taxes, import tariffs, export taxes, sales taxes, factor income, and transfers from other governmental units and the ROW\(^5\). This shows the versatility of the format and the Lofgren model. However, when looking at Georgia, not all of these apply. Georgia’s revenue is derived using direct taxes on individuals and enterprises, taxes on factors, indirect taxes, and transfers from the federal government. For our purposes, federal government transfers are left unchanged and we focus on the taxes altered by the proposed reform: income tax, sales tax, and taxes on intermediate inputs.

In the model we simulate a change in the income tax by adjusting the ratio of transfers to the state as a proportion of total expenditure. However, total expenditure equals total income, and household income is derived from the labor endowment as well as the capital endowment, transfer payments, and dividends. An additional complication arises because the

---

\(^5\) For brevity we omit the equation for total government revenue, but for each source of tax revenue the tax rate is either applied to the stock, as in the case of factors, or applied to the product of the price and the total for that source, as in the case of a value added tax (Revenue = Tax * (Price of Value Added * Total Value Added)). These taxes can be institution, factor, activity, commodity, or trading partner specific.
direct transfers from households to the state include not only income tax, but also property tax, estate tax, and some minor fees such as hunting licenses. These calculations are explained in the simulations section. Regarding the model, the simulation is done by declaring a variable:

\[ ty_h = \frac{SAM(SG, H)}{SAM(Total, H)} \]  

(8)

where,

\( ty_h \) = direct tax rate given by the SAM for a household \( h \),

\( SAM(SG, H) \) = transfers from households \( H \) to the state government \( SG \),

\( SAM(Total, H) \) = total expenditure for a household \( H \).

The value of this parameter is then controlled in the counterfactual simulation. We cannot simply declare a variable for the ratio of transfers from households as a proportion of labor income (though we tried) because the direct tax rate on households is used repeatedly elsewhere in the model. How this is used to adjust the tax on the factor labor is explained in the simulations section.

The corporate income tax (CIT) is similarly problematic as it encompasses transfers from the capital factor to the state and transfers from enterprises to the state. Compounding the problem is the aggregation of enterprises and investment. A calculation similar to the case of the income tax is possible, but a look at the original unaggregated IMPLAN data reveals that the enterprise portion of the CIT captures 0.6% of the total CIT paid to the state and represents 0.0026% of the aggregated column total. Furthermore, all portions of this aggregation are estimated by IMPLAN rather than retrieved from primary data sources. Finally, this portion of
the SAM plays a small role in the variables we are using to evaluate the policy simulations and serves primarily to facilitate the investment and savings closure conditions. The enterprise portion of the CIT is being ignored because: it is effectively inconsequential to the CIT; it is almost lost in the column aggregation; it is based on an estimated IMPLAN SAM; and it would require modification of numerous closure rules. Thus, we may declare a variable:

\[ ty_k = \frac{SAM(SG,K)}{SAM(Total,K)} \]  

(9)

where,

\[ ty_k = \text{tax rate on capital factor } k, \]

\[ SAM(SG,K) = \text{transfer from capital } K \text{ to the state government } SG, \]

\[ SAM(Total,K) = \text{total expenditure of capital } K. \]

The value of this parameter is controlled in the counterfactual simulation.

The sales tax is found in two places: as a portion of the transfers from activities to indirect taxes and in transfers from commodities to the state. Transfers to the state from commodities are pure sales taxes. Transfers from activities to indirect taxes include state and local sales taxes, property taxes, motor vehicle taxes, payments for licenses and fees, and others. In this case we are not concerned primarily with the exact amount of revenue raised by the sales taxes separate from the other indirect taxes. Rather, we are interested in the amount of additional tax revenue raised by an increase in the sales tax rates in certain industries, as well as the effects of these tax increases along with other tax changes on the general equilibrium itself. Because our focus is broad enough, we can use the variable \( t_q \) found in the equation for
household consumption of market commodities as seen in Equation 1:

\[
QH_{c,h} = Y_{c,h} + \beta_{c,h} \left( EH_h - \sum_c P_{c}(1 + t_{qc})Y_{c,h} \right) \ast \left( P_{c}(1 + t_{qc}) \right)^{-1}
\]

(10)

where,

- \( QH_{c,h} \) = the quantity consumed of commodity \( c \) by household \( h \),
- \( Y_{c,h} \) = the subsistence level of consumption of market commodity \( c \) for household \( h \),
- \( \beta_{c,h} \) = the marginal share of consumption spent on market commodity \( c \) for household \( h \),
- \( EH_h \) = net income of taxes, savings, and transfers,
- \( PC \) = the composite price of commodity \( c \),
- \( t_{qc} \) = the sales tax on commodity \( c \).

This approach will allow us to determine in the model the change in revenue from the imposition of an additional tax on commodities by industry. The use of this variable is simple, but the calculation of this variable is not. Because we wish to expand the tax to previously untaxed sectors, while in the aggregation we have some untaxed industries combined with taxed industries, the estimation of this tax change must include sales taxes already paid. This can only be roughly approximated to give us an average sales tax rate on final goods. The calculation is detailed in the simulations section.

\[6\] Georgia also has local sales taxes that often equal the state’s rate. In the model, these would be included in the transfers from activities to indirect taxes, allocated to the state, and then distributed to the local governments for education and investment. The amount transferred to the local governments, those that don’t collect direct taxes, for education and investment is approximately equal to the total transfers from activities to indirect taxes.
The final tax is the tax on intermediate inputs. There is not enough information in the SAM to isolate this tax, declare a parameter, and control it in the counterfactual. However, again we can ignore our inability to isolate the tax, its revenue, and its rate because we are primarily concerned with the effects of its change. In this instance, we allow the price of intermediate goods to be tax inclusive in the baseline. We assume the tax on inputs is zero in the baseline and alter it in the counterfactual to simulate the reforms. Here, we include a tax on intermediate inputs, tqinp, when calculating the quantity of intermediate use of commodity $c$ by activity $a$:

$$QINT_{c,a} = \frac{SAM(C, A)}{PQO_c \times (1 + tqinp_{a,c})}$$

(11)

where,

$QINT_{c,a} =$ intermediate use of commodity $c$ by activity $a$,

$SAM (C, A) =$ marketed outputs of commodity $c$ produced by activity $a$,

$PQO_c =$ composite commodity price of commodity $c$,

$tqinp_{a,c} =$ tax on activity $a$ used to produce commodity $c$.

This variable, $tqinp$, also appears in the calculation of government revenue and value added price. The Leontief coefficients in the production function are unaffected by the tax on inputs.
D  Trade

Trade is modeled between Georgia, the RUS, and the ROW. Each region is a monopoly provider of their differentiated exports. Trade plays a minor role in this model as the aggregate effects of Georgia’s policy change has little effect on the value of the dollar and Georgia uses the same currency as its domestic trading partners. For this reason, the exchange rate is held constant while the ROW and the RUS savings are allowed to adjust. Equation 12 gives the trade calculation for the current account balance:

$$\sum_{CM} PWM_c \times QM_c + \sum_{F} TFA_f = \sum_{CE} PWE_c \times QE_c + \sum_{i} TIA_i + FSAV$$

(12)

where,

$$PWM_c =$$ import price of commodity $c$,

$$QM_c =$$ quantity of imported commodity $c$,

$$TFA_f =$$ total factor transfers to ROW and RUS,

$$PWE_c =$$ export price of commodity $c$,

$$QE_c =$$ quantity of exported commodity $c$,

$$TIA_i =$$ transfers from ROW and RUS to institution $i$,

$$FSAV =$$ foreign savings.

In our closure rules, with foreign savings endogenous, the exchange rate is normalized and held constant while foreign savings adjusts. The result is that the sum of non-government savings,
government savings, and foreign savings is equal to the sum of fixed investment and the stock change.

V. CALIBRATION

A. Tax Revenue

From the SAM we derive the total amount of revenue collected by the state through taxes on commodities, activities, households, and capital. In the table below, we show the allocation we take from IMPLAN compared to the FY 2010 Governor’s Budget Report (in millions of dollars). Note that we divide taxes within our SAM into the personal income tax (PIT), the corporate income tax (CIT), and the sales tax. The category ‘other’ refers to the taxes on motor fuels, insurance premiums, vehicle licenses, alcohol, tobacco, and property. Within IMPLAN, we cannot identify exactly where each of these is allocated and in what proportion. Furthermore, we are only concerned with revenue that corresponds to the state’s taxes rather than federal and local taxes, so those tax revenues have been excluded from Table 2.

<table>
<thead>
<tr>
<th>TABLE 2 – Data extract and budget comparison (in millions of $)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>PIT</td>
</tr>
<tr>
<td>Sales and Use</td>
</tr>
<tr>
<td>CIT</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
Because IMPLAN aggregates taxes together while our SAM contains divisions of taxes collected by the state for both the state and localities and from numerous taxes, our numbers do not exactly match the FY 2010 numbers from the Georgia budget. However, the totals are very close, with our IMPLAN data giving us a total revenue number 1.7% higher than the FY2010 budget numbers.

B. Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticity of substitution for production between labor and capital</td>
<td>.9</td>
</tr>
<tr>
<td>Elasticity of substitution (Armington) between Georgia output and imports</td>
<td>2</td>
</tr>
<tr>
<td>Elasticity of substitution (transformation) between Georgia and foreign demand</td>
<td>2</td>
</tr>
<tr>
<td>Elasticity of substitution (transformation) between ROW and RUS for exports</td>
<td>1.35</td>
</tr>
<tr>
<td>Elasticity of substitution (Armington) between ROW imports and RUS imports</td>
<td>1.35</td>
</tr>
<tr>
<td>Income elasticity</td>
<td>1</td>
</tr>
<tr>
<td>Investment on commodities elasticity</td>
<td>1</td>
</tr>
<tr>
<td>Consumption flexibility</td>
<td>-1</td>
</tr>
<tr>
<td>Investment demand flexibility</td>
<td>-1</td>
</tr>
<tr>
<td>Supply elasticity for labor</td>
<td>2</td>
</tr>
<tr>
<td>Supply elasticity for capital</td>
<td>.5</td>
</tr>
</tbody>
</table>

Note that the elasticity of substitution between labor and capital in the production function is set to near unity so the CES functional form closely resembles Cobb-Douglas. The elasticities of substitution between Georgia and its trading partners—the ROW and RUS—are set higher than those between the ROW and RUS. This decision was made to simulate the greater degree of openness found in regional economies than found in national or international
The income elasticity and investment on commodities elasticity parameters were taken from the recommended values of Holland, Stodick, and Davadoss (2004). The flexibility parameters are used to set the subsistence level of consumption of investment. Having these set equal to -1 allows for no minimum level. The supply elasticities of labor and capital reflect that labor is more easily substituted than capital. Sensitivity analysis was conducted by altering functional forms and parameter values with no substantive change in results.

VI. SPECIAL COUNCIL SIMULATIONS

We simulate the general tax reforms recommended by the Special Council, which include a reduced and flat PIT of 4%, a reduced CIT of 4%, and an expansion of the 4% state sales tax to previously untaxed food and services. In addition to these three changes, the Special Council called for an expansion of the sales tax on inputs for the movie industry, health services, and education services. In the case of the movie industry, this was originally done to attract the industry to Georgia. For health and education, these were not taxed for political reasons: when consumed as final goods, they enjoy exemptions from sales taxes on inputs. Because the sales tax on these as final goods does not apply, tax cascading cannot occur, so it was recommended that the exemption be eliminated. Finally, the Special Council recommended new tax exemptions on energy inputs for agriculture, mining, and manufacturing.

7 See the average US Armington elasticities in Galloway, McDaniel, and Rivera (2003) as well as Thaiprasert, Faulk, and Hicks (2011) for these figures use in an IMPLAN data based CGE model.
The PIT in the model is given by the ratio of direct taxes to total expenditures:

\[ ty_h = \frac{\text{SAM}(SG,H)}{\text{SAM}(Total,H)} \]  

(13)

We are interested in the ratio of direct taxes to labor income, which cannot be directly controlled in the model. To determine the change here, we first look at the original statutory tax code and the proposed tax code, and calculate the average tax rate for each household under the original tax code and the proposed new code. This calculation was done for both the original tax code and the proposed reform for single filers and filers who are married with two children (M2K). These were then averaged to determine the ratio of the average tax rate under the reform to the original tax code. This gives us the ratio that we can apply to ratio of the direct tax as a proportion of labor income. We applied this ratio to our variable \( ty \) and checked that the desired effect was achieved. The difference between the ratio of income tax rate in the simulation to the income tax rate in the baseline, and the ratio of the income tax rate in the reform to the income tax rate under the previous statutes is nearly identical\(^8\). This reveals that the change in income tax we are simulating is very similar in size and scope to the proposed reform.

Also of note regarding the direct tax rates by income group are some discrepancies in the SAM regarding the average tax rates and the income groups. Note in Table 4 that the calculated income per capita does not fall in the income range as aggregated in the extraction for household groups 2, 6, 7 and 8. The disparity is largest for household 2.

\(^8\) Refer to Table A1 in the appendix for calculations of the differences between the alternative tax treatments.
Regarding the tax rates, they are unusually high for household group 1 and unusually low for household group 2. This could be because the poorest group is primarily single filers with few deductions, while household group 2 has a higher proportion of married households with children and thus more deductions. Regardless, we apply the tax reform as calculated to the tax rates as extracted. These unusual IMPLAN tax rates for low income groups could cause problems if adjustments are not made relative to the baseline.

<table>
<thead>
<tr>
<th>Income range</th>
<th>HHD1</th>
<th>HHD2</th>
<th>HHD3</th>
<th>HHD4</th>
<th>HHD5</th>
<th>HHD6</th>
<th>HHD7</th>
<th>HHD8</th>
<th>HHD9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline tax rate</td>
<td>5.20%</td>
<td>1.35%</td>
<td>3.40%</td>
<td>4.03%</td>
<td>3.96%</td>
<td>4.26%</td>
<td>4.78%</td>
<td>4.96%</td>
<td>7.24%</td>
</tr>
<tr>
<td>Simulated tax rate</td>
<td>3.27%</td>
<td>1.00%</td>
<td>3.29%</td>
<td>3.96%</td>
<td>3.32%</td>
<td>3.28%</td>
<td>3.54%</td>
<td>3.54%</td>
<td>4.95%</td>
</tr>
<tr>
<td>Income per capita</td>
<td>$3,458</td>
<td>$6,335</td>
<td>$16,010</td>
<td>$28,547</td>
<td>$44,748</td>
<td>$76,525</td>
<td>$103,929</td>
<td>$156,262</td>
<td>$376,941</td>
</tr>
</tbody>
</table>

For the expansion of the sales tax to food and services, we look at three industries: food, other services, and information services. To simulate this tax reform we must increase the sales tax rate from its current rate to 4%. In each of these industries, some amount of indirect taxes is paid, so we must account for this as we calculate the additional tax. To do this, we first calculate the amount of revenue to be raised by a 4% tax on final consumption. We then subtract out the indirect taxes already paid. This is an approximation because we only have the breakdown of indirect taxes as an aggregation of all industries. However, from the IMPLAN breakdown we know that the proportion of sales taxes paid to the state as a proportion of total indirect taxes is 21%. Using this percentage, we can estimate the amount of sales taxes already paid as a proportion of sales taxes that would be raised by a 4% sales tax, and then calculate
the additional tax needed to raise that revenue. This simulates an expansion of the sales tax so that the average sales tax rate is 4%.

We alter the tax rate on intermediate inputs to simulate the elimination or expansion of taxes on inputs used by specific industries. For the elimination of the tax exemption for movies, health services, and education services, we increase the taxes paid on activities used to produce the industry’s commodities. For movies, the Special Council recommends the sales tax be applied to purchases of “production equipment by film producers and film production companies used to produce films for nationwide distribution.” To simulate this, we introduce a 4% intermediate input tax to movie industry activities used in the production of movie commodities. For health and education services, this tax applies to all activities that produce health and education services. To introduce new sales tax exemptions for energy used by the agriculture, mining, and manufacturing industries, we introduce a negative intermediate input tax on the use of utilities by these industries. This last change to the intermediate input price of utilities for agriculture, mining, and manufacturing is an approximation of the actual change, as the utilities industry is not exclusively energy.

Three simulations are done relative to the calibrated baseline. The three simulations differ according to their treatment of labor and capital mobility and the endowments. In the long run, both capital and labor are mobile and the endowments are variable. There are two short run simulations. In the shortest run, labor is mobile between industries, but the total endowment is fixed. Capital, in the shortest run, is industry specific and fixed by activity. Relaxing the capital restrictions from the shortest run, we get a short run simulation, with labor
again mobile between industries with a fixed total endowment, but capital is mobile with a
fixed total state endowment.

VII. SPECIAL COUNCIL SIMULATION RESULTS

We compare the simulations to the baseline scenario and one another by looking at the
effects on the state’s economy and budget, households, and industries.

A. State Results

There are four ways we can look at the effects of tax reform on the state. These are
labeled in Table 4 as GDP-1, GDP-2, GDP-3, and GDP-4. GDP-1 is the wage and capital bill at
factor cost. GDP-2 is the traditional consumption, investment, government, and net exports
calculated at market prices. GDP-3 is the value added given by the wage and capital bill plus
indirect taxes. GDP-4 is given by the total activity minus intermediate costs. Note that in the
baseline, GDP-1 and GDP-4 are equal, and GDP-2 and GDP-3 are equal. In the counterfactual
simulations, we see that they differ as the numeraire prices set to unity in the baseline change
in the simulations.

In Table 5, we see the results given in millions of dollars. The GDP changes are all
positive for short run and long run simulations. The increase is more than twice as large in the
long run as in either of the short run simulations. We see the GDP increases slightly in the
shortest run than in the short run, likely due to the slightly higher prices that result in this
We can interpret this result by saying that, within the model, GDP for the state will increase by a bit less than one tenth of one percent in the long run, given this tax reform. However, results of a magnitude this small should be interpreted with restraint. Because the changes are so small, a more precise interpretation may be that this revenue neutral tax reform will have a negligible impact on the state’s GDP.

<table>
<thead>
<tr>
<th>TABLE 5 – Baseline and simulated state GDP (in millions of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Long Run</strong></td>
</tr>
<tr>
<td>Base</td>
</tr>
<tr>
<td>GDP-1 393,829</td>
</tr>
<tr>
<td>GDP-2 423,435</td>
</tr>
<tr>
<td>GDP-3 423,435</td>
</tr>
<tr>
<td>GDP-4 393,829</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Short Run</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
</tr>
<tr>
<td>GDP-1 393,829</td>
</tr>
<tr>
<td>GDP-2 423,435</td>
</tr>
<tr>
<td>GDP-3 423,435</td>
</tr>
<tr>
<td>GDP-4 393,829</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Shortest Run</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
</tr>
<tr>
<td>GDP-1 393,829</td>
</tr>
<tr>
<td>GDP-2 423,435</td>
</tr>
<tr>
<td>GDP-3 423,435</td>
</tr>
<tr>
<td>GDP-4 393,829</td>
</tr>
</tbody>
</table>

Regarding the state government’s budget, Table 6 breaks out the changes to revenue from various sources of tax revenue. Note that the revenue from intermediate taxes is set to zero in the baseline, although the state does collect this tax. The currently collected intermediate tax is found within indirect business taxes, which are not included here as they are transferred to the localities. Also not included here are transfers to the state from the federal
government which remain constant. The intermediate row and the sales tax row are separated in the simulation SAM, so that their sums give us the changes caused by our tax adjustments.

**TABLE 6 – Baseline and simulation tax revenue by source (in millions of dollars)**

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Long Run</th>
<th>Short Run</th>
<th>Shortest Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calculated</td>
<td>Difference</td>
<td>Calculated</td>
<td>Difference</td>
</tr>
<tr>
<td>PIT</td>
<td>9,886</td>
<td>7,435</td>
<td>-2,451</td>
<td>7,429</td>
</tr>
<tr>
<td>CIT</td>
<td>816</td>
<td>564</td>
<td>-252</td>
<td>564</td>
</tr>
<tr>
<td>Sales</td>
<td>4,083</td>
<td>6,727</td>
<td>2,644</td>
<td>6,724</td>
</tr>
<tr>
<td>Intermediate</td>
<td>0</td>
<td>-10</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>Total</td>
<td>14,785</td>
<td>14,716</td>
<td>-70</td>
<td>14,707</td>
</tr>
</tbody>
</table>

Here we see that the state collects less total taxes, but the reform is almost budget neutral, as the largest change in any of the simulations is $78 million dollars less than the original tax revenue of $14.79 billion. We also see that the change adds slightly more revenue in the long run model than in either of the short run models.

**B. Household Results**

We calculate utilities and equivalent variations for each household group under each of the three simulations. We see in Tables 7 and 8 that the effect of the tax reform is minimal. This is expected, as the state tax burden represents a fraction of the total tax burden. With the exception of household 1 in the long run, we see that the effects on utilities are negative for households 1 through 5, those making less than $50,000, and positive for households 6 through 9, those making more than $50,000.
TABLE 7 – Baseline and simulation utility by household

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Long Run</th>
<th>% Difference</th>
<th>Short Run</th>
<th>% Difference</th>
<th>Shortest Run</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHD1</td>
<td>7.359</td>
<td>7.361</td>
<td>0.021</td>
<td>7.358</td>
<td>(0.012)</td>
<td>7.359</td>
<td>(0.010)</td>
</tr>
<tr>
<td>HHD2</td>
<td>6.912</td>
<td>6.912</td>
<td>(0.006)</td>
<td>6.910</td>
<td>(0.038)</td>
<td>6.910</td>
<td>(0.037)</td>
</tr>
<tr>
<td>HHD3</td>
<td>7.798</td>
<td>7.796</td>
<td>(0.025)</td>
<td>7.794</td>
<td>(0.047)</td>
<td>7.794</td>
<td>(0.046)</td>
</tr>
<tr>
<td>HHD4</td>
<td>8.032</td>
<td>8.028</td>
<td>(0.048)</td>
<td>8.027</td>
<td>(0.064)</td>
<td>8.027</td>
<td>(0.063)</td>
</tr>
<tr>
<td>HHD5</td>
<td>8.523</td>
<td>8.522</td>
<td>(0.012)</td>
<td>8.521</td>
<td>(0.025)</td>
<td>8.521</td>
<td>(0.024)</td>
</tr>
<tr>
<td>HHD6</td>
<td>9.043</td>
<td>9.045</td>
<td>0.016</td>
<td>9.044</td>
<td>0.008</td>
<td>9.044</td>
<td>0.009</td>
</tr>
<tr>
<td>HHD7</td>
<td>8.653</td>
<td>8.656</td>
<td>0.038</td>
<td>8.656</td>
<td>0.030</td>
<td>8.656</td>
<td>0.032</td>
</tr>
<tr>
<td>HHD8</td>
<td>8.657</td>
<td>8.662</td>
<td>0.056</td>
<td>8.662</td>
<td>0.050</td>
<td>8.662</td>
<td>0.051</td>
</tr>
<tr>
<td>HHD9</td>
<td>9.034</td>
<td>9.040</td>
<td>0.070</td>
<td>9.039</td>
<td>0.063</td>
<td>9.039</td>
<td>0.064</td>
</tr>
</tbody>
</table>

We can look at Table 8 for the equivalent variations, which show us the amount of money represented by the change in utility. Again, we see the total change for households is small and the net effect of the tax change is regressive in nature. This is a result of the relatively smaller decrease in PIT for middle-income people and the relatively larger proportion of their expenditure that is used to consume goods, like food, which are now taxed.

TABLE 8 – Equivalent variation by household source (in dollars)

<table>
<thead>
<tr>
<th></th>
<th>Long Run</th>
<th>Short Run</th>
<th>Shortest Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHD1</td>
<td>16.55</td>
<td>(9.31)</td>
<td>(7.91)</td>
</tr>
<tr>
<td>HHD2</td>
<td>(2.87)</td>
<td>(18.48)</td>
<td>(17.94)</td>
</tr>
<tr>
<td>HHD3</td>
<td>(33.50)</td>
<td>(63.33)</td>
<td>(62.70)</td>
</tr>
<tr>
<td>HHD4</td>
<td>(83.38)</td>
<td>(112.56)</td>
<td>(110.99)</td>
</tr>
<tr>
<td>HHD5</td>
<td>(38.62)</td>
<td>(78.75)</td>
<td>(76.56)</td>
</tr>
<tr>
<td>HHD6</td>
<td>85.04</td>
<td>40.47</td>
<td>45.90</td>
</tr>
<tr>
<td>HHD7</td>
<td>134.06</td>
<td>105.20</td>
<td>109.48</td>
</tr>
<tr>
<td>HHD8</td>
<td>193.05</td>
<td>171.17</td>
<td>174.62</td>
</tr>
<tr>
<td>HHD9</td>
<td>341.28</td>
<td>304.30</td>
<td>310.98</td>
</tr>
</tbody>
</table>
C. Industry Results

Industries are aggregated into 15 categories, as labeled in Table 8\(^9\). The industries give us labels for both activities and commodities. Activities and commodities are differentiated using by an ‘A’ or ‘C’, respectively, as seen in Tables 10 and 11.

<table>
<thead>
<tr>
<th>Aggregation Label</th>
<th>Aggregation Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFFH</td>
<td>Agriculture, forestry, fishing, and hunting</td>
</tr>
<tr>
<td>MIN</td>
<td>Mining</td>
</tr>
<tr>
<td>MANUF</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>MEDIMAN</td>
<td>Medical equipment manufacturing</td>
</tr>
<tr>
<td>UTIL</td>
<td>Utilities</td>
</tr>
<tr>
<td>FOOD</td>
<td>Groceries for home consumption</td>
</tr>
<tr>
<td>INFOSER</td>
<td>Information services</td>
</tr>
<tr>
<td>HEEDSER</td>
<td>Health and education services</td>
</tr>
<tr>
<td>OTHSER</td>
<td>All other services</td>
</tr>
<tr>
<td>CONST</td>
<td>Construction</td>
</tr>
<tr>
<td>WHOLTRAD</td>
<td>Wholesale trade</td>
</tr>
<tr>
<td>RETTRAD</td>
<td>Retail trade</td>
</tr>
<tr>
<td>TRAN</td>
<td>Transportation</td>
</tr>
<tr>
<td>MOVIE</td>
<td>Motion picture and music video production</td>
</tr>
<tr>
<td>GOVSPC</td>
<td>Government services</td>
</tr>
</tbody>
</table>

In Tables 10 and 11 we have industrial output by commodity and by activity. In analyzing these results, we see the importance of the commodity and activity structure where a commodity can be produced by any activity and any activity can produce any commodity. For

\(^9\) Table 8, identical to Table 1, is placed here for the reader’s convenience
example, a farm can produce both agriculture and wholesale trade commodities if that firm is vertically integrated.

Table 10 shows the value of the total amount of a commodity that is produced regardless of which activity produced it. Table 11 shows the value of all of an activity’s output regardless of which commodities it is producing. Here we can see that total industrial activity and commodity production are increased by between a fifth and a quarter of one percent in the long run. The biggest growth sectors are utilities, retail trade, and health and education services. Note that health and education services had increased taxes on inputs; taxes on utilities decreased when used as an input across agriculture, mining, and manufacturing; and retail trade was unaffected. The hardest hit industries by the reform are food, other services, and movies, which all had tax increases imposed upon them. Total output increases as we progress from the shortest run to the long run, and as capital and labor adjust.
### TABLE 10 – Output by commodity (in millions of dollars)

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Long Run</th>
<th>Short Run</th>
<th>Shortest Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calculated</td>
<td>% Difference</td>
<td>Calculated</td>
<td>% Difference</td>
</tr>
<tr>
<td>AFFH-C</td>
<td>10,038</td>
<td>10,033</td>
<td>(0.05)</td>
<td>10,036</td>
</tr>
<tr>
<td>MIN-C</td>
<td>1,781</td>
<td>1,786</td>
<td>0.29</td>
<td>1,787</td>
</tr>
<tr>
<td>MANUF-C</td>
<td>103,260</td>
<td>103,371</td>
<td>0.11</td>
<td>103,361</td>
</tr>
<tr>
<td>MEDIMAN-C</td>
<td>5,583</td>
<td>5,594</td>
<td>0.20</td>
<td>5,595</td>
</tr>
<tr>
<td>UTIL-C</td>
<td>14,450</td>
<td>14,514</td>
<td>0.45</td>
<td>14,505</td>
</tr>
<tr>
<td>FOOD-C</td>
<td>45,166</td>
<td>44,948</td>
<td>(0.48)</td>
<td>44,959</td>
</tr>
<tr>
<td>INFOSER-C</td>
<td>38,675</td>
<td>38,776</td>
<td>0.26</td>
<td>38,765</td>
</tr>
<tr>
<td>HEEDSER-C</td>
<td>53,522</td>
<td>54,095</td>
<td>1.07</td>
<td>54,040</td>
</tr>
<tr>
<td>OTHSER-C</td>
<td>245,030</td>
<td>244,113</td>
<td>(0.37)</td>
<td>243,963</td>
</tr>
<tr>
<td>CONST-C</td>
<td>33,797</td>
<td>33,795</td>
<td>(0.01)</td>
<td>33,790</td>
</tr>
<tr>
<td>WHOLTRAD-C</td>
<td>38,985</td>
<td>39,152</td>
<td>0.43</td>
<td>39,136</td>
</tr>
<tr>
<td>RETTRAD-C</td>
<td>32,450</td>
<td>32,790</td>
<td>1.05</td>
<td>32,763</td>
</tr>
<tr>
<td>TRAN-C</td>
<td>26,788</td>
<td>26,867</td>
<td>0.29</td>
<td>26,855</td>
</tr>
<tr>
<td>MOVIE-C</td>
<td>1,227</td>
<td>1,225</td>
<td>(0.16)</td>
<td>1,225</td>
</tr>
<tr>
<td>GOVSPC-C</td>
<td>79,687</td>
<td>79,820</td>
<td>0.17</td>
<td>79,800</td>
</tr>
<tr>
<td>Average</td>
<td>0.22</td>
<td>0.19</td>
<td>0.08</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 11 – Output by activity (in millions of dollars)

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Long Run</th>
<th>Short Run</th>
<th>Shortest Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calculated</td>
<td>% Difference</td>
<td>Calculated</td>
<td>% Difference</td>
</tr>
<tr>
<td>AFFH-A</td>
<td>9,622</td>
<td>9,618</td>
<td>(0.04)</td>
<td>9,622</td>
</tr>
<tr>
<td>MIN-A</td>
<td>1,734</td>
<td>1,739</td>
<td>0.33</td>
<td>1,740</td>
</tr>
<tr>
<td>MANUF-A</td>
<td>102,187</td>
<td>102,304</td>
<td>0.11</td>
<td>102,294</td>
</tr>
<tr>
<td>MEDIMAN-A</td>
<td>5,475</td>
<td>5,486</td>
<td>0.21</td>
<td>5,488</td>
</tr>
<tr>
<td>UTIL-A</td>
<td>11,745</td>
<td>11,900</td>
<td>1.32</td>
<td>11,896</td>
</tr>
<tr>
<td>FOOD-A</td>
<td>45,098</td>
<td>44,900</td>
<td>(0.44)</td>
<td>44,919</td>
</tr>
<tr>
<td>INFOSER-A</td>
<td>44,652</td>
<td>44,764</td>
<td>0.25</td>
<td>44,760</td>
</tr>
<tr>
<td>HEEDSER-A</td>
<td>49,882</td>
<td>50,415</td>
<td>1.07</td>
<td>50,349</td>
</tr>
<tr>
<td>OTHSER-A</td>
<td>236,884</td>
<td>235,975</td>
<td>(0.38)</td>
<td>235,859</td>
</tr>
<tr>
<td>CONST-A</td>
<td>33,797</td>
<td>33,794</td>
<td>(0.01)</td>
<td>33,788</td>
</tr>
<tr>
<td>WHOLTRAD-A</td>
<td>38,985</td>
<td>39,147</td>
<td>0.42</td>
<td>39,128</td>
</tr>
<tr>
<td>RETTRAD-A</td>
<td>32,246</td>
<td>32,577</td>
<td>1.03</td>
<td>32,544</td>
</tr>
<tr>
<td>TRAN-A</td>
<td>26,197</td>
<td>26,270</td>
<td>0.28</td>
<td>26,257</td>
</tr>
<tr>
<td>MOVIE-A</td>
<td>1,214</td>
<td>1,203</td>
<td>(0.93)</td>
<td>1,202</td>
</tr>
<tr>
<td>GOVSPC-A</td>
<td>77,069</td>
<td>77,162</td>
<td>0.12</td>
<td>77,112</td>
</tr>
<tr>
<td>Average</td>
<td>0.22</td>
<td>0.20</td>
<td>0.08</td>
<td></td>
</tr>
</tbody>
</table>
VIII. INCOME TAX ELIMINATION SIMULATIONS

An interesting extension is available with our current model. One feasible alternative to the Special Council’s proposed tax reform is a complete elimination of personal and corporate income taxes, coupled with the replacement of this lost revenue with an expanded uniform sales tax. With the previous simulation, we instituted the recommendations as closely as possible to the Special Council’s proposal. In this simulation, we eliminate the state income tax on individuals and corporations, and then increase a uniform sales tax rate on all final goods until we achieve approximate revenue neutrality. This simulation is hypothetical and done purely for comparison purposes. However, Georgia’s two neighboring states, Florida and Tennessee, have tax codes with no income taxes, and as that is the general direction of the Special Council’s reform proposal, it can provide guidance as we think about tax changes.

The specifications of this tax change include a state tax rate of zero on personal and corporate income. We also expand the sales tax to groceries for home consumption and previously untaxed services, so that the state sales tax rate is uniform across goods. We also, rather arbitrarily, included the Special Council’s recommendations regarding tax deductions. Thus, we remove the favored tax treatment of the movie industry, and include deductions on intermediate utilities used in agriculture, mining, and manufacturing. While the inclusion of these structural changes could have been left out of this application, they were justified to maintain fairness, and for tax cascading reasons in the previous simulation. We also wanted to focus this comparison on the drastic changes in sales and income taxes, without clouding the analysis by their removal in this iteration. With this new simulation of a total replacement of
the personal and corporate income taxes with an increased and expanded sales tax, we again look at the effects on the state, households, and industries.

In these simulations, the baseline of the state remains unchanged from what it was in the Special Council simulations. The methodology for imposing constraints on the model in this application has not changed from what was described above. The change to the treatment of intermediate goods in the movie, agriculture, mining, and manufacturing industries is unchanged. For both the corporate and personal income tax changes, we imposed a rate of zero.

For the sales tax rate, we used our previous work in the expansion of the sales tax to groceries and services. We then incrementally increased the now uniform tax rate until we achieved approximate revenue neutrality. This process revealed that revenue neutrality was reached with a sales tax rate of 9.2%. As this would be an unlikely tax rate for a state, we set this at 9% and allowed for an approximately revenue neutral tax change with a net decrease in revenue of 4%.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sales Tax Rate</th>
<th>Exclusions</th>
<th>Revenue</th>
<th>Revenue ÷ sales tax rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4%</td>
<td>Food and services</td>
<td>$4,083</td>
<td>$1,021</td>
</tr>
<tr>
<td>Special Council</td>
<td>4%</td>
<td>None</td>
<td>$6,726</td>
<td>$1,682</td>
</tr>
<tr>
<td>Income Tax Elimination</td>
<td>9%</td>
<td>None</td>
<td>$14,300</td>
<td>$1,589</td>
</tr>
</tbody>
</table>

Table 12 shows the average revenue collected by the sales tax across labor and capital closure rules by treatment. Here we see the magnitude of the tax expansion to food and services relative to the baseline, and to the expansion coupled with an increase in tax rate from
4% to 9%. Also note that the amount of revenue per percentage point of sales tax decreases from $1,682 to $1,589 as we increase the rate from 4% to 9%. This result is what we would expect, given consumers’ ability to substitute for imports as a result of our Armington elasticities. The increase from the baseline to the treatments is a result of the expanded base.
IX.  INCOME TAX ELIMINATION RESULTS

A.  State Results

In Table 13 we have the same four GDP measures introduced in the previous simulation.

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Calculated</th>
<th>Difference</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Long Run</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP-1</td>
<td>393,829</td>
<td>393,414</td>
<td>-416</td>
<td>-0.11</td>
</tr>
<tr>
<td>GDP-2</td>
<td>423,435</td>
<td>423,288</td>
<td>-147</td>
<td>-0.03</td>
</tr>
<tr>
<td>GDP-3</td>
<td>423,435</td>
<td>423,233</td>
<td>-202</td>
<td>-0.05</td>
</tr>
<tr>
<td>GDP-4</td>
<td>393,829</td>
<td>393,468</td>
<td>-361</td>
<td>-0.09</td>
</tr>
<tr>
<td><strong>Short Run</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP-1</td>
<td>393,829</td>
<td>393,446</td>
<td>-383</td>
<td>-0.10</td>
</tr>
<tr>
<td>GDP-2</td>
<td>423,435</td>
<td>423,323</td>
<td>-113</td>
<td>-0.03</td>
</tr>
<tr>
<td>GDP-3</td>
<td>423,435</td>
<td>423,268</td>
<td>-168</td>
<td>-0.04</td>
</tr>
<tr>
<td>GDP-4</td>
<td>393,829</td>
<td>393,501</td>
<td>-328</td>
<td>-0.08</td>
</tr>
<tr>
<td><strong>Shortest Run</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP-1</td>
<td>393,829</td>
<td>393,075</td>
<td>-754</td>
<td>-0.19</td>
</tr>
<tr>
<td>GDP-2</td>
<td>423,435</td>
<td>422,919</td>
<td>-517</td>
<td>-0.12</td>
</tr>
<tr>
<td>GDP-3</td>
<td>423,435</td>
<td>422,862</td>
<td>-573</td>
<td>-0.14</td>
</tr>
<tr>
<td>GDP-4</td>
<td>393,829</td>
<td>393,132</td>
<td>-698</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

In this case, we get results of similar magnitude, but of an opposite sign. Note that in all three closure options simulating long run, short run, and shortest run, the impact on the GDP is negative and ranges from -0.19 in the shortest run, to -0.03 in the short and long run.
treatments. The average impact in the shortest run is -0.1575. The average impacts in the two treatments where labor and capital have greater mobility are -0.0625 in the short run and -0.07 in the long run. As with the interpretation of the changes that took place in the previous simulation, the most important finding here is that the magnitude is in a range between -15 and -7 basis points. The proper interpretation may not be one that emphasizes the negative values, but rather the negligible magnitude.

Table 14 shows revenue collected, by source, by the state government. Here we see the absence of personal and corporate income taxes, and the considerably larger amount of revenue generated by the sales tax to compensate. The intermediate tax revenue is essentially unchanged from the previous treatment, as those policies are again imposed here. Also, the figures below show approximately 90% of the net decrease in revenue. The remainder of the 4% decrease in revenue is found in a lower factor income as a result of the now lower market clearing rental rate of capital.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Long Run</th>
<th>Short Run</th>
<th>Shortest Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calculated</td>
<td>Difference</td>
<td>Calculated</td>
<td>Difference</td>
</tr>
<tr>
<td>PIT</td>
<td>9,886</td>
<td>0</td>
<td>-9,886</td>
<td>0</td>
</tr>
<tr>
<td>CIT</td>
<td>740</td>
<td>0</td>
<td>-816</td>
<td>0</td>
</tr>
<tr>
<td>Sales</td>
<td>4,083</td>
<td>14,308</td>
<td>10,225</td>
<td>14,310</td>
</tr>
<tr>
<td>Intermediate</td>
<td>0</td>
<td>-11</td>
<td>-11</td>
<td>-11</td>
</tr>
<tr>
<td>Total</td>
<td>14,785</td>
<td>14,297</td>
<td>-488</td>
<td>14,299</td>
</tr>
</tbody>
</table>
B. Household Results

In our household results, we see the model confirm economic intuition. We expect an elimination of the income tax to mostly benefit those with the highest prior tax rate. We would further expect the expansion and increase of the sales tax to harm those for whom taxable consumption is the largest proportion of their income. These results are found in results for both utilities and equivalent variation.

In our utilities measures, found in Table 15, we see that the poorest households are hit hardest by the reform, with a decreased utility between -1.6% in the short run, and -1.5% in the long run. We see that utility changes are negative for all groups with annual incomes below the $50,000 cutoff. For groups of annual incomes of $50,000 or more, we see utility changes near zero or positive reaching a high for the richest household group with an increase in utility of approximately .3% in the long run.10

10 Households 1-5 have incomes less than $50,000. For more details, refer to Table 4,
In Table 15, we see that the equivalent variation for the average household in each income group agrees with our utility findings. The equivalent variations for the poorest five income groups with incomes below $50,000 per year all show negative equivalent variations, with the lowest being $543 for the poorest household group. Equivalent variations for the richest four households are noticeably higher, with a low of -$7 and a high of $1,377. As with utilities and in our other findings, we see very little difference between our short run and long run closures, but both are uniformly higher than the shortest run treatment.

The magnitude of the equivalent variation gives an approximate scale to the utility findings. It is true that, in the simulation, household income net of taxes increases for each household, but in the after tax price of final goods, the increase ranges between 5% for previously taxed goods, and approximately 9% for previously untaxed goods. These increases hit the poorest households hardest, as they consume a much higher proportion of income. The -$514 value for the poorest group in the long run represents approximately 15% of their taxable income. This is even higher than the new increased tax rate. Obviously, if 100% of their income were now spent on the goods with the highest tax increase, we should not expect an equivalent
variation proportionally above the tax rate. This proportion is high because transfers from government, other households, and a small amount of capital income increases the total resources available for expenditure above the calculations used for income, subject to the personal income tax. It is also notable that the magnitude for the richest household group is less than their savings from the income tax elimination. Their proportion is less than a single percent of their total taxable income. This may be a result of the relatively lower return to capital, which represents approximately 40% of their income.

<table>
<thead>
<tr>
<th></th>
<th>Long Run</th>
<th>Short Run</th>
<th>Shortest Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHD1</td>
<td>(514)</td>
<td>(515)</td>
<td>(543)</td>
</tr>
<tr>
<td>HHD2</td>
<td>(283)</td>
<td>(283)</td>
<td>(304)</td>
</tr>
<tr>
<td>HHD3</td>
<td>(460)</td>
<td>(461)</td>
<td>(507)</td>
</tr>
<tr>
<td>HHD4</td>
<td>(348)</td>
<td>(348)</td>
<td>(373)</td>
</tr>
<tr>
<td>HHD5</td>
<td>(304)</td>
<td>(306)</td>
<td>(488)</td>
</tr>
<tr>
<td>HHD6</td>
<td>82</td>
<td>77</td>
<td>11</td>
</tr>
<tr>
<td>HHD7</td>
<td>27</td>
<td>23</td>
<td>(7)</td>
</tr>
<tr>
<td>HHD8</td>
<td>499</td>
<td>496</td>
<td>442</td>
</tr>
<tr>
<td>HHD9</td>
<td>1,377</td>
<td>1,366</td>
<td>1,339</td>
</tr>
</tbody>
</table>

These household findings could be an understatement of the regressivity in other ways as well. We might expect richer households to have a greater ability to avoid taxes by importing goods from other regions. This would require justification, but variation in the Armington elasticities between income groups could exacerbate the regressivity. Higher sales tax might harder hit industries such as tourism, which hire many lower-wage workers. Also, the equivalent variation for household 1 (HHD1) may be understated because that household had a high initial income tax rate (shown in Table 4) and thus received unusually high income tax
relief with its elimination. Also not included in this model are any feedback effects on federal income taxes or transfers. For example, high earners would now be transferring more to the federal government because they are deducting less for state income taxes paid; for the same reason, low earners might receive less in transfers as a result of higher federal income tax liability.

We are reluctant to draw more refined conclusions from the magnitude of the household effects for low income groups due to peculiarities in the IMPLAN extract for these households, especially groups 1 and 2. Also, the magnitudes for low earners are particularly acute, while those for the high income earners are particularly weak. Finally, corner solution models with tax rates of zero can present problems that are unresolvable with a model designed for general rather than specific purposes. Regardless of our trepidation regarding magnitudes, the regressivity of the reform is clear.
C. Industry Results

In our industry results for this treatment we use the labels found in Table 17, which are the same as those listed in Tables 1 and 9.

TABLE 17 – Aggregated industry labeling key

<table>
<thead>
<tr>
<th>Aggregation Label</th>
<th>Aggregation Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFFH</td>
<td>Agriculture, forestry, fishing, and hunting</td>
</tr>
<tr>
<td>MIN</td>
<td>Mining</td>
</tr>
<tr>
<td>MANUF</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>MEDIMAN</td>
<td>Medical equipment manufacturing</td>
</tr>
<tr>
<td>UTIL</td>
<td>Utilities</td>
</tr>
<tr>
<td>FOOD</td>
<td>Groceries for home consumption</td>
</tr>
<tr>
<td>INFOSER</td>
<td>Information services</td>
</tr>
<tr>
<td>HEEDSER</td>
<td>Health and education services</td>
</tr>
<tr>
<td>OTHSER</td>
<td>All other services</td>
</tr>
<tr>
<td>CONST</td>
<td>Construction</td>
</tr>
<tr>
<td>WHOLTRAD</td>
<td>Wholesale trade</td>
</tr>
<tr>
<td>RETTRAD</td>
<td>Retail trade</td>
</tr>
<tr>
<td>TRAN</td>
<td>Transportation</td>
</tr>
<tr>
<td>MOVIE</td>
<td>Motion picture and music video production</td>
</tr>
<tr>
<td>GOVSPC</td>
<td>Government services</td>
</tr>
</tbody>
</table>

There is an important caveat to address in our industry results: our decision to impose a 9% rather than a 9.2% sales tax reveals itself here in our findings for government services. The entire decrease of 4% of the budget is not located here, as the remainder is spread out over transfers to households and other levels of government, but that negative value is a result of our balanced budget closure rule and our decision to impose a sales tax without decimals. The remaining results are endogenous and reflect the new equilibrium resulting from the policy changes.
In Tables 18 and 19, we see that there is little difference between the effects by commodity and activity, respectively, as the values are quite similar. As in the case of the Special Council simulation, we see negative effects on food, all newly taxed services, and the movie industry. The exception here is in health and education, which sees robust growth. We also note that the utilities industry, which enjoys some new tax advantages, grows fastest. The other notable success is in retail trade, which survives the higher sales tax and apparently thrives with the now moderately lower equilibrium wage rate. The remaining industries are unaffected or see moderate growth. The average increase is between 0.16% in the shortest run and 0.39% in the long run.
<table>
<thead>
<tr>
<th>Industry</th>
<th>Baseline</th>
<th>Long Run</th>
<th>Short Run</th>
<th>Shortest Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calculated</td>
<td>% Difference</td>
<td>Calculated</td>
<td>% Difference</td>
</tr>
<tr>
<td>AFFH-A</td>
<td>9,622</td>
<td>9,659</td>
<td>0.38</td>
<td>9,662</td>
</tr>
<tr>
<td>MIN-A</td>
<td>1,734</td>
<td>1,744</td>
<td>0.57</td>
<td>1,744</td>
</tr>
<tr>
<td>MANUF-A</td>
<td>102,187</td>
<td>102,441</td>
<td>0.25</td>
<td>102,443</td>
</tr>
<tr>
<td>MEDIMAN-A</td>
<td>5,475</td>
<td>5,516</td>
<td>0.76</td>
<td>5,518</td>
</tr>
<tr>
<td>UTIL-A</td>
<td>11,745</td>
<td>12,109</td>
<td>3.09</td>
<td>12,112</td>
</tr>
<tr>
<td>FOOD-A</td>
<td>45,098</td>
<td>45,119</td>
<td>0.04</td>
<td>45,135</td>
</tr>
<tr>
<td>INFOSER-A</td>
<td>44,652</td>
<td>44,504</td>
<td><strong>(0.33)</strong></td>
<td>44,513</td>
</tr>
<tr>
<td>HEEDSER-A</td>
<td>49,882</td>
<td>51,521</td>
<td>3.28</td>
<td>51,519</td>
</tr>
<tr>
<td>OTHER-A</td>
<td>236,884</td>
<td>236,141</td>
<td><strong>(0.31)</strong></td>
<td>236,176</td>
</tr>
<tr>
<td>CONST-A</td>
<td>33,797</td>
<td>33,308</td>
<td><strong>(1.45)</strong></td>
<td>33,308</td>
</tr>
<tr>
<td>WHOLTRAD-A</td>
<td>38,985</td>
<td>39,307</td>
<td>0.83</td>
<td>39,308</td>
</tr>
<tr>
<td>RETTRAD-A</td>
<td>32,246</td>
<td>32,015</td>
<td>2.39</td>
<td>32,015</td>
</tr>
<tr>
<td>TRAN-A</td>
<td>26,197</td>
<td>26,420</td>
<td>0.85</td>
<td>26,421</td>
</tr>
<tr>
<td>MOVIE-A</td>
<td>1,214</td>
<td>1,186</td>
<td><strong>(2.27)</strong></td>
<td>1,187</td>
</tr>
<tr>
<td>GOVSPC-A</td>
<td>77,069</td>
<td>75,302</td>
<td><strong>(2.29)</strong></td>
<td>75,297</td>
</tr>
<tr>
<td>Average</td>
<td>0.39</td>
<td>0.40</td>
<td>0.20</td>
<td></td>
</tr>
</tbody>
</table>

If we remove government services from the calculation above to see the growth rates of all industries without the artificial decrease we imposed by our inexact budget neutral tax change, we have a higher average for the remaining 14 private sector industries. Using this measure, the average growth rates vary from 0.29% in the shortest run for commodities, and as much as 0.59% for activities in the short run. Table 18 shows the values for both private sector commodity and activity growth rates and their average across treatment. The average of the growth rates of both commodities and activities is an arbitrary measure that can be interpreted as the growth of the general sector of the economy.
X. CONCLUSIONS

In both of our simulations, we see what one would expect from a modest subnational tax reform package that is intended to be revenue neutral: modest effects. In either simulation, the effect on gross state product is measured in basis points. In the Special Council reform, the effect on GDP is negligibly positive, while in the income tax elimination simulation the effect is negligibly negative. In both cases, the long run, with mobile and variable capital and labor, has a higher GDP than in the shortest run, with activity specific capital and fixed supplies of both labor and capital. This suggests that either reform will cause some growing pains before all adjustments are made.

In the Special Council’s simulation, Georgia’s wealthier four household groups would be wealthier, in the long run, by at least $85, while the poorest five groups are either unaffected or poorer by no more than $83 dollars. In the long run, those making less than $50,000 will have their utilities decline by less than five basis points, while those making more than $50,000 will have their utilities increase by as much as seven basis points. These dollar figures and utility changes are so insignificant as to be disregarded in the decision whether or not to institute the Special Council reform.
The more extreme hypothetical of replacing the income tax with an expanded uniform sales tax reveals the regressivity of the general direction of the more balanced Special Council reform. We see the poorest lose 1.5% of their utility while the richest gain 0.3%. In dollar terms, the poorest are hit with a negative equivalent variation greater than the proportion of the new sales tax to their taxable income, and the richest benefit by less than 1%. Again, these effects are in the direction we would expect in theory, and even the largest swing in utility is small enough to perhaps be compensated for by transfers. However, the total negative equivalent variation for the 58% of the population that has a negative value would require more in terms of transfers than is gained by the remainder.

In the Special Council simulation, industrial output is approximately 0.25% above what it would have been, although food, other services, and movie industrial sectors suffer. The remaining industries are unaffected or have output as much as 1.07% higher. In the income tax elimination model, we see more robust growth from our industries than that seen in the Special Council simulation, with a bit more than 0.33% increase in the long run. Furthermore, this growth would be 0.5% without inclusion of the artificially low government.

As planned, the Special Council’s tax reform is essentially budget neutral, with a shortfall of $70 million. This would be diminished by the elimination of the sales tax holiday or other unsimulated reforms. The income tax elimination simulation makes an arbitrary decision to allow for a 4% decrease in the size of the state’s budget to avoid an unwieldy 9.2% sales tax. This 4% decrease is the approximate size of the simulated corporate income tax relief.

The imposition of either tax reform is not unambiguously positive for all participants in the economy. In the Special Council simulation, we see that the GDP and output increase, so
we know that this reform expands economic activity. Furthermore, the welfare gains from those with positive equivalent variations are enough to compensate for the losses. Regarding the efficacy of the distribution of gains in industry, those industries that had previously benefited from exclusions in the tax code suffer when those exclusions are removed and are treated like the rest of the sectors under the uniform code.

The income tax elimination is a more extreme adjustment and may require additional model refinement to draw precise conclusions. However, this approach is considerably more regressive than the Special Council’s recommendation. The effect on GDP, the budget, and industry output are mixed, with the first being nearly unaffected, the second decreases, and the latter increases.

Further research may include dynamics to simulate the proposed implementation over time to tease out the adjustment path. Additional attention could also be paid to household specific elasticities to try to get more precise measures of magnitude for the household effects. Alternative industry aggregations could be considered to observe subsectors of industries that are more affected by the reforms. Finally, one could include additional parameters for the feedback effects on individuals regarding transfers received from the government or taxes paid as a result of diminished taxable income.
CHAPTER THREE: A SIMULATED FUTURE OF EGYPT

Thanks to coauthors: Manal Metwaly, Nour Abdul-Razzak, and Andrew Feltenstein

I. INTRODUCTION

Computable general equilibrium (CGE) models are frequently used to simulate fiscal policy changes, trade liberalization, or monetary policy actions to estimate the resulting effects on economic variables such as growth, income distribution, or deficits. However, the CGE framework also allows for inclusion of other exogenous events by altering key parameters after calibration. In most cases, this exercise is applied to simulate some minor change to the productivity of factors, as in the effect of a drought on an economy by decreasing the productivity of land in the agriculture sector, for example. The application of this approach to more drastic changes has, in the past, been limited by the unavailability of important data.

The Egyptian revolution in 2011 provides an interesting opportunity to use this feature of CGE models to study a drastic change to an economy. Egypt’s revolution had this type of substantial macroeconomic impact by negatively impacting key industries, balance of payments, budget deficits, foreign direct investment, and other observable and measurable variables. Furthermore, as the revolution took place, the Egyptian bureaucracy continued to collect data on the economy. This paper will use pre-revolution historical data for calibration and post-revolution data to incorporate known exogenous effects of the Egyptian revolution in a
dynamic general equilibrium model that endogenously generates tax avoidance behavior. We will then simulate the current policy and a fiscal reform in post-revolution Egypt.

II. EGYPT BEFORE AND AFTER THE REVOLUTION

Over the past twenty years, Egypt has transformed its economy. Beginning in 1991 with the Economic Reform and Structural Adjustment Program, Egypt restored macroeconomic equilibrium by increasing the role of the private sector, relaxing price controls, reducing trade restrictions, and taming inflation and budget deficits. Egypt instituted structural reforms in the area of monetary policy in 2000 with abolishment of the de jure exchange rate peg. It introduced a domestic currency overnight interbank market, and a foreign exchange interbank market, in 2001 and 2004, respectively. In 2005, in an effort to control inflation and stabilize prices, the Central Bank of Egypt (CBE) established a ‘corridor system’ with a ceiling and a floor for the overnight interest rates on both lending from and deposits to the CBE. Their goals were not met. According to the International Monetary Fund (IMF), inflation at the beginning of the decade was under 3%, but by 2008 it had reached 20%.

Modest tax reform took place in 2001, with the general sales tax extended to the wholesale and retail sectors. Major reforms were enacted in 2005. The top personal income tax rate was decreased from 32% to 20%. Taxes on corporate profit were cut from 40%, to 20% on profits under $10 million EGP, and to 25% on profits above $10 million EGP. Property tax rates were cut from 46% to 10%. Sales taxes were standardized and cut from 46% to 30% for luxury goods; 3% to 0% for essential goods; and a uniform rate of 10% for all non-luxury,
nonessential goods. Further restructuring included the consolidation of numerous tax collection agencies into a single agency and the implementation of self-assessment of tax liability.

Following the major fiscal and monetary reforms in 2005, Egypt’s economy tracked in a generally positive direction. Growth rates reached as high as 7.2% before the financial crisis triggered a low of 4.7%. Unemployment fell from a rate of 11.5% in 2005 to 9% in 2010. The debt-to-GDP ratio fell from 103% to 70% in 2008. Inflation, however, rose from 4.7% to 20.2% in the same period. This inflation is often cited as an instigating factor of the revolution, as the poor were hardest hit by rising food prices.

In January of 2011, the Egyptian revolution ousted Mubarak from the Presidency of Egypt, the office he had held for nearly 30 years. According to protestors, the revolution was largely a political one for democracy, and against police and government corruption. We believe that it is reasonable to assume that Egypt’s new leadership will not drastically alter the structure of the economy by nationalizing private companies or pursuing socialist or isolationist policies. For the purpose of our model, we assume that the largely free market economic system in Egypt, as it existed prior to the revolution, will continue to exist.

The direct effects of the revolution on the economy were significant. During the revolution, crime rates rose causing tourism to fall dramatically. Tourism in 2010 accounted for 13% of GDP, 11% of total employment, $14 billion in export revenue, and 22% of total exports (WTTC, 2010). According to the Central Agency for Public Mobilization and Statistics (CAPMAS),
tourism fell by one third in 2011. Outside sources have put the figure as high as 70%\textsuperscript{11}. After the revolution, unemployment increased from 9% to 12.1%; real GDP growth fell from 5.1% to 1.8%; and Egypt saw its bond ratings downgraded by all three major ratings agencies (EMOP). Business starts decreased, consumption fell, and investment decreased. Quarterly foreign direct investment fell from an inflow of nearly $2.5 billion to an outflow of $163 million (MOED). Regarding fiscal policy, following the revolution, leaders stipulated a 15% increase in wages and pensions for the government sector, and the top marginal income tax rate was increased to 25%.

Billions of dollars were pledged by foreign governments to the Egyptian people in the form of foreign aid for post-revolution recovery. Initial infusions of cash and petroleum products from Qatar and Saudi Arabia have kept the currency afloat. The interim military government was able to raise funds by selling Egyptian bonds, but the interest rate on a one year bond was 16%. After the June 30, 2012, election of Mohamed Morsi as the new Egyptian President, the IMF worked unsuccessfully with the new Egyptian government to set terms of a $3.2 billion loan. Morsi’s first official trip was to Saudi Arabia, where he received $1.75 billion in aid. In the first year after the revolution, foreign exchange reserves fell from $36 billion to $15.5 billion, enough to cover three months of imports.

In November 2012, President Morsi issued a declaration immunizing his decrees from legal challenge. The president justified this as a move to protect the work of the constitutional

\textsuperscript{11} It is difficult to use CAPMAS data for tourism because Tunisian, Libyan, and other refugees cannot be separated from tourists.
assembly, but instead it set the stage for a second uprising. The following month, the constitution was approved by referendum, despite protests, with approval of 63% of voters. The unrest continued until a large protest, scheduled in June 2013, continued until July 3, when Egyptian army chief general Abdel Fattah el-Sisi removed Morsi from power. The next day, el-Sisi named Adly Mansour, a former judge, as Egypt’s interim President, but observers noted that el-Sisi was running the country. In January 2014, a new constitution was enacted with 98% approval. Elections for the Presidency are scheduled for late May 2014, with el-Sisi polling well after the March 26th announcement of his candidacy.

The new Egyptian President will inherit an economy with significant problems. As a result of a lack of security, crime, curfews, and civil unrest, GDP growth fell to an annualized rate of 1% in the first quarter of 2014. GDP forecasts for 2014 range between 2% and 2.5%. The deficit is currently at 13% of GDP, with a debt-to-GDP ratio of nearly 90%. Aid from Saudi Arabia and others has kept foreign reserves above the 3 month minimum, but inflation has increased over the last few months from a 7.6% annual rate to a monthly rate equal to an annual inflation of more than 13%. Table 1 displays key indicators of the Egyptian economy before and after the 2005 tax reforms and the revolution. Inflation continues to rise and impede investment and confidence in the stability of the Egyptian economy. Furthermore, despite efforts to reduce public spending, public domestic debt has increased to 90% compared to an average of 50% in the Middle East and North Africa (Achy, 2010).
TABLE 21 – Egyptian Economy Before and After 2005 Tax Reforms and 2011 Revolution

<table>
<thead>
<tr>
<th>Year</th>
<th>Nominal GDP (Billion US$)</th>
<th>Real GDP (Billion EGP)</th>
<th>Real GDP Growth Rate</th>
<th>Price Index (1999 = 100)</th>
<th>Inflation Rate</th>
<th>Unemployment Rate</th>
<th>Gov’t Debt (% of GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>100</td>
<td>355</td>
<td>5.4</td>
<td>101.1</td>
<td>1.1</td>
<td>9.0</td>
<td>n/a</td>
</tr>
<tr>
<td>2001</td>
<td>97</td>
<td>367</td>
<td>3.5</td>
<td>103.4</td>
<td>2.3</td>
<td>8.8</td>
<td>n/a</td>
</tr>
<tr>
<td>2002</td>
<td>86</td>
<td>379</td>
<td>3.2</td>
<td>106.2</td>
<td>2.7</td>
<td>10.1</td>
<td>90.4</td>
</tr>
<tr>
<td>2003</td>
<td>81</td>
<td>391</td>
<td>3.2</td>
<td>110.5</td>
<td>4.1</td>
<td>11.3</td>
<td>102.3</td>
</tr>
<tr>
<td>2004</td>
<td>79</td>
<td>407</td>
<td>4.1</td>
<td>123.4</td>
<td>11.7</td>
<td>10.5</td>
<td>101.5</td>
</tr>
<tr>
<td>2005</td>
<td>90</td>
<td>425</td>
<td>4.5</td>
<td>129.2</td>
<td>4.7</td>
<td>11.5</td>
<td>103.3</td>
</tr>
<tr>
<td>2006</td>
<td>107</td>
<td>454</td>
<td>6.8</td>
<td>138.5</td>
<td>7.2</td>
<td>10.9</td>
<td>90.3</td>
</tr>
<tr>
<td>2007</td>
<td>130</td>
<td>487</td>
<td>7.1</td>
<td>150.4</td>
<td>8.6</td>
<td>9.2</td>
<td>80.2</td>
</tr>
<tr>
<td>2008</td>
<td>162</td>
<td>521</td>
<td>7.2</td>
<td>180.7</td>
<td>20.2</td>
<td>8.8</td>
<td>70.2</td>
</tr>
<tr>
<td>2009</td>
<td>189</td>
<td>546</td>
<td>4.7</td>
<td>198.7</td>
<td>10.0</td>
<td>9.5</td>
<td>73.0</td>
</tr>
<tr>
<td>2010</td>
<td>219</td>
<td>574</td>
<td>5.1</td>
<td>220.0</td>
<td>10.7</td>
<td>9.0</td>
<td>73.2</td>
</tr>
<tr>
<td>2011</td>
<td>236</td>
<td>584</td>
<td>1.8</td>
<td>245.9</td>
<td>11.8</td>
<td>12.1</td>
<td>76.6</td>
</tr>
<tr>
<td>2012</td>
<td>262</td>
<td>597</td>
<td>2.2</td>
<td>272.5</td>
<td>10.8</td>
<td>12.3</td>
<td>80.6</td>
</tr>
<tr>
<td>2013</td>
<td>271</td>
<td>609</td>
<td>2.1</td>
<td>289.5</td>
<td>6.2</td>
<td>13.0</td>
<td>89.5</td>
</tr>
</tbody>
</table>

Source: International Monetary Fund, World Economic Outlook Database, April 2014

**At an exchange rate of $1=£0.155, Egyptian Nominal GDP is approximately £1,753 in 2013.
III. EGYPTIAN TAX EVASION AND INFORMAL SECTOR

A. Tax Evasion

High levels of tax evasion represent serious challenges for many developing nations as they seek to grow and expand their public services. Trade liberalization is a significant part of many reforms in developing nations. Consequently, there is a need to increase domestic revenues to replace revenues lost to decreased tariffs (Toye, 2000). Furthermore, if taxes are too high or too cumbersome to pay, the threat of citizens’ migration to an informal economy becomes more likely (Turnovsky and Basher, 2009). Thus, it is in the government’s best interest to develop policies that creatively increase tax compliance while promoting economic growth.

Egypt is an interesting case, as it has transformed itself in the past thirty years from an economy dominated by the public sector to a private sector and market-oriented economy (Dobronogov et al., 2005). At the same time, Egypt has implemented a series of tax reforms. Although many other Arab countries have instituted tax reforms and structural adjustment programs, Egypt is the largest and most diverse non-oil based Arab economy to manage such extensive reforms. Egypt has seen moderate growth since the implementation of structural adjustment programs. However, following the global financial crisis of 1997 and a domestic financial scandal in 1998, Egypt’s economic growth slowed and failed to sustain a high growth rate. Prior to the revolution, negative global shocks continued and Egypt’s fiscal situation deteriorated with steadily increasing budget deficits. According to the IMF, fiscal vulnerabilities remain as Egypt’s main macroeconomic risk (“Arab Republic of Egypt...” IMF, 2010).
Egypt’s tax revenue-to-GDP ratio in 2010 was only 14.1%\textsuperscript{12}, which is relatively low compared to other Arab economies of similar size and nature, indicating the need to explore policies that curb tax evasion and improve growth rates. Determining the extent to which the tax administration in Egypt is a significant constraint on private sector development is vital. A survey of 1000 enterprises conducted by the World Bank\textsuperscript{13} in 2004 found that tax-related issues were ranked as severe by almost 80% of participants ("Egypt National Investment..." OECD, 2006). Tax authority officials are known to exercise significant discretion in applying rules related to enterprise regulation and public service access. To complicate matters, tax laws are excessively complex, thereby giving more room for the tax authority to act arbitrarily ("Egypt Country Profile..." FEMISE, 2004). These issues have led to an underreporting of income, tax evasion, and subsequently low revenues for the government. Although there is a dearth of literature in this area, the few articles that have explored the cost of tax evasion in Egypt conclude that the benefits of tax evasion exceed its costs at this time (El-din et al., 2000)\textsuperscript{14}. An analysis done by the Egyptian Center for Economic Studies found that the levels of tax evasion in Egypt and other developing nations is a serious issue (Tohamy, 1998). With tax revenue at 14.1% of GDP in 2010, Egypt’s tax effort is relatively similar to that of the Philippines at 15.7%, Indonesia at 15.5%, and Thailand at 15.7% (Gordon and Li, 2009). Developing nations’ tax revenues average about 19.6% of GDP compared to 28.4% in the developed world. However, 

\textsuperscript{12} Some additional revenue is obtained from Suez Canal fees that is not included in the tax to GDP ratio, but the ratio only increases to 16.8% with its inclusion.

\textsuperscript{13} World Bank Investment Climate Survey of Egypt

\textsuperscript{14} El-din, Fawza and Refaat did not determine how tax evasion affects investment quantitatively because of the lack of information regarding transactions costs of tax compliance and the magnitude of tax evasion.
Egypt’s tax-to-GDP ratio falls well below that of other neighboring Arab countries with similar economies, such as Morocco (at 24%), Tunisia (at 21%) and Jordan (at 20%). This further emphasizes Egypt’s weak fiscal situation, possibly as a result of high rates of tax evasion. As with many other problems in Egypt, tax evasion was exacerbated by the revolution, when tax revenue as a percent of GDP fell to 13.2%. This put Egypt slightly below Columbia (13.3%) and slightly above Uganda (13%).

Although Egypt was labeled the top tax policy reformer in the world by the Doing Business Report of 2008, substantial obstacles remain, especially for small and medium enterprises that comprise 80% of Egypt’s GDP. A World Bank Investment Climate Survey from 2004 found that access to financing and its associated costs are the main reasons for constrained investment and growth of small and medium enterprises. Credit in the private sector has averaged around 40% of GDP in the past 5 years. Access to bank credit is necessary to support growth of the private sector, and it could partially replace self-financing and the now absent foreign direct investment. A survey conducted by the Egyptian Center for Economic Studies found a mismatch between banks’ excess lending capacity and the volume of loans provided to the private sector (Abdel-Kader, 2006). For a majority of firms (70%), the main source of financing was the firm’s own funds (retained earnings).

Despite a large banking system, credit in the private sector remains concentrated among large enterprises (“International Bank for Reconstruction...” World Bank, 2010). Over half of the credit given to the private sector goes to less than 0.2% of bank clients, according to the Central Bank of Egypt. The 2009 Investment Climate Assessment survey found that firm size is the most important characteristic associated with whether or not a firm had a loan or
overdraft capacity. Reforms have taken place to increase access to credit, including creating a new private credit bureau: iScore. Measures were also taken to reduce the minimum capital required to start a business, from 50,000 Egyptian pounds to 1,000 Egyptian pounds (Alissa, 2007). Egypt has strong future growth prospects; however, the low level of private credit to businesses and households as a percentage of GDP remains problematic (IMF, 2010).

B. Egyptian Informal Sector

With an estimated 8.2 million people in the informal sector (37% of the workforce), there is great opportunity to broaden Egypt’s tax base (World Bank 2010). A USAID report found that between the years 1998 to 2006, the informal economy grew at an annual rate of 5.3% (Alissa, 2007). Furthermore, USAID found that about 40-60% of the cost of doing business is result of the cumbersome regulatory framework that promotes the informal economy.

Very few studies have explored the nature of the informal economy in Egypt. Economist Hernando de Soto of the Institute for Liberty and Democracy led years of fieldwork and analysis for the Egyptian government to determine how much of the economy operated “extralegally” (de Soto, 2011). This notable study concluded that the underground economy was the nation’s largest employer in 2004. He found that 9.6 million people worked in the extralegal sector, while 6.8 million were employed in the private sector, and 5.9 million in the public sector. Furthermore, 92% of Egyptians hold their property without normal legal title. Without any legal title to assets and real estate, entrepreneurs cannot leverage these assets as collateral for loans
or investment capital. As a result, the majority of enterprises remain small and poor. At the time, de Soto estimated the value of these extralegal businesses and properties (in both the rural and urban parts of Egypt) to be $248 billion, 6 times greater than total savings and deposits in commercial banks in Egypt, and 30 times more than the market value of the companies registered in the Cairo Stock Exchange. The survey also identified the primary causes for extralegality in Egypt, notably the convoluted and redundant legal requirements for the various stages of a firm’s development. The primary cause identified for the difficulty of expansion is the lack of access to credit. de Soto’s findings have since been corroborated by other Egyptian studies and surveys.

The Egyptian Labor Market Survey Data for 2006 found that medium and large firms hire nearly 25% of their workers informally and thus without a secure contract or social security (World Bank, 2010). The 2009 Investment Climate Survey by the World Bank found that managers surveyed ranked tax rates, and uncertainty about economic and regulatory policies as major constraints to businesses. Furthermore, El-din et al. (2000) found that taxation has a major impact on competitiveness and net profitability through its effect on the cost of capital in Egypt. They showed that debt financing alleviates the effective tax burden on projects and therefore provides an additional incentive to borrow. However, this means of financing new investments is not easily accessible to non-corporate businesses or small or medium enterprises, as they are unable to provide necessary collateral to the banks. As a result, small firms are left with a higher burden of taxation than are large corporations.

Given these findings, we see that even after the tax reforms of 2005, evasion and informality remain key impediments for growth. Many Arab countries have sought taxation
reform through improvements in tax administration and institutional reform. Furthermore, many countries have instituted full-fledged value added taxes (VAT), with Morocco having one of the highest rates in the region. Other Middle East and North African (MENA) tax reforms include lowering corporate income tax rates and implementing online systems (Paying Taxes, 2010). Jordan recently simplified tax forms and introduced an electronic payment system. In 2009, Tunisia mandated that all companies with a high turnover use the online tax system. Both Djibouti and Iran have recently replaced their sales tax with a new value added tax.

Comparisons within the MENA region have shown the detrimental effects of widespread tax evasion and informal economies similar to those found in Egypt. Given the difficult economic times, the revolution, and the inefficient tax system, new policies are needed to stimulate growth, increase revenues, and increase private sector access to credit. As explained below, this model accommodates the large amount of tax evasion and informality as it correlates the underground economy to tax rates and the need to access the banking system.

IV. GENERAL EQUILIBRIUM SPECIFICATION

In this section we develop the formal structure of the dynamic general equilibrium model. This is a dynamic model that endogenously generates tax avoidance behavior by firms. We will detail the model specifications regarding dynamics, production, banking, consumption, government, and the foreign sector.
A. Dynamics

Our model is a sequentially dynamic model\textsuperscript{15} and thus has $n$ discrete time periods. All agents optimize in each period over a 2 period time horizon. That is, in period $t$ they optimize given prices for periods $t$ and $t+1$ with expectations for prices for the future after period $t+1$. When period $t+2$ arrives, agents re-optimize for period $t+2$ and $t+3$, based on new information about period $t+2$. Agents have perfect foresight for the next 2 periods, and adaptively generate expectations for the future thereafter.

B. Production

There are eight factors of production and three types of financial assets:

1-5. Capital types
6. Urban labor
7. Rural labor
8. Land
9. Domestic currency
10. Bank deposits
11. Foreign currency.

\textsuperscript{15} This methodology using discrete time has been in use since early work on inventory policy by Arrow, Harris and Marschak (1951) was generalized by Bellman (1953) and contrasts with optimizations done in continuous time. This method allows us to calibrate our model before adjusting foreign demand.
The five types of capital correspond to five aggregate nonagricultural productive sectors:

A. Light Manufacturing  
B. Heavy Industry  
C. Electricity, Water, Sewage  
D. Transport, Hotel  
E. Housing, Health Services.

An input-output matrix, $A_t$, is used to determine intermediate and final production in period $t$. We use a 25 x 25 Egyptian input-output matrix that is described in the next section. Corresponding to each sector in the input-output matrix, sector-specific value added is produced using capital and urban labor for the nonagricultural sectors, and land and rural labor in agriculture. Hence $A_t$ may have any dimension, but capital is specific to sectors aggregated in the above way. Accordingly, capital is perfectly mobile across a given subsector, but is immobile across other subsectors. Labor, on the other hand, may migrate from the rural to the urban sector.\(^{16}\) This rural-urban migration is an important feature of the Egyptian economy.

The specific formulation of the firm’s problem is as follows. Let $y_{ki}^j$, $y_{li}^j$ be the inputs of capital and urban labor to the $j$th nonagricultural sector in period $i$. Let $Y_{Gi}$ be the outstanding stock of government infrastructure in period $i$. The production of value added in sector $j$ in period $i$ is then given by:

$$va_{ji} = va_{ji}(y_{ki}^j, y_{li}^j, Y_{Gi})$$

\(^{16}\) We assume that the labor market is not segmented and there is no wage differential between workers in the underground and the formal economy.
where public infrastructure may act as a productivity increment to private production.

Sector $j$ pays income taxes on inputs of capital and labor, given by $t_{ki}$, $t_{lij}$ respectively, in period $i$. The interpretation of these taxes is that the capital tax is a tax on firm profits, while the labor tax is a personal income tax that is withheld at source.

We suppose that each type of sector capital is produced via a sector-specific investment technology that uses inputs of capital and labor to produce new capital. Investment is carried out by the private sector and is entirely financed by domestic borrowing.

Let us define the following notation:

\[
C_{Hi} = \text{The cost of producing the quantity } H \text{ of capital } C \text{ of a particular type in period } i.
\]

\[
r_i = \text{The interest rate } r \text{ in period } i.
\]

\[
P_{Ki} = \text{The return to capital in period } i.
\]

\[
P_{Mi} = \text{The price of money in period } i.
\]

\[
\delta_i = \text{The rate of depreciation of capital.}
\]

Suppose, then, that the rental price of capital in period 1 is $P_1$. If $C_{H1}$ is the cost-minimizing cost of producing the quantity of capital, $H_1$, then the cost of borrowing must equal the present value of the return on new capital. Hence:

\[
C_{H1} = \sum_{i=2}^{n} \left[ \frac{P_{Ki}(1-\delta)^{i-2}H_1}{\prod_{j=1}^{i-1}(1+r_j)} \right]
\]  

(15)
where is the interest rate in period j, given by:

\[ r_j = \frac{1}{P_{ Bj}} \]  
(16)

where \( P_{ Bj} \) is the price of a bond in period j. The tax on capital is implicitly included in the investment problem, as capital taxes are paid on capital as an input to production.

The decision to invest depends not only on the variables in the above equation, but also upon the decision the firm makes as to whether it should pay taxes. This decision determines the firm’s entry into the underground economy. We assume that the firm’s decision is based upon a comparison of the tax rate on capital with the rate of return on new capital. If the tax rate on capital is less than the corresponding rate of return, the firm pays the full tax. If the tax rate is greater than the return to new capital, then the firm pays less than the full capital tax. That is, it withdraws, at least partially, into the underground economy.

Formally, in a two period world, suppose that:

\[ \frac{P_{K2}}{1 + r_i} \geq t_{K1} \]  
(17)

such that the present value of the return on one unit of new capital is greater than the current tax rate on capital. In this case, we assume the investor pays the full tax rate on capital inputs. Suppose, on the other hand, that:

\[ \frac{P_{K2}}{1 + r_i} \leq t_{K1} \]  
(18)

Here the discounted rate of return is less than the tax rate on capital, and the firm will attempt to reduce its tax payments by moving into the underground economy. The extent to which the
firm goes into the underground economy is determined by the gap between the tax rate and the rate of return to investment. That is, the tax rate of the firm is $\bar{t}_{k1}$ where:

$$
\bar{t}_{k1} = t_{k1} \left[ 1 - \left( \frac{t_{k1} - P_{k2}}{1 + r_2} \right) \right]^{\alpha}
$$

(19)

Here $0 \leq \alpha$ and higher values of $\alpha$ lead to lower values of taxes actually paid. That is, the ratio $\frac{\bar{t}_{k1}}{t_{k1}}$ reflects the share of the sector that operates in the above-ground economy. Hence $\alpha$ represents a firm-specific behavioral variable. An “honest” firm would set $\alpha = 0$, while a firm that is prone to evasion would have a high value for $\alpha$. We should note that the firm does not actually pay a “rate” lower than the statutory rate. Rather, it under-reports its income so that the effective tax rate paid is $\bar{t}_{k1}$. If a sector can avoid paying taxes, as above, by going into the underground economy, why does it pay taxes at all? That is, why does it simply not set $\bar{t}_{k1} = 0$?

In the next section we develop a simple approach that supposes that a firm’s refusal to pay taxes reduces its ability to borrow from the commercial banking system. Thus, a firm’s desire to invest will constrain its evasion of tax payments.

Suppose that the firm carries out this strategy of reducing tax payments, based on its honesty coefficient. We suppose that the firm’s goal is to maximize the real value of capital stock in its final period, T. Accordingly, the firm wishes to maximize $\bar{V}_{jt}$ where:
$$V_{jt} = \frac{P_{Kjt}[(1 - \delta)^TH_0 + \sum_{l=2}^{T} (1 - \delta)^{T-l}H_l]}{CPI_T}$$

and $CPI_T$ is the consumer price index in period $T$.

C. Banking

The banking sector in our model is quite simple and is meant to capture some of the key features and problems in Egypt as well as many other developing countries. We will suppose that there is one bank for each nonagricultural sector of the economy. There are five such sectors, and hence five banks, corresponding to each of the sectors in the aggregate national income accounts. Such sector specialization of the banking system reflects the reality of many developing countries.

Each bank lends primarily to the sector with which it is associated. The banks are, however, not fully specialized in their corresponding sector. We make the simplifying assumption that each bank holds a fixed share of the outstanding debt of its particular sector. It then holds additional fixed shares of the debt of each of the remaining sectors. We make this assumption of diversification of assets in order to allow for a situation in which a firm that evades taxes, and thereby enters the underground economy, might receive varying degrees of credit rationing from the different banks to which it applies for loans.

We choose a simple approach to determine the degree of credit rationing that firms face. Our premise is that banks have no direct way of knowing whether specific firms operate in
the underground economy. We assume that banks only care about the estimated amount of capital the firm may have. If the firm defaults on its loan, then this represents the best estimate of the amount that the bank could seize. The bank would, presumably, be willing to lend an amount equal to at least the firm’s estimated capital. If the firm requests a loan larger than its estimated capital, the bank may choose to grant the full loan, or it may choose to restrict the loan amount. This restriction would depend, in turn, upon the bank’s degree of risk aversion.

How can the bank estimate the value of the firm’s capital if this information is not directly revealed by the firm? We assume the borrower is required to show the bank his tax returns in order to obtain a loan. There is a single, flat corporate tax rate that the borrowing firm faces. Hence, suppose that $T_{k_1}$ represents taxes actually paid by the borrower in period 1. This is known to the bank, as the potential borrower is required to present his tax returns. Thus, if the borrower is in full compliance with his tax obligation, and hence carried out no underground activity, the value of his capital, $\hat{K}_1$, would be given by:

\[
\hat{K}_1 = \frac{T_{k_1}}{t_{k_1}}
\]  

(21)

Accordingly, the bank would be willing to lend at least $\hat{K}_1$ to the borrower, as this would represent a minimum estimate of the value of the firm’s capital, which could be seized in the
event of a default.\textsuperscript{17} Suppose, however, that the amount the firm wishes to borrow, $C_{H1}$, as in equation (15), such that:

$$C_{H1} > \hat{K}_1$$

(22)

In this case the bank lends an amount $L_1$, where $L_1 < C_{H1}$, as the bank would not be able to seize the full value of the loan in the case of a default. The situation we have described would, in the case of perfect certainty, prompt credit rationing when the estimated value of the firm’s capital is less than its loan request. If the firm’s capital is greater than its loan request, there would be no credit rationing.

In a more realistic case of uncertainty about both the true value of the firm, as well as about the bank’s own ability to seize the firm, one might expect the lending process to be somewhat different. Accordingly, we will suppose that a simple functional form determines bank lending as a function of the amount requested as well as the estimated value of the firm’s capital. We define the amount the bank lends, $L_1$, as:

$$L_1 = C_{H1} \left[ \frac{\hat{K}_1}{C_{H1}} \right]^{y} = C_{H1} \left[ \frac{\hat{K}_1}{C_{H1} + \hat{K}_1} \right]$$

(23)

\textsuperscript{17} We have not explicitly incorporated bankruptcies and defaults in this model, for the sake of simplicity. However, bankruptcies and corresponding bank contractions can be introduced as in Ball and Feltenstein (2001) and Blejer, Feldman, and Feltenstein (2002).
Here $\gamma$ represents a measure of risk aversion by the bank. If $\gamma = 0$, there are no credit restrictions, and the bank ignores estimates of the borrower’s estimated net worth. As $\gamma$ rises, the bank increasingly restricts lending if the term in brackets is less than 1. If the firm pays no taxes, hence operating entirely in the underground economy, $\hat{K}_1 = 0$ and hence $L_1 = 0$, that is there is no lending. If $\frac{\hat{K}_1}{C_{H_1}}$ increases, as would be the case if the value of the firm increases relative to its borrowing request, then $L_1 \Rightarrow C_{H_1}$, that is, the bank lends the full value of the request.

Thus, if a firm operates entirely in the underground economy it will not be able to borrow to finance investment. If banks are highly risk averse, they will never lend more than a firm’s estimated net worth, which is based on its tax return. This tax return, therefore, represents all the information the bank needs in order to determine its response to a request for a loan.

D. Consumption

There are two types of consumers, representing rural and urban labor.\(^{18}\) We further divide the two consumer categories into quintiles. We suppose that each of the now ten representative consumers has differing Cobb-Douglas demands. The consumers also differ in

\(^{18}\) We use two consumer categories in order to correspond to available country data classifications, as described in the next section.
their initial allocations of factors and financial assets. Cobb-Douglas parameters, as well as factor and asset allocations, are parameterized according to the SAM. There is no differentiation between quintiles of either urban or rural labor in the production function; so, to a firm, there are only two sources of labor, rather than the ten we have simulated for consumer income analysis.

The consumers maximize intertemporal utility functions, which have as arguments the levels of consumption and leisure in each of the two periods. We permit rural-urban migration, which depends upon the relative rural and urban wage rate. The consumers maximize these utility functions subject to intertemporal budget constraints. The consumer saves by holding money, domestic bank deposits, and foreign currency. He requires money for transactions purposes, but his demand for money is sensitive to changes in the inflation rate. The consumer pays taxes on his consumption, and does not have any direct contact with the underground economy. That is, he pays the full nominal rates under all circumstances\(^\text{19}\).

E. Government

The government collects personal income, corporate profit, and value-added taxes, as well as import duties. It pays for the production of public goods, as well as for subsidies. In

\(^\text{19}\) Refer to Dabla-Norris and Feltenstein for the specific form or the consumer’s problem.
addition, the government must cover both domestic and foreign interest obligations on public debt. The central government deficit is defined by: \(^{20}\)

\[
D_1 = G_1 + S_1 + r_1 B_0 + r_{F1} e_1 B_{F0} - T_1
\]

(24)

where,

\[D_1 = \text{government deficit in period 1},\]

\[G_1 = \text{spending on goods and services in period 1},\]

\[S_1 = \text{subsidies given in period 1},\]

\[r_1 B_0 = \text{interest obligations on the stock of domestic debt},\]

\[r_{F1} e_1 B_{F0} = \text{interest obligations on the stock of foreign debt},\]

\[T_1 = \text{tax revenue in period 1}.
\]

Note that the tax revenue is partially determined by the degree to which firms enter or exit the formal sector.

The resulting deficit is financed by a combination of monetary expansion, as well as domestic and foreign borrowing.

\[
D_2 = G_2 + S_2 + r_2 (\Delta y_{BGI} + B_0) + e_2 r_{F2} (C_{F1} + B_{F0}) - T_2
\]

(25)

where,

\[D_2 = \text{government deficit in period 2},\]

\(^{20}\) As before, 1 denotes period \(i\) and 2 denotes period \(i+1\).
\( \Delta y_{BG1} \) = interest on initial domestic debt stock plus period 1 borrowing,
\( e_2 r_F (C_F + B_{F_0}) \) = interest on initial foreign debt stock plus period 1 foreign borrowing,
\( T_2 \) = tax revenue in period 2.

The government finances its budget deficit by a combination of monetization, domestic borrowing, and foreign borrowing. We assume that foreign borrowing in period \( i \), \( C_{Fi} \), is exogenously determined by the lender. The government then determines the face value of its bond sales in period \( i \), \( \Delta y_{BGi} \), and finances the remainder of the budget deficit by monetization. Hence:

\[
D_i = P_{Bi} \Delta y_{BGi} + P_{Mi} \Delta y_{Mi} + e_i C_{Fi}
\]

(26)

F. The Foreign Sector

The foreign sector is represented by a simple export equation in which aggregate demand for exports is determined by domestic and foreign price indices, as well as world income. The specific form of the export equation is:

\[
\Delta X_{n0} = \sigma_1 \left[ \frac{\pi_1}{\Delta e_i + \pi_{Fi}} \right] + \sigma_2 \Delta y_{wi}
\]

(27)

where,
\[ \Delta X_{no} = \text{change in the dollar value of exports in period } i, \]

\[ \pi_i = \text{inflation in the domestic price index}, \]

\[ \Delta e_i = \text{percentage change in the exchange rate}, \]

\[ \pi_{fi} = \text{foreign rate of inflation}, \]

\[ \Delta y_{wi} = \text{percentage change in world income, denominated in dollars}, \]

\[ \sigma_1 = \text{real foreign income elasticity}, \]

\[ \sigma_2 = \text{real exchange rate elasticity of export demand}. \]

The combination of the export equation and domestic supply responses determines aggregate exports. Demand for imports is endogenous and is derived from the domestic consumers' maximization problems. Foreign lending is assumed to be exogenous. Thus, gross capital inflows are exogenous, but the overall change in reserves is endogenous. Finally, we will suppose that the exchange rate is fixed.

V. DATA SOURCES

In order to simulate our model we have used a variety of data sources and parameter estimates for Egypt. We will first describe the sources of data regarding production, consumption, effective tax rates, initial stocks, and the estimation of behavioral equations before we turn to the implementation of the model.
A. Production

The input-output structure of intermediate and final production is derived from the Social Accounting Matrix (SAM) from 2008. This SAM was provided by Cairo University and is the product of the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS). Our input-output matrix is aggregated to 25 x 25 with an additional row and column for foreign trade.

Real value added per unit output for each of the 25 domestic sectors is derived from the corresponding shares of wages and gross operating surpluses in each sector's value added. The government is assumed to have a Cobb-Douglas production function whose coefficients are those of the aggregate economy. Finally, in the absence of direct estimation of investment functions, we have taken the functions to be the same for each type of capital. The coefficients of these functions are taken to be those of the value added function for the construction industry. Even though the functions are the same, it does not imply that the levels of investment in the different capital types will be identical. This is because investment depends on the interest rate and the rate of return to capital, which may differ across capital types.

21 See Appendix E for information regarding the Egyptian SAM.
B. Effective Tax Rates


C. Consumption

There are two domestic consumer categories in our model: urban and rural. Each of these consumer groups is divided into quintiles for consumer income analysis. We take consumption weights on each of the 26 input-output goods (including foreign trade) as the expenditure shares in the input-output matrix. We assume that there is a single foreign consumer, representing the rest of the world. These consumers’ demand weights are given by export expenditure shares.

D. Initial stocks

22 Our late colleague Manal Metwaly of Cairo University was instrumental in helping us overcome the language barrier to collect this data.
In our simulations, all initial allocations of factors and financial assets are taken to be stocks at the end of 2008. Stocks of urban and rural labor are obtained by applying the shares of income going to urban and rural labor by quintile (derived from the Egypt SAM) to 2008 Egyptian GDP. Money stocks are taken as M2 for 2008, while initial holdings of interest bearing assets are taken as total government domestic debt, all derived from Central Bank of Egypt’s Monthly Statistical Bulletin. Foreign assets are taken from the same source. The stock of land is taken to be the real value added to agriculture and is taken from the Egypt SAM as the gross operating surplus of the agricultural sector in 2008. Finally, capital stocks are determined as the gross operating surpluses of the corresponding aggregate sectors in the Egyptian SAM.

E. Estimation of Behavioral Equations

Here are the estimations of the behavioral parameters of money demand and export supply for the Egyptian economy. An export demand equation is not estimated here due to Egypt’s small share in the world trade. We use estimation techniques that have been used in the past for other developing countries.
The demand for money is taken from El-Shazly, 2009. The specific form we use is the long run demand for real broad money

\[
(m_2 - p)_t = 2.278 + 0.962 y_t - 0.010 i_t^d + 0.041 r_t^f - 0.032 q_t - 0.032 \pi_t
\]  

(28)

The terms on the right hand side of the equation are:

- \(y_t\) = real income,
- \(i_t^d\) = domestic interest rate,
- \(r_t^f\) = foreign interest rate,
- \(q_t\) = real exchange rate,
- \(\pi_t\) = inflation rate.

All of these are generated within our simulations, with the foreign interest rate being exogenous.

For the export supply equation, we use Ikram, 2006, in which an Egyptian export price elasticity of -1.03 is given, while the world income demand elasticity is approximately 1.0. We assume that total world expenditure on Egyptian exports is divided into demand for the input-output goods according to the shares of exports from each sector in the SAM.
VI. SIMULATIONS

There are three simulations that we refer to as: baseline, revolution, and revolution with tax cut. The model is calibrated to the Egyptian economic data for the years 2008—the year of the SAM, to 2010—the year for the national accounts, and using some new data from 2011 and onward regarding tax changes. The baseline model includes no exogenous changes to any variables or implementation of alternative policies. The revolution simulation includes a 70% decrease in the foreign demand for those industries that were hit hardest by the revolution: tourism, transportation, hotels and restaurants, as well as trade and finance. This adjustment is conducted for a single time period to isolate the effect of the foreign trade aspect of the revolution in that year and on the long term growth path. The final simulation, revolution with tax cut, is identical to the revolution treatment except the corporate income tax is reduced by 25% for the duration of the model to study the effects of the revolution on the economy with an alternative fiscal policy that encourages higher tax compliance.

VII. RESULTS

In analyzing these results we look at the macroeconomic effects on the economy and the government’s budget, the effects on consumers’ utility and income, and the effects on the sectors’ participation in the formal economy.
A. Gross Domestic Product

Regarding the growth rate, in Figure 1 we find that our model, absent the revolution, predicts a return to the robust growth rates seen in the 2005-2010 time period when our SAM was built. However, Figures 1 and 2 reveal that with the revolution the real GDP growth rate is 4.3% less than the baseline in the absence of the lower tax on capital. With the lower corporate income tax rate, we see a 3% net decrease from the higher growth path. The long run effect on GDP of the one-year change in foreign demand is that, five years after the revolution, real GDP is diminished by 3.25%. The effect on GDP is lessened by a more robust growth path in the presence of a cut in corporate income taxes.

FIGURE 1 – Real GDP Growth Rates

<table>
<thead>
<tr>
<th>Year</th>
<th>Baseline</th>
<th>Revolution</th>
<th>Revolution and Tax Cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4.15%</td>
<td>4.15%</td>
<td>4.01%</td>
</tr>
<tr>
<td>3</td>
<td>2.38%</td>
<td>-1.88%</td>
<td>-0.61%</td>
</tr>
<tr>
<td>4</td>
<td>10.42%</td>
<td>10.56%</td>
<td>10.05%</td>
</tr>
<tr>
<td>5</td>
<td>8.84%</td>
<td>8.62%</td>
<td>9.76%</td>
</tr>
<tr>
<td>6</td>
<td>8.09%</td>
<td>8.40%</td>
<td>8.00%</td>
</tr>
<tr>
<td>7</td>
<td>9.07%</td>
<td>9.40%</td>
<td>9.49%</td>
</tr>
<tr>
<td>8</td>
<td>5.21%</td>
<td>5.67%</td>
<td>5.61%</td>
</tr>
</tbody>
</table>
FIGURE 2 – Normalized Real GDP Growth Rate

B. Inflation

Regarding inflation, our simulation results again show a return to the high inflation found in 2008-10 during the time our data was extracted and inflation averaged 13.6%. Our baseline inflation rate averages 10.9% and ranges from 5% to 17.4%. Inflation in the course of the revolution simulation is lower, with an average of 10.6%, while the final treatment, including the tax cut, shows an average inflation rate of 11.5%. Figure 3 reveals the increasing inflation and the effect of the revolution and tax cut on inflation over the duration of the simulation.
C. Budget

Figure 4 shows that the revolution has a negligible effect on tax collections as a percent of GDP, although they are slightly lower as a result of decreased tax revenues from the effected sectors of the economy, but this effect is offset by the smaller economy in that simulation. As we would expect, the lower tax rate on corporations does diminish the tax revenue as a percent of the overall economy. However, the decrease in revenue is not the absolute amount that a static analysis would reveal, as additional firms enter the formal economy and begin paying taxes on their capital in order to access capital markets. Figure 4 also shows that the model predicts a slight increase in the tax-to-GDP ratio from approximately 19% to a bit less than 21%.
Regarding deficits, we see the government running increasingly large deficits into the future (Figure 5). The problem of the deficit is exacerbated by the revolution and further compounded by the tax cut.
D. Consumers

In Table 2, we see the real incomes of the ten consumer groups in period 8. Consumers 1-5 are urban, consumers 6-10 are rural, and the poorest quintiles are 1 and 6. The first thing to note is that urban consumers are considerably wealthier than their rural counterparts. In fact, all but the poorest urban quintile are richer than the richest rural quintile. We also see that the simulated revolution affects urban consumers especially hard, while rural consumers are
actually helped, though the high percentages are an artifact of their low base. This result occurs because the diminished foreign demand almost exclusively affects urban labor, provided by urban consumers. The diminished demand for goods produced using urban labor results in a diminished relative urban wage. We also see that the increased growth provided by the lower tax rate on capital brings urban consumers back to the baseline while increasing the gains made by rural consumers.

<table>
<thead>
<tr>
<th>TABLE 22 – Real income in period 8 by consumer</th>
<th>Baseline</th>
<th>Revolution</th>
<th>Revolution with Tax Cut</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Income</td>
<td>Income</td>
<td>% Change</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer 1</td>
<td>14.6</td>
<td>13.8</td>
<td>-5.33%</td>
</tr>
<tr>
<td>Consumer 2</td>
<td>21.3</td>
<td>20.1</td>
<td>-5.36%</td>
</tr>
<tr>
<td>Consumer 3</td>
<td>26.5</td>
<td>25.2</td>
<td>-5.23%</td>
</tr>
<tr>
<td>Consumer 4</td>
<td>35.2</td>
<td>33.5</td>
<td>-4.92%</td>
</tr>
<tr>
<td>Consumer 5</td>
<td>76.6</td>
<td>74.3</td>
<td>-3.03%</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer 6</td>
<td>3.5</td>
<td>3.9</td>
<td>13.34%</td>
</tr>
<tr>
<td>Consumer 7</td>
<td>4.9</td>
<td>5.5</td>
<td>12.30%</td>
</tr>
<tr>
<td>Consumer 8</td>
<td>6.1</td>
<td>6.8</td>
<td>11.96%</td>
</tr>
<tr>
<td>Consumer 9</td>
<td>7.6</td>
<td>8.5</td>
<td>11.63%</td>
</tr>
<tr>
<td>Consumer 10</td>
<td>19.6</td>
<td>21.3</td>
<td>8.36%</td>
</tr>
</tbody>
</table>

In Table 3, we see the utility values in period 8 relative to the baseline, which is normalized to 100. Again, we see in the revolution simulation that rural consumers gain from the increased relative wage rate and urban consumers suffer. However, with the inclusion of the tax cuts, losses for urban consumers are largely diminished or reversed, while rural consumers have increased gains.
TABLE 23 – Utility in period 8 by consumer

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Baseline</th>
<th>Revolution</th>
<th>% Change</th>
<th>Revolution with Tax Cut</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Utility</td>
<td>Utility</td>
<td>% Change</td>
<td>Utility</td>
<td>% Change</td>
</tr>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer 1</td>
<td>100.0</td>
<td>88.8</td>
<td>-11.2%</td>
<td>95.2</td>
<td>-4.8%</td>
</tr>
<tr>
<td>Consumer 2</td>
<td>100.0</td>
<td>92.3</td>
<td>-7.7%</td>
<td>98.5</td>
<td>-1.5%</td>
</tr>
<tr>
<td>Consumer 3</td>
<td>100.0</td>
<td>93.8</td>
<td>-6.2%</td>
<td>99.9</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Consumer 4</td>
<td>100.0</td>
<td>95.0</td>
<td>-5.0%</td>
<td>101.0</td>
<td>1.0%</td>
</tr>
<tr>
<td>Consumer 5</td>
<td>100.0</td>
<td>98.9</td>
<td>-1.1%</td>
<td>104.7</td>
<td>4.7%</td>
</tr>
<tr>
<td><strong>Rural</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer 6</td>
<td>100.0</td>
<td>121.2</td>
<td>21.2%</td>
<td>127.3</td>
<td>27.3%</td>
</tr>
<tr>
<td>Consumer 7</td>
<td>100.0</td>
<td>120.8</td>
<td>20.8%</td>
<td>126.7</td>
<td>26.7%</td>
</tr>
<tr>
<td>Consumer 8</td>
<td>100.0</td>
<td>121.6</td>
<td>21.6%</td>
<td>127.3</td>
<td>27.3%</td>
</tr>
<tr>
<td>Consumer 9</td>
<td>100.0</td>
<td>121.9</td>
<td>21.9%</td>
<td>127.6</td>
<td>27.6%</td>
</tr>
<tr>
<td>Consumer 10</td>
<td>100.0</td>
<td>116.3</td>
<td>16.3%</td>
<td>120.9</td>
<td>20.9%</td>
</tr>
</tbody>
</table>

E. Formal Sector

Our final variable of interest is the level to which sectors are entering or leaving the formal sector of the economy. Figures 6 and 7 show the percentage participation of each capital sector in the formal economy relative to the baseline for the two alternative treatments. In Figure 6, we see that Heavy Industry and Electricity, Water, and Sewage decrease their levels of compliance and thus operate in the informal sector at a greater rate as a result of the revolution. The other industries are not affected.
Figure 7 shows the effect on participation in the formal economy of the capital sectors relative to the baseline in the final treatment. Here we see that, despite the revolution, the decreased tax on capital has an unambiguously positive impact on participation in the formal economy, as all capital sectors operate in the formal sector at an equal or greater rate. This affirms our theory’s prediction, given that the lower tax rate increases the return to capital, and thus makes borrowing capital and paying taxes to verify assets more attractive. Also of note is that transportation and light manufacturing are not affected in either simulation.
VIII. CONCLUSIONS

From the treatments, we see the long run negative effects and consequences of the revolution on the Egyptian economy. We also see that some of the negative effects can be mitigated by implementing a lower tax on capital and drawing more economic activity into the formal economy. We expect the economic impact of the revolution to be particularly hard on urban workers, as their industries were hardest hit by diminished foreign demand for those goods that they produced. We also expect macroeconomic trends to worsen as the duration of
the revolution lengthens beyond our single time period simulation. One important policy implication of this research is that a significant portion of the economic damage done by the revolution could be mitigated with increased investment spurred by a lower corporate tax rate. However, this would exacerbate some budgetary pressures, though not by the amount indicated by a static analysis, as tax compliance and growth would both be greater.

Extensions of this research may include alternative monetary policies or more comprehensive fiscal policies. Future researcher may also consider alternative uses of the large foreign aid packages being pledged to Egypt. The most obvious extension would expand the shock of the revolution to include multiple time periods representing specific years and calibrated to new data on the Egyptian economy. This analysis may include a comparison of optimistic and pessimistic assumptions about the return of foreign demand.
CHAPTER FOUR: SUMMARY AND CONCLUSIONS

The objective of this research was to investigate the effects of alternative fiscal policies on growth, welfare, and budgets in two interesting and very different cases and then contrast the variations in methodology and findings of the two applications. Regarding the findings, in Georgia we found that a revenue neutral tax reform in direction of greater efficiency negligibly improved gross state product and had a negligibly regressive impact on households, while a more drastic tax reform in the same direction negligibly decreased state product and had a significantly regressive impact on households. We found that the effects on industries of implementing a uniform tax harms those who had paid a below average rate and helps those who had paid an above average rate, but that in the more drastic tax reform the magnitude of the effects is greater with a net positive effect on output greater than we found in the milder reform.

In Egypt, we found that the effects of a brief decrease in the foreign demand for tourism related industries has long lasting consequences. The negative effects of the foreign demand decrease can be better absorbed by an economy with a lower corporate income tax and the resulting larger formal sector. We also find that the effects of the revolution hit the relatively richer urban households significantly harder than the poorer rural households.

Contrasting the findings on growth in the two applications, we can see that the lower taxes in have an ambiguous effect: Egyptian GDP growth rates are improved in just as many years as they are decreased, while in Georgia the growth rates are positive in the modest
reform and negative in the more comprehensive reform. We also see that the tax changes in
Egypt are significantly progressive while the tax changes in Georgia are mildly regressive.

Regarding the designs, we show the flexibility of the methodology for adapting to
sensitive analysis of tax reform in a stable economy or for comparing alternative futures in light
of a regime change. We approached this by presenting various decisions modelers face in the
including the level of policy control, trading circumstances, economic stability, etc. We present
the basic alternatives available, which we chose for our purposes, why, and how.

This research extends the existing literature in a number of ways. The analysis of
Georgia models the joint effects of a tax reform package that includes adjustments to the
personal and corporate income tax, the sales tax, and taxes on intermediate goods in a regional
CGE model. No previous study has examined this combination of fiscal changes. The model also
utilizes a unique aggregation of industries to isolate industry specific tax changes and the
consequent adjustments to output by industry. We also look at the effects of an incremental
step towards an income tax elimination compared to the complete elimination. We simulate
the short and long run effects of each policy to analyze the adjustment paths relative to the
mobility and flexibility of factors. Finally, we extend the basic framework of the model
originally developed by Lofgren, et al. and present the calibration techniques and code for
future modelers.

In Egypt, we apply an existing CGE model involving tax evasion to simulate the future
growth path for Egypt after a decrease in foreign demand using the newest SAM data available.
No previous study has been published studying the post revolution Egyptian economy in this
manner. We look at the immediate and long run effects of the fall in foreign demand on
macroeconomic variables and on the welfare of urban and rural quintiles. We study the effects of the resulting also simulate the regime change in alternative fiscal policy environments to compare macroeconomic indicators.

Finally, this comparison of computable general equilibrium models in very different economies may serve as a useful guide to future modelers interested in a fiscal policy application. In the literature, this methodology has been used primarily for trade analysis and environmental applications such as carbon emissions. However, this methodology is equally useful in fiscal policy analysis, evaluation, and comparison. With what we hope is a useful contrast of CGE application in very different economies, some future modeler may encroach on the private sector and think-tank dominance of CGE fiscal policy analysis.
APPENDIX

APPENDIX A – INCOME TAX CALIBRATION CHECK

In Appendix Table A1, note that the difference between the ratio of the reformed tax rate to the statutory tax rate and the ratio of the baseline tax rate to the simulated tax rate is near zero. This is a check to confirm that we are accurately simulating the tax reform.

<table>
<thead>
<tr>
<th>TABLE A1- Check for accuracy of income tax calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHD1</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Baseline ty</td>
</tr>
<tr>
<td>Simulation ty</td>
</tr>
<tr>
<td>Statutory (Single)</td>
</tr>
<tr>
<td>Statutory (M2K)</td>
</tr>
<tr>
<td>Average (Statutory)</td>
</tr>
<tr>
<td>Reform (Single)</td>
</tr>
<tr>
<td>Reform (M2K)</td>
</tr>
<tr>
<td>Average (Reform)</td>
</tr>
<tr>
<td>Ratio (Reform/Stat)</td>
</tr>
<tr>
<td>Baseline income tax rate</td>
</tr>
<tr>
<td>Simulation income tax rate</td>
</tr>
<tr>
<td>Ratio (Baseline/Sim)</td>
</tr>
<tr>
<td>Difference</td>
</tr>
</tbody>
</table>
APPENDIX B - SPECIAL COUNCIL SIMULATION GAMS code

*Income Tax (SG/TOTAL)
ty('SGOVNE','HHD1') = .00317;
ty('SGOVNE','HHD2') = .00154;
ty('SGOVNE','HHD3') = .01135;
ty('SGOVNE','HHD4') = .01938;
ty('SGOVNE','HHD5') = .01966;
ty('SGOVNE','HHD6') = .02427;
ty('SGOVNE','HHD7') = .02596;
ty('SGOVNE','HHD8') = .02670;
ty('SGOVNE','HHD9') = .02538;

*Sales Tax (GA Sales Tax Rate expanded to untaxed sectors until rate is 4%)
tq("AFFH-C") = 0.0;
tq("MIN-C") = 0.0;
tq("MANUF-C") = 0.0;
tq("MEDIMAN-C") = 0.0;
tq("UTIL-C") = 0.0;
tq("FOOD-C") = 0.034293;
tq("INFOSER-C") = 0.010062;
tq("HEEDSER-C") = 0.0;
tq("OTHSER-C") = 0.021532;
tq("CONST-C") = 0.0;
tq("WHOLTRAD-C") = 0.0;
tq("RETTRAD-C") = 0.0;
tq("TRAN-C") = 0.0;
tq("MOVIE-C") = 0.0;
tq("GOVSPC-C") = 0.0;

*Intermediate Inputs Tax
tq_inp("UTIL-A","AFFH-C") = -.04;
tq_inp("UTIL-A","MIN-C") = -.04;
tq_inp("UTIL-A","MANUF-C") = -.04;
tq_inp("HEEDSER-C") = .04;
tq_inp("MOVIE-A","MOVIE-C") = .04;

*Corporate Income Tax
taxc("SGOVNE","CAP") = .004427*.66;

APPENDIX C - INCOME TAX ELIMINATION GAMS code

*Income Tax (SG/TOTAL)
*Sales Tax  (GA Sales Tax Rate increased to a uniform 9% rate)

tq("AFFH-C") = 0.05;
tq("MIN-C") = 0.05;
tq("MANUF-C") = 0.05;
tq("MEDIMAN-C") = 0.05;
tq("UTIL-C") = 0.05;
tq("FOOD-C") = 0.084293;
tq("INFOSER-C") = 0.060062;
tq("HEEDSER-C") = 0.05;
tq("OTHSER-C") = 0.071532;
tq("CONST-C") = 0.05;
tq("WHOLTRAD-C") = 0.05;
tq("RETTRAD-C") = 0.05;
tq("TRAN-C") = 0.05;
tq("MOVIE-C") = 0.05;
tq("GOVSPC-C") = 0.05;

*Intermediate Inputs Tax (Tax treatment of intermediate inputs is identical to Special Council *simulation with the exception of the rate increase)

tq_inp("UTIL-A","AFFH-C") = -.04;
tq_inp("UTIL-A","MIN-C") = -.04;
tq_inp("UTIL-A","MANUF-C") = -.04;
tq_inp("A","HEEDSER-C") = .09;
tq_inp("MOVIE-A","MOVIE-C") = .09;

*Corporate Income Tax

taxc("SGOVNE","CAP")= .004427*0;
APPENDIX D – GEORGIA SAM

The Georgia 2010 Social Accounting Matrix is 53 rows x 53 columns, and thus too large for inclusion here, but it is available upon request. The original unaggregated IMPLAN data is available for purchase at https://implan.com/.

APPENDIX E – EGYPTIAN SAM

The Egypt 2008 Social Accounting Matrix is 72 rows x 72 columns, and thus too large for inclusion here, but it is available upon request. For I-O and supply-use matrices from CAPMAS for Nov. 2010 and Sept. 2008, visit http://www.capmas.gov.eg/pages_ar.aspx?pageid=1475.


114


Vargas, Eliecer E, Dean Schreiner, Gelson Tembo, and David Marcouiller. "Computable General Equilibrium Modeling for Regional Analysis." Regional Research Institute, West Virginia University Morgantown, West Virginia, 1999.


Jeffrey Condon was born in New Orleans in 1980 and spent much of his childhood in Peachtree City, Georgia. He attended college at the University of Georgia studying Finance and Economics. Upon graduating he moved to Birmingham, Alabama to work as an auditor for Regions Financial before returning to Atlanta as an Economist for the Bureau of Labor Statistics. While there he attended Georgia State University for his Master of Arts in Economics. After completing his MA he then enrolled in the PhD program at GSU and began teaching for Georgia Military College. Mr. Condon’s fields are public finance and experimental economics. He has researched tax reform in the state of Georgia as well as fiscal and monetary policies in Egypt and Mauritius.