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Bard

*An Exploration of Stock-Flow Consistent Models:
An Analysis of Fiscal Policy Effectiveness*

*Senior Project submitted to
The Division of Social Studies
Of Bard College*

By:

Quinn McInerney

Annandale-on-Hudson, New York

May 2017

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Abstract

This project explores the stock-flow consistent (SFC) approach to modeling with the goal of examining the effectiveness of different fiscal policy tools, specifically tax policies and government expenditure. By exploring the historical and theoretical elements of stock-flow consistent models, we aim to gather insight on past successful models proven to predict crises. This paper begins with a history and continues into a simple SFC model thought experiment, which emphasizes the flexibility of the models as well as a precursor to the shock approach we employ at the end of the paper. We create Model ECONOMY with several strong assumptions, such as modeling a closed economy with an absence of the financial sector. By thoroughly comparing the results from the equations that comprise Model ECONOMY to that of historical data, we aim to provide legitimacy to the model. Once established, we will use the results from the baseline of Model ECONOMY and introduce shocks to the system. These shocks are forms of fiscal policy, from a decrease in taxes to an increase in government expenditures. We compare the results of the shocks to that of historical data from the same time period (2008-2015) in order to see what the effect would have been for each policy proposal. The goal of the paper is to use the SFC model to find an effective fiscal policy proposal.

1. Introduction

For the importance of money essentially flows from its being a link between the present and the future- John Maynard Keynes

Imagine a world where all individuals behave rationally, where everyone is behaving in a way that maximizes their own utility. Imagine this same world where workers decide whether wages are worth trading their leisure time in order to work. Imagine a world where prices are flexible and there is always full employment, unless these prices are too high. This world is not the current world that we live in...and yet the models used by key players in the world are based on these unrealistic assumptions. What is the purpose of a model if it is not applicable to the real world?

The failure to predict the 2008 Financial Crisis by most economic experts has always interested me. This is because it was a failure of both the financial sector, with their subprime lending, as well as the economic experts, due to their inability to foresee a crisis of this magnitude. For me, even before I became educated in this area, there was something wrong with the system; it was time to discard the orthodox view of thought and look for models/ideas that worked. One such economist who was able to accurately predict the financial crisis was the late Wynne Godley, who promoted the use of sectoral balances to map the economy. The models he created were called stock-flow consistent (SFC) models. In effect, one looks at a country's economy through the lens of a balance sheet. This was very appealing to me because SFC models have a proven record of being able to predict financial crises.

There are some issues with this area because some examples of SFC models are very theoretical, and while economically sound, are not as applicable to mapping a country's economy. However, some SFC models are much more empirically accurate and can be used for macro predictions accurately. Alternatively, many of these SFC models are either overly complicated with an exhaustive list of variables and equations, or were more focused on the

economy that their underlying theories were sometimes blurred. With that in mind, my goal was to create a SFC model that was concise¹ but also able to accurately model the United States' economy.

In the process of creating my model, I analyzed Godley's work, as well as other notable SFC users such as Marc Lavoie, Gennaro Zezza, Stephen Kinsella, and many others. With Godley specifically, I recreated his simplest model, and experimented with altering the consumption functions in order to demonstrate the flexibility of these models. By doing so, I was able to learn how SFC models work as well as draw inspirations for the model that I created for this paper.

With that being said, SFC models must have a specific purpose. This paper aims to use a SFC model to measure the effectiveness of different fiscal policies, such as tax rate decreases, increases, and increases in government expenditures. It is important to be able to have a model that clearly shows the effect of a dramatic tax on corporations or increasing the tax rate to 90 percent. By exploring SFC models we can analyze fiscal policy endeavors. This paper begins by describing the history of SFC models and some of the key influencers in the development of the model created in this paper. From here, we will create the simplest of SFC models in order to give the reader the proper background information. Once created, we will make some alterations to one of the behavioral equations in the model, thereby showing the flexibility of SFC models to other schools of thought as well as laying the groundwork for the methodology behind our shock process. After this, we will take a closer look at two SFC models that we will draw heavy influence from. The SFC model created will provide the framework of the model with the transaction matrix to listing behavioral equations. The equations in the model will be tested to

¹ I.e. not too many variables and equations.

make sure they produce data that is comparable to historical data. Once our model has legitimacy, we can create the baseline model. From this baseline, we will alter the parameters of specific exogenous variables and compare results and analyze the effectiveness of different fiscal policies. The whole purpose of this paper is to demonstrate how to create a model that has been proven to have at least some real-world modeling capabilities.

2. Literature Review and Theory Development

This section aims to explore the history of stock-flow consistent models as well as conduct a thought experiment exploring the simplest stock-flow consistent model in order to demonstrate a basic grasp of the concepts. In addition, this thought experiment will look to modify the simplest model by calculating the model with two different consumption functions. This will be a useful exercise in showing how a stock-flow consistent model operates.

2.1 History of Stock-Flow Consistent Models

Stock-flow consistent models can trace their roots to the early 1950's following John Maynard Keynes revolutionary work, specifically in the field of macroeconomics. Eugenio Caverzasi and Antoine Godin studied extensively the history of stock-flow consistent models and concluded that the work of Morris A. Copeland was vital to the theoretical framework of these models. Copeland wrote "A Study of Moneyflows in the United States," which traced where income came from and where it went among the various sectors of the national economy in a six-year period (Fowler 1989). Caverzasi and Godin wrote that "The intuition of Copeland was to enlarge the social accounting perspective—which had been until then used mainly in the study of national income—to the study of money flows" (Caverzasi and Godin 2013). In effect, Copeland asked important questions of where the money came from in the national income equation, thus delving into the idea of a flow of funds, which is the basis in order to study the flow of funds. The authors explain that it was Copeland who provided us with the quadruple entry system,

which shows that within a flow of funds framework, one sector's inflow is another's outflow, thereby doubling the standard double-entry system found in accounting.

In addition to Copeland, Michal Kalecki's contributions to economics was indirectly very important to SFC models, particularly his work defining a firm's profit function. He defines a firm's profit is equal to $C + A$ where C represents consumption by capitalists and A is accumulation (Kalecki 1971). This is important because it separates the firms and households into separate sectors while at the same time linking them together. As a household consumes more, a firm gains a greater profit and vice versa. While much has been written about interest rates, it can be very valuable, especially in SFC models, to link firms and households at the profit and consumption level. Whereas Keynes played a large role in the development of consumption functions used in SFC models, Kalecki laid out the groundwork for the production sector and profit decisions.

The next economist who made large contributions to the SFC approach was James Tobin, who in 1981 won the Nobel Prize "for his analysis of financial markets and their relations to expenditure decisions, employment, production and prices" (Nobel). While it was for his overall body of work, Tobin made important contributions to the foundations of SFC models, specifically in his Nobel Memorial lecture and the accompanying book. According to Tobin (1982): "The principal features that differentiate the proposed framework from the standard macromodel are these: (i) precision regarding time...; (ii) tracking of stocks...; (iii) several assets and rates of return...; (iv) modeling of financial and monetary policy operations; (v) Walras's Law and adding-up constraints." Tobin shows that in these models, which show the economy over a short period of time, must have a clearly identified time period. This is a clear divide from traditional neoclassical models that rely on an economy that constantly returns to equilibrium.

The next requirement of Tobin's models are the tracking of stocks in which the dynamics of flows and stocks, investment and capital, saving and wealth be represented. He does not find a defensible reason not to include these, disagreeing with the classical argument that in the short-run, stocks do not change enough to warrant their inclusion. Along these lines, Tobin argues for several assets and rates of return instead of combining all non-monetary assets into a single asset, because this does not allow for policy, institutional, or event analysis regarding these rates. By breaking assets into categories, and by extension having multiple rates, Tobin believed that this would create more accurate modeling of financial and monetary policies. Lastly, Tobin believes that all the models must satisfy Walras's Law and the adding up of constraints. Walras's law is critical for SFC models because it states that "excess demand functions of an economic agent must sum to zero for every vector of the variables that are arguments in any of the functions" (Tobin 1981) This means that the model must satisfy the budget constraint with supply and demand equaling each other. These five features should be central in all SFC models, yet some argue that this is not the case. However, as C.H. Dos Santos cleverly points out, differences with Tobin were not in the methodology but in the specification of the behavioral equations.

The other founder of SFC models is Wynne Godley, who along with Marc Lavoie, authored the textbook Monetary Economics, which is one of the main sources for not only this paper, but almost any paper involving SFC models. The textbook is a culmination of some of Godley's life work regarding his groundbreaking research involving SFC modeling from past papers as well as current research with Marc Lavoie. Because modern industrial economies are complex, Godley and Lavoie argue that it requires a new model to gain an understanding of how these complex economies work as a whole. This model is centered around the idea that every transaction by one sector has an equal and opposite transaction in another sector. The same holds

true for financial balances, as well as with every sector's financial asset must have a financial liability in another sector. Godley and Lavoie explain that the method involves creating accounting identities and valuing all stocks and flows, which are then described by stylized facts and systems of equations. Once the parameters are created, numerical simulation is used to check the accuracy as well as gauge the accuracy of the model. Once the equilibrium of the model is created, shocks to the system are introduced and the reactions are gauged.

There is currently a debate over who is the founder of SFC models. Most would narrow it down between Tobin and Godley, the two main economists mentioned above. The historians Caverzasi and Godin believe it depends on whether stock-flow consistent is applied to the models in the Post-Keynesian tradition, which would mean the father would be Godley, or any model bearing the five main features, in which case the founder would be Tobin.

Other current economists specializing in the area of SFC models include Gennaro Zezza, Claudio H. Dos Santos, Antoine Godin, and Stephen Kinsella. The first two economists are Levy Economics Institute scholars, Zezza and Dos Santos, who together co-wrote "A Simplified "Benchmark" Stock-flow Consistent (SFC) Post-Keynesian Growth Model" which we will use in this paper to help demonstrate investment in SFC models. In addition, Zezza provides detailed code to create SFC models in Excel and Eviews that prospective SFC modelers can use for guidance, which was a very useful resource for this paper. The latter two economists, Godin and Kinsella have also contributed greatly to SFC models of the economy. Both were key contributors to the SFC model created by the Bank of England, referenced later in this paper. Godin is also currently creating an SFC simulator in R, compared to the Eviews program we will use for the models in this paper.

Wynne Godley was one of 12 individuals to accurately predict the 2008 Financial crisis **before** 2007 according to economist Dirk Bezemer, who concludes, “They demonstrated again the US economy’s dependence on debt growth and argued that only the small slowdown in the rate at which US household debt levels were rising, resulting from the house price decline, would immediately lead to a “sustained growth recession ... somewhere before 2010.”(Bezemer 2010). Of the 12 economists, only Godley, who used SFC models, and Steve Keen, who used a “complex systems approach to Minsky’s ‘Financial Instability Hypothesis’ (Minsky 1977); and two key indicators – sectoral imbalances and the ratio of private debt to GDP.” (Keen 2013). These SFC models are able to accurately show solely the flow of funds and therefore are not under the influence of speculative bubbles.

In another paper, Bezemer writes about the usefulness of general accounting economic models with respect to financial crises. In the section about SFC models, Godley is specifically referenced multiple times. Since one can separate the banks for the economy and analyze it separately, it is easier to track the debt of the sectors. He writes that “A benchmark scenario of financially sustainable growth is when the economy expands with constant fractions of its credit flows are going to the financial and real sectors.” (Bezemer 2009). Following the Minsky’s Financial Instability Hypothesis, when an economy starts to become more similar to speculative and Ponzi, that is when crises eventually occur. An SFC model is able to show which sector of the economy is experiencing the growth as well as where the growth is coming from. In addition, Bezemer notes that in Godley-like SFC models, money is endogenous to the system. This means that it has an important role to play, which is counter to the traditional neoclassical school who believe that money is just a medium of exchange. By viewing money in this light, it also allows modelers to view and properly value wealth and debt and show how they affect the real sector. In

the paper, Bezemer credits Godley as one of the few who were able to see the 2008 financial crisis, who he acknowledges predicted “The small slowdown in the rate at which US household debt levels are rising resulting from the house price decline, will immediately lead to a ...sustained growth recession ... before 2010” (Bezemer 2009). This is important because it not only rightly validates SFC models but also shows there is the possibility for using them for predictive purposes.

In addition, Godley-like models have been proven to be quite effective when modeling fiscal policy. Because of their design with parameters and behavioral equations, it is very easy to create scenarios modeling fiscal policy. Godley shows in his paper “Fiscal Policy in a Stock-Flow Consistent (SFC) Model”, that even a simple model can be used to draw conclusions of the effects of fiscal policy. Godley writes that “we arrive at two unconventional conclusions: first, that an economy (described within an SFC framework) with a real rate of interest net of taxes that exceeds the real growth rate will not generate explosive interest flows, even when the government is not targeting primary surpluses; and, second, that it cannot be assumed that a debtor country requires a trade surplus if interest payments on debt are not to explode (Godley 2008). These conclusions were drawn modeling the economy through the SFC approach and creating scenarios that represent the fiscal policy. While all models have flaws, it is important to note the credibility behind this type of model and in particular this economist, due to his success in being one of the few economists able to predict the 2008 Financial Crisis.

A similar type of model is a Dynamic Stochastic General Equilibrium (DSGE) model, which aims to try and model economic growth, business cycles, etc. These models are unsusceptible to the Lucas Critique because as the economist Argia M. Sbordone et. al. wrote, “These models are built on microeconomic foundations and emphasize agents’ intertemporal

choice...outcomes makes the models dynamic and assigns a central role to agents' expectations in the determination of current macroeconomic outcomes.”(Sbordone 2013). In effect, because of the microfoundations, the Lucas Critique is not applicable in addition to the fact they factor in time, which separates them from other micro-based models. The authors continue to explain that DSGE models used for policy analysis revolve around three main parts: a demand portion, a supply portion, and a monetary policy portion. All of these parts are composed of microeconomic equations. However, DSGE models are not without criticism. Robert Solow criticized them in a report to Congress on their inability to predict the 2008 Financial Crisis, arguing that “The DSGE school populates its simplified economy – remember that all economics is about simplified economies just as biology is about simplified cells – with exactly one single combination worker-owner-consumer-everything-else who plans ahead carefully and lives forever. One important consequence of this “representative agent” assumption is that there are no conflicts of interest, no incompatible expectations, no deceptions.” (Solow 2010). As with many micro-based models, the oversimplification and agent problem is prevalent and is part of the main critique of DSGE models.

While we will follow relatively closely to the Godley SFC model, its flaws must be noted. There is criticism that this method is heavily influenced by the author's vision of sequence of events; for example, where the money begins in the economy. This is a common critique from those who disagree with the Modern Monetary Theorists view of money, because as the economist Brett Fiebiger would argue, “it must be accepted that most federal spending is financed by taking money from people within society (non-voluntarily for taxes) creating winners and losers.” (Fiebiger 2013). This was a specific critique of the SFC models from the Levy Economics Institute. However, SFC models can be modified based on the author's view

and do not necessarily need to follow the traditional SFC approach of viewing taxes (i.e. government spending) as the driver of the economy. Along these lines, Celia Firmin writes that “Rather than quantifying the effects obtained, this method tends to give a qualitative narrative vision of the observed sequences of events, which may be a limit to the analysis,” so again we return to this notion of the author’s vision playing a large role in the SFC approach (Firmin 2009). In addition, some critics argue that these models become too complex with the excessive amount of variables. This in turn can blur the degree of causality each variable actually has. The economists from the Bank of England² note that “The models are complicated, which makes it hard to explain the main economic mechanisms at work.” Similar to adding too many control variables to regressions, the same is true for SFC models. In addition, only one shock is able to be tested at a time. As Firmin writes, “...it is not possible to integrate several shocks within a single simulation, because it would then be impossible to know what comes from one shock rather than from another. Effects that contradict one another would also be hard to identify in this type of analysis” (Firmin 2009). This is an interesting issue that sometimes occurs: what happens when two shocks contradict each other? Is it the model, the equations, the parameters, or some unknown factor? It is impossible to tell, because as Firmin clearly states, only one parameter is able to be tested at a time. Even with this being said, one can clearly see that there is great potential for SFC models and their usefulness in economics today.

2.2 What is a SFC Model? A Simple Example

What exactly are SFC models? SFC models usually consist of two main components: an accounting part and a set of behavioral equations describing the system. The consistency of the

² Stephen Burgess, Oliver Burrows, Antoine Godin, Stephen Kinsella and Stephen Millard

accounting is ensured by the use of matrices: i) the aggregate balance sheets, with all the initial stocks, ii) the transaction flow, recording all the transactions taking place in the economy. As Minsky (1975) once wrote “an ultimate reality in [such] a capitalist economy is the set of interrelated balance sheets among the various units.” The behavioral equations are used for the calculations of each entry, although the equations are dependent based on the particular school of thought subjective to the modeler. But these equations and models are not just subjective to a particular school of thought, but what exactly the modeler is looking to show in the SFC model. While some call this a critique of SFC models because of the author’s heavy influence, it is very practical. For example, if one is to try and gauge the effect of the Keynesian multiplier, it would be beneficial to create a SFC model with a Keynesian consumption function and possibly an exogenous government money supply. However, if one is trying to measure the impact of financial assets and interest rates on the consuming out of net wealth, then a consumption equation that incorporates these features would be more beneficial. Therefore, it is up to the modeler to determine which equations to use based on the overall purpose of the SFC model.

In their book, Godley and Lavoie present the simplest model, Model SIM, which is an economy that is closed and composed of three sectors. A closed economy is one in which there are no imports or exports. The assumption in this model is that besides governments, the other aspects of the economy can be broken down into just two sectors: one that sells services and pays wages and the other receives income, consumes, and accumulates wealth. Because this is the simplest model, we assume that production is instantaneous, so inventories do not exist. In addition, this production is provided by producers who have no capital equipment or intermediate costs of production. Therefore in this model, there is no need for finance, which eliminates the role of private banks. This model is created by the authors for the sole purpose to

demonstrate the flow of funds, so the economy modeled is similar to a “pure labor economy, where production is carried out by labor alone” (Godley and Lavoie 2012). The role of the government is to print money, which is accepted because of a legal tender law, and buy services with this money. In order to create a circular flow, the government levies taxes that must be paid for in money, which means households must sell their services in order to acquire it. Much can be said about the role of money. “The concept of ‘money’ is indispensable, yet money is an asset to which there is not, in general, a counterpart liability and which often has no accounting relationship to other variables.” (Godley and Lavoie 2012). This is a very MMT view of money but it fits within this system. With that being said, this simple model tries to model how money works within a simplified economy. In this basic model, the government sets the price for these services and there is an unlimited supply of labor that is potentially available. The balance sheet of this model is constructed in Table 1.

Table 1:Balance Sheet

	Households	Production	Government	Sum
Money Stock	+H	0	-H	0

In SFC models, a balance sheet is used to describe each sector's stock of assets and liabilities and their relationship with each of the other sectors. As in accounting, each financial asset owned by one sector must have a financial liability in another. In this model, money (H) is an asset for households and a liability of the government. Assets are represented with a + sign and liabilities are represented with a - sign. People as producers are assumed to hold no cash at all, which is why there is a zero in the production column. However, as in accounting, balance sheets offer only an overview and do not show the transactions that lead to the final balance. In Table 2, we

are able to see all the transactions that take place, which is known as the accounting matrix. It is in these accounting matrix that begin to show the modeler's vision.

Table 2: Transaction Matrix

	Households	Production	Government	Sum
Consumption	-C	+C		0
Government Expenditures		+G	-G	0
Output		[Y]		0
Income	+W	-W		0
Taxes	-T		+T	0
Change in money stock	- ΔH		+ ΔH	0
Sum	0	0	0	0

The lines "Consumption" through "Taxes" represent the variables that comprise the National Income and Product Accounts (NIPA). These variables are arranged in a transaction matrix and represent a specified period of time. The "Change in money stock" line describes the changes in the financial assets and liabilities, which equates with the Flow-of Funds and is essential to complete the system of accounts. Households receive wages (W) for their labor, pay taxes (T), and consume (C). Firms produce an output [Y], which will be bought by households and the government, and pay households wages for their labor. The government sector buys output (G) from firms and receives an income from taxes through the household sector. There is only one asset: money stock (H). All income that is not consumed by households is thus saved as cash. If households have positive savings, then the government has to have a deficit. Notice how both the horizontal sum and the vertical sum column equal zero. Godley and Lavoie demonstrate that this

is because horizontally, each component of the matrix must have an equivalent component or sum of equivalent components (think double-entry accounting), and vertically, the matrix shows how any sector's financial balance (the difference between inflows of incomes and outflows of expenditures) must be exactly matched by the sum of transactions in stocks of financial assets. All incoming flows of money are sources of funds denominated with a plus sign while all uses of funds appear with a minus sign. The only variable that does not have a plus or minus is output, which is because it is not a transaction. Total output (Y) is defined by the following equation:

$$Y = C + G = WB$$

In words, output is either equal to all expenditures on goods and services or as a sum of all payments of income.

While this is a simple model, it can be used to show the identities that must be satisfied in all models. In the previous accounting matrix, there is nothing that can be said about the model itself. It is purely an accounting matrix. In order to understand the system as a whole, we must first ensure that the mechanisms behind the model are accurate and then implement behavioral equations. In Table 3, the accounting matrix is modified to incorporate basic assumptions for the mechanisms.

Table 3: Modified Accounting Matrix

	Households	Production	Government	Sum
Consumption	$-C_d$	$+C_s$		0
Government Expenditures		$+G_s$	$-G_d$	0
Output		[Y]		0
Income	$+W*N_s$	$-W*N_d$		0
Taxes	$-T_s$		$+T_d$	0
Changes in money stock	$+\Delta H_h$		$-\Delta H_s$	0
Sum	0	0	0	0

As in the previous table, the horizontal and vertical “Sum” columns maintain their identity of always equaling zero. Table 3 describes the relationships the columns have with each other by incorporating subscripts as well as equations. The subscripts s, d, and h represent supply, demand, and household holdings respectively. These subscripts add additional meaning to the variables by equating them as well as helping to identify signs. We now are able to begin the analysis by starting with the variables and creating equations so supply and demand our equal. In this scenario, there are four equations which do so.

$$C_s=C_d \quad G_s=G_d \quad T_s=T_d \quad N_s=N_d$$

Godley and Lavoie write that these four equations imply that whatever is demanded is also supplied.³ Mathematical economic equations are also implemented in this matrix. Most would

³ These four equations imply that whatever is demanded (services, taxes and labour) is always supplied within the period. This is an economy that has no supply constraints and assumes that there is excess unemployed workers willing to work at the current wage at any location (Godley and Lavoie 2012).

agree that at its simplest definition, income can be written as the product of wage rate (W) multiplied by employment (N), which is noted in Table 3 as $W*N$. Godley and Lavoie stress that in this model, C_s and G_s represent the sales of consumption goods and government services, thereby demanding a positive sign. On the other hand, C_d and G_d denote the purchases of consumption goods and government services. The authors argue that it could be a potential of four mechanisms⁴ from both paradigms of economic schools, but the end result is an equality between sales and purchases.

2.3 Various Behavioral Assumptions and Equations

It is important to be reminded of the fact that the authors are using this approach within the contextual framework of the Keynesian tradition, so the inclusion of money stock (Table 1 line 1) and transactions of money stock (Table 2 line 6) provide conclusions about motivation and equilibrium that are in contrast to conventional mainstream economics. We will try to create a money stock using alternative methods in the following section. As Tobin proved in his Nobel Prize winning lecture⁵, stock-flow consistent modeling can be used in most schools of economic thought. However, this SFC model is just one example of the possible economic situations that can be described via the balance sheet and accounting matrix. While it was alluded to at the end of Section 2.2 with the mechanisms equating sales and purchases, SFC models are able to

⁴ The first mechanism is related to Neoclassical theory: variations in prices clear the market. Excess demand leads to higher prices, which is assumed to reduce excess demand. The second mechanism is associated with the so-called rationing theory, also called constrained equilibrium theory. So whenever supply and demand are different, because of these rigid prices, the adjustment is done on the short side of the market. The third mechanism is linked to the existence of inventories where sales are always equal to demand because it is assumed that inventories are always large enough to absorb any discrepancy between production and demand. The fourth mechanism is the Keynesian, or Kaleckian, quantity adjustment mechanism where producers produce exactly what is demanded. (Godley and Lavoie 2012).

⁵ Current and recent real disposable incomes were major determinants of consumption in Keynesian models, but post-war theory has downplayed their role in favor of forward-looking calculations of long-run disposable resources (Tobin 1981)

encompass many schools of economic thought. One might wonder how exactly different economic theories can be incorporated into a model that is essentially a balance sheet and an accounting matrix? This is where the behavioral equations are used to not only demonstrate how the model works within the system, but also integrate economic theories based on the economic school of the modeler. We will begin with a Keynesian approach, closely following the work of Godley and Lavoie.

Model SIM and the Keynesian Consumption Function

In Model SIM, the authors use Keynesian theories, specifically with respect to consumption. The authors begin by making two behavioral assumptions: 1. Firms sell whatever is demanded. 2. Sales are equal to output, which means that one does not have to account for inventories. While the first assumption is maintained throughout, the second one can be dropped with the slight variation where sales are equal to output minus change in inventory. For simplicity, we will keep both assumptions. For this model, there are several behavioral equations that are used to provide legitimacy due to the grounding in economic theory. The first equation is to calculate disposable income, which the authors define as

$$YD = W * N_s - T_s$$

Disposable income (YD) is simply the income earned by households ($W * N_s$) and subtracting for taxes (T_s). The equation to calculate taxes is

$$T_s = \theta * W * N_s$$

This means that the government acquires a percentage of income (θ) from household's wages.

The next equation needed is the consumption function, which the authors write as the following:

$$\alpha_1 YD + \alpha_2 H_{h-1}$$

The authors suggest that households consume from a portion of their disposable income (YD) and their previous savings, hence household wealth (H). It is also to be noted that $\alpha_2 < \alpha_1 < 1$, which in a very Keynesian approach, shows that disposable income is a larger factor of consumption than acquired wealth. The next equation deals with money stock from the transaction matrix, which is written as

$$\Delta H_s = H_s - H_{s-1} = G_d - T_d.$$

This reads that the change in the money supplied by the government (H_s) is equal to the government's revenue (taxes) and expenditures (G_d). In this model, the change in money stock and the government deficit are endogenous. If government expenditures exceed government revenue, the government issues debt, in this case cash, to cover the difference. Government revenue is determined by the tax rate, which is arbitrarily decided in this model as well as government expenditures. Therefore the government deficit, and by extension change in money stock, are determined through the solving of the model. Another equation that is derived from the accounting matrix is for household wealth, which is determined by their financial balance and is written as follows:

$$\Delta H_h = H_h - H_{h-1} = YD - C_d$$

Since there are no other assets in this model, H_h represents cash that households keep, also known as their savings. This means that the change in household wealth is disposable income minus consumption. The authors also stress the importance of including expressions that determine employment (N) and output (Y). The national income identity is $Y = C_s + G_s$, which can be written in this model as $Y = W * N_d$. Altering this expression provides us with an equation for employment: $N_d = Y/W$.

In summation, there are a total of 11 equations and 11 variables in this model, with three of the variables, G_d , θ , and W being exogenous. In this model, one can experiment with values for G_d and θ in order to see the effects of fiscal policy. Wages are usually determined by the labor market, but for this model we are considering them exogenous. Many of the solutions will be determined from the values of variables from the previous time period. In addition, the stock of money supplied and demanded, which this model is created to analyze, are not forced to be in an equilibrium state for this model to work. However, when the model is eventually solved, the two changes in values (H_h and H_s) must equal. As with all SFC models, the equations must produce values that when introduced to the accounting matrix, sum zero.

Table 4: Government Injects 100 dollars

Period	1	2	Infinity
G	0	100	100
$Y=G+C$	0	172.41	333.33
$T= \theta*Y$	0	51.72	100
$YD=Y-T$	0	120.69	233.33
$C_d = \alpha_1*YD + \alpha_2 * H_{h-1}$	0	72.41	233.33
$\Delta H_s=G_d-T_d$	0	48.28	0
$\Delta H_h=YD-C$	0	48.28	0
$H=\Delta H+H_{.1}$	0	48.28	233.33

Example Computation

Given Values

Government Expenditure: 100 dollars

Tax Rate: 30%

$\alpha_1=60\%$

$\alpha_2=40\%$

In Table 4, we have a numerical example in Keynesian tradition that incidentally shows the multiplier effect where for each dollar the government (G) spends, there is an even greater

output. In column 1, we have all zeros, which represents a previously non-existent economy where households have no wealth. The government begins the virtuous cycle by introducing 100 dollars into the economy. Output is calculated as the sum of government spending and consumer spending. Because in this simplified model all participants have perfect foresight, national income in the consumption function must be equivalent to national income in the production function. By rearranging this equation we get the following:

$$Y^* = G/1 - \alpha_1*(1 - \theta).^6$$

When imputing our given values we calculate 172.41 for national income. We then calculate tax ($\theta*Y$) and subtract it from national income in order to get a disposable income value of 120.69.

As mentioned in the assumptions, households do not have prior wealth. Therefore the consumption function for the first year is α_1*YD , and after substituting in values equals 72.41. Now that we have calculated taxes, disposable income, and consumption, we are now able to see the change in money stock. After substituting values into the H_s and H_h equations, we arrive at 48.28 for both, which is important because one of the expressions that bounds this matrix is $\Delta H_h = \Delta H_s$. Since this is the first year of the economy, H is the same as both ΔH_h and ΔH_s .

From here, we will calculate values if the economy continued along these trends indefinitely. G remains 100 as it is a given value. In order to calculate Y , we will treat it like an annuity so the new formula is G/θ which equals 333.33. Next we subtract tax ($\theta*Y$) in order to get disposable income which equals 233.33. Since $H_h \equiv YD^* - C^* = 0$, Godfrey and Lavoie state that it is implied that $YD=C$. Therefore our long run consumption is equal to YD at 233.33. The same can be done for H , so the long run value of the money stock is 233.33 as well. This

⁶ Original equation: $Y=C+G$ which is equivalent to $Y= \alpha_1(Y^*(1 - \theta))+G$.

completes the simulation using Keynesian behavioral equations to calculate variables such as consumption and place it within the accounting matrix.

2.4 Alternative Consumption Functions

So far in this paper, we have used a Keynesian approach to creating SFC models. This is for two main reasons: 1. A main influence on this paper is Godley's textbook on SFC models which follow the general theories of the Keynesian paradigm and 2. Robert Solow, as well as many other prominent economists believed that "perhaps the largest theoretical gap in the model of the General Theory was its relative neglect of stock concepts, stock equilibrium and stock-flow relations." (Solow 1983). Because of the large theoretical gap, SFC models were sought as an alternative approach to provide insight into such matters, in addition to the controversial usefulness of IS-LM models. Edward Nelson of the Federal Reserve Bank of St. Louis writes that "With the order rearranged, the six objections to IS-LM in the literature that we contemplated were: (i) IS-LM analysis presumes a fixed, rigid price level; (ii) It does not distinguish between real and nominal interest rates; (iii) It permits only short-run analysis; (iv) It treats the capital stock as fixed; (v) It does not recognize enough distinct assets; (vi) It is not derivable from explicit maximizing analysis of rational economic agents" (Nelson 2003). As noted several times throughout this paper, SFC models are simply an accounting matrix and behavioral equations. Therefore these models do not need to be defined by Keynesian behavioral equations, but could also be defined by theories from other schools of economic thought.

With that being said, there is one caveat: it will be impossible to create an SFC model using Neoclassical assumptions even though SFC models are just accounting matrixes. As economist Marc Lavoie explains in his book, Post-Keynesian Economics: New Foundations, the

five features⁷ that Tobin says must be present in all SFC models directly **contradict** basic Neoclassical assumptions. For example, SFC models are precise regarding to time in the short-run, which refutes the Neoclassical idea that there is a repetitive equilibrium⁸ that the economy settles in. The same can be said about the second feature of all SFC models that says all models must track stocks, which one can argue is the primary function of SFC models, but this is counter to the Neoclassical idea that in the short run stocks do not matter since in the short-run they cannot change that much. This is true for all five of the features described by Tobin. In addition, Lavoie notes that “...neoclassical economists have rejected Tobin’s approach and have fallen back on the unrealistic representative agent, where producers and consumers are the same...” (Lavoie 2014). In order to create an SFC model with Neoclassical behavioral equations, one would need to either break key assumptions integral to Tobin or Neoclassical school of thought, either of which would void any conclusions drawn from the model. Therefore this cannot be done.

However, knowing this caveat, it is still very possible to create alternative SFC models by modifying some of the behavioral equations. For example, one could substitute the Keynesian consumption function used by Lavoie and Godley with an alternative version of the Keynesian consumption function. However, before we can create a modified Model SIM, we must first expand Model SIM by adding additional years. This will allow us to get a greater idea of the trends to get a better comparison.

⁷ The principal features that differentiate the proposed framework from the standard macromodel are these: (i) precision regarding time...; (ii) tracking of stocks...; (iii) several assets and rates of return...; (iv) modeling of financial and monetary policy operations; (v) Walras’s Law and adding-up constraints.” (Tobin)

⁸ Tobin said in his Nobel Prize lecture that “It is one step of a dynamic sequence, not a repetitive equilibrium into which the economy settles.”

There is only one main difference between computing year two and year three: wealth factor. In order to find national income (Y) in the identity $Y=C+G$, we substitute the consumption function into C and solve for Y like we did in Table 4. But we did not factor in the $\alpha_2 \cdot H_{h-1}$ portion of the equation because one of the assumptions of the model was that it is a brand new economy with no prior assets (wealth). However, in Year 2 we must incorporate consumption from wealth in order for the model to be accurate. Therefore when we are solving for national income (Y), we must include the second half of the consumption function. It will look like this:

$$Y = \alpha_1 \cdot (Y \cdot (1 - \theta)) + \alpha_2 \cdot H_{h-1} + G$$

We already know the H_{h-1} because we calculated it in year 2, so $\alpha_2 \cdot H_{h-1}$ is just a number. From here we solve for Y and the rest of the calculations are the same, with the caveat that in the consumption function we include the previous year's wealth. The change in money stock should once again be equal, and the overall H value should be the summation of year three and year two change in money stock. The results are calculated in Table 5. One additional caveat is that we will change α_1 to 85 percent to more accurately represent the percentage of disposable income usually consumed.⁹ In addition, for the next three tables, we will include the first three years and years 18-20. This is to show the first three years of development in a new economy but also the values of later years as the economy trends toward a steady state. You will notice that the equations ΔH_s and $\Delta H_h =$ begin to trend toward zero, which is what we had shown in Table 4 of an economy in a steady state. In addition, H, YD, and C_d all begin to converge to the same value as in a steady state economy.

⁹Various literature has the α_1 value ranging anywhere from 85 to 95 percent.

Table 5: Keynesian Consumption Function

Period	1	2	3	18	19	20
G	100	100	100	100	100	100
Y=G+C	246.91	256.52	265.05	321.66	322.96	324.11
T= θ *Y	74.07	76.95	79.51	96.50	96.89	97.23
YD=Y-T	172.84	179.56	185.54	225.17	226.07	226.88
$C_d = \alpha_1 * YD + \alpha_2 * H_{h-1}$	146.91	156.52	165.05	221.66	222.96	224.11
$\Delta H_s = G_d - T_d$	25.93	23.05	20.48	3.50	3.11	2.77
$\Delta H_h = YD - C$	25.93	23.05	20.48	3.50	3.11	2.77
H= $\Delta H + H_{-1}$	25.93	48.97	69.46	205.33	208.44	211.21

Given Values

Government Expenditure: 100 dollars

Tax Rate: 30%

$\alpha_1 = 85\%$

$\alpha_2 = 15\%$

Now that we have set up the model with these modifications, we can now begin looking at how to implement other consumption functions. For the next consumption function, we will stay within a Keynesian approach. I propose that we create the next model, Model SIMD using the following Keynesian consumption function:

$$C_d = \alpha_1 Y_{-1} + \beta.$$

This is known as the Keynesian consumption function with a Robertsonian lag where the economists believe that one consumes not out of their current income but their past income. In addition, β represents the minimum consumption required to sustain oneself. This equation is feasible because there is a section of it (Y_{-1}) that incorporates data from the previous year, which is critical because there must be a change from year to year until a model hits the steady state. Godley and Lavoie state that “In models without growth, its use renders the model unstable”

(Godley and Lavoie 2012). To solve Model SIMD, it is very similar to Model SIM in that our first step is to plug the consumption function, in this case $C_d = \alpha_1 Y_{-1} + \beta$, into the national income equation. We will assume that β is given at a value of 10 and for continuity purposes, we will assume that α_1 is the same as in Model SIM. Unlike the last one, we do not need to rearrange our consumption function to find national income because we already know the Y value (Y_{-1}). For the first year, we assume that Y_{-1} is zero because there was no income from the previous year. By plugging this value into the equation along with the other givens we are able to arrive at a Y value. From here, the steps are exactly the same in Model SIMD as Model SIM. Once the calculations are completed, the same steps will be taken for the following years with the exception that Y_{-1} is no longer zero but rather the previous year's disposable income. The results can be shown in Table 6.

Table 6: Alternative Keynesian Consumption Function

Period	1	2	3	18	19	20
G	100	100	100	100	100	100
$Y = G + C$	110	175.45	214.39	271.58	271.59	271.60
$T = \theta * Y$	33	52.64	64.32	81.47	81.48	81.48
$YD = Y - T$	77	122.82	150.07	190.11	190.11	190.12
$C_d = \alpha_1 Y_{-1} + \beta$	10	75.45	114.39	171.58	171.59	171.60
$\Delta H_s = G_d - T_d$	67	47.37	35.68	18.53	18.52	18.52
$\Delta H_h = YD - C$	67	47.37	35.68	18.53	18.52	18.52
$H = \Delta H + H_{-1}$	67	114.37	150.05	453.03	471.55	490.07

Given Values

Government Expenditure: 100 dollars

Tax Rate: 30%

$\alpha_1 = 85$ percent

$\beta = 10$

When observing Table 6 closely, one would notice how it appears that the economy modeled is in a steady state since the national income is no longer growing. However, ΔH_h and ΔH_s are nowhere near zero, hovering around 18.52. This is because we do not have a factor in the equation, since the consumption function is comprised of the previous year's income and a basic minimum consumption rate. Therefore in the steady state, YD does not equal C like in previous models. But that does not mean we cannot use this model; Godley and Lavoie explain why this model is still theoretically sound, using a slightly different equation as an example¹⁰. They argue that "The average propensity to consume can be unity" which will be the indicator for an economy in a steady state. The equation for the average propensity to consume (APC) is given as $APC = \text{consumption } (C_d) / \text{disposable income } (YD)$. In our example, APC equals $171.60 / 190.12$, which computes to 90 percent. To ensure accuracy, instead of calculating the average propensity to save (APS) by using the equations $APS = 1 - APC$, we will calculate APS from our table. The variable ΔH_h represents the change of money stock from one year to the next, so if the number is positive, then the household is saving money¹¹. Therefore, APS is equal to household savings (ΔH_h)/disposable income (YD). In our model, $18.52 / 190.12$, which computes to 10 percent. It must be noted that if the model is setup correctly, APC and APS will always equal one, even when not in a steady state. In order to determine the steady state, it is important to see a lack of growth in national income, disposable income, and consumption. The use of APC and APS is to provide theoretical validation in models where there is no wealth factor.

¹⁰ Godley and Lavoie (2012) use $C = \alpha_0 + \alpha_1 \cdot YD$ as an example equation.

¹¹ While we are calculating APS, the variable $\Delta H_h = Y$ would not have to be a positive number. If negative, APS would be a negative percent while APC would be a percent greater than 100.

In this next section, I will incorporate an alternative consumption function that is not a pure Keynesian consumption function from economist Thomas Palley’s paper “The Relative Income Theory of Consumption: A Synthetic Keynes-Duesenberry-Friedman Model”. In this paper, Palley generates a consumption function that blends Keynes, Friedman, and Dusenberry theories. This consumption differs from the traditional Keynesian consumption function because “the share of permanent income devoted to consumption is a negative function of household relative permanent income” (Palley 2010). Palley believes his consumption function is more consistent with modern empirical findings that show high-income households tend to save a larger percentage of income, and by extension “why consumption inequality is less than income inequality” (Palley 2010). However, it is important to note that since Model SIM does not distinguish between households, we will not be able to show the differences in households.

We begin to create a modified Model SIM with the Relative Income Theory of Consumption. For practical purposes, we shall call the Relative Income Theory of Consumption, the relative consumption function, and the modified Model SIM will be called Model SIMR. Now in Thomas Palley’s paper, he begins by using Milton Friedman’s consumption and defines it as

$$C_{i,t} = c(Y_{i,t}/Y_t)Y_{i,t} \text{ where } i = 1,2,$$

In this equation, $i=1$ and $i=2$ are two different types of households. This is Palley’s way of differentiating the consumption functions between two types of households, typically high and low income. From here, he incorporates Dusenberry’s concept of relative income by incorporating the function

$$Y_{1,t} = aY_{2,t} \quad 0 < a < 1$$

In this equation, a is the relative income parameter. Since a is less than one, it represents a fraction of the income, which means it is a lower income household. From here, Palley includes the equations

$$Y_t = qY_{1,t} + [1 - q]Y_{2,t} \quad \text{and} \quad qaY_{2,t} + [1 - q]Y_{2,t}$$

In this equation, q = household composition parameter $0 < q < 1$, and Y_t = exogenous average income. These equations, specifically q , are used to incorporate the proportions of household that are high and low income. In effect, a is used to measure degree of inequality and q is used to measure the ratio of inequality. From here, we need an aggregate per capita consumption function that captures the weighted average of household consumption, so Palley derives the consumption function

$$C_t = qc(Y_{1,t}/Y_t)Y_{1,t} + [1-q] c(Y_{2,t}/Y_t)Y_{2,t}$$

The variable c comes from Friedman and represents the marginal propensity to consume. In this consumption function, there are too many Y variables to accurately substitute it into the national income equation. Luckily, Palley shows us that we can substitute the previous equations into the consumption to get a reduced form expression for aggregate consumption which is the following:

$$C_t = qc(a/[1+qa-q])aY_t/[1+qa-q] + [1-q] c(1/[1+qa-q])Y_t/[1+qa-q]^{12}.$$

While it appears to be a messy equation, it is quite useful because we have only one Y variable, Y_t , which means we can substitute it into the national income equation to find Y . Even though it is a different consumption function than in Model SIM, we proceed in the same way by substituting the relative consumption function into $Y=G+C$. Do not forget to include the tax rate

¹² In Model SIMR, we deviate slightly from this equation because we will add the the wealth factor.

as we did in the previous model, so it is not in our consumption function but rather $Y^*(1-\theta)$. By combining like terms and rewriting the equation, we arrive at

$$Y = G / (1 - qca^2[1-\theta] / [1+qa-q]^2 - [1-q]c[1-\theta] / [1+qa-q]^2).^{13}$$

Now that we have an equation where Y is equal to something, we substitute our values in. We will keep G the same in both models, but we will need to provide values for q , a , and c , because similar to the tax rate, α_1 and α_2 , they are exogenous to the model. For Model SIMR, we will let $q=0.8$, $a=0.6$, and $c=0.85$. By giving these values, we are saying that 80 percent of households control 60 percent of income. To put it another way, the top 20 percent of households control 40 percent of income, which is in line with current trends. The variable c represents the marginal propensity to consume, so we set that equal to .85 for continuity with the other models. These numbers are arbitrary and can be adjusted accordingly. As with the previous models, we must substitute the consumption function into the national income and solve for Y . Once Y is calculated, the rest of the calculations are the same as Model SIM, with the condition that we will use the relative consumption function instead of the old one.

¹³ While the equation may appear to be unwieldy, a useful tip is to create the variable $x=1+qa-q$ because it makes simplifying the equation much easier. In addition, we will not take taxes out of the initial Y for simplicity and because it is actually composed of two variables $Y_{1,t}$ and $Y_{2,t}$

Table 7: Relative Income Hypothesis

Period	1	2	3	18	19	20
G	100	100	100	100	100	100
Y=G+C	268.77	276.58	283.45	326.12	326.99	327.76
T= θ *Y	80.63	82.97	85.03	97.84	98.10	98.33
Y _t =Y-T	188.14	193.61	198.41	228.28	228.89	229.43
$C_t = qc(a/[1+qa-q])aY_t/[1+qa-q] + [1-q] c(1/[1+qa-q])Y_t/[1+qa-q] + \alpha_2 H_{h-1}$	168.77	176.58	183.45	226.12	226.99	227.76
$\Delta H_s = G_d - T_d$	19.37	17.03	14.97	2.16	1.90	1.67
$\Delta H_h = YD - C$	19.37	17.03	14.97	2.16	1.90	1.67
H= H+H ₋₁	19.37	36.39	51.36	144.40	146.30	147.98

Government Expenditure: 100 dollars

Tax rate= 30%

c= marginal propensity to consume=.85

a= relative income parameter $a < 1 = .6$

q= household composition parameter $q < 1 = .8$

α_2 = portion of savings that are used for consumption = .4

Notice how H_s and H_h are equivalent; this is essential and a check to see the accuracy of the model. In order to show an economy with growth, we must include a variable to account for the accumulation of savings. For this to work, we will assume a similar parameter as the original Keynesian consumption function in that a portion of the previous year's savings will be used for consumption. To do this, all we will need to do is add $\alpha_2 * H_{h-1}$ to the consumption. The steps are exactly the same: substitute the consumption function with the added wealth factor back into the national income equation to find national income. The subsequent steps are the same. I have included the simulation for year four as well. Notice how H_h or H_s continue to get smaller which means by continuing the simulation we will eventually achieve a steady state.

The purpose of Model SIMR was to demonstrate the flexibility of SFC models with regards to behavioral equations. We substituted a Keynesian consumption function with a relative consumption function and were able to balance the model. There was no need to create a new balance sheet or transaction matrix because everything else stays the same. For example consumption is still an expenditure by the household and a revenue stream by the government. While the prevalent type of SFC model uses Keynes's consumption function, or at least a variation of it, I wanted to demonstrate how a SFC model can accommodate other schools of economic thought by altering the consumption function. This will be very important going forward when I create my own model, which differs from the Gennaro Zezza and Claudio H. Dos Santos that will be explained later, which both differ from the Bank of England's SFC model. In addition, this was an important exercise in showing how scenarios work. We have the baseline model, Model SIM, and we created two scenarios with the different consumption functions and then we will compare the results. While not exactly fiscal or monetary policy work, it is an important introduction into the analysis of stocks.

2.5 Model Comparisons

In this next section, I will compare the three models previously created with each other to highlight similarities and differences. However, it must be noted that while these models hold true to basic economic principles, the models cannot be an accurate predictor of a country's economy. This is because these models were created with very strict and unrealistic assumptions¹⁴. These models compare the results of consumption function variations, but this does not mean we can use these models in their current simplistic states to determine which

¹⁴ For example, such strict and unrealistic assumptions are that only two main players in the economy, households and governments, the only asset is cash, etc, previously described when explaining Model SIM.

consumption function is most accurate. Instead, we can compare and contrast the simulations, because with the exception of the consumption functions, the models are very similar with respect to the exogenous variables and equations. In Tables 8-10, I have graphed the results of the calculations for each variable for the first 20 years.

Table 8: National Income Comparison graph

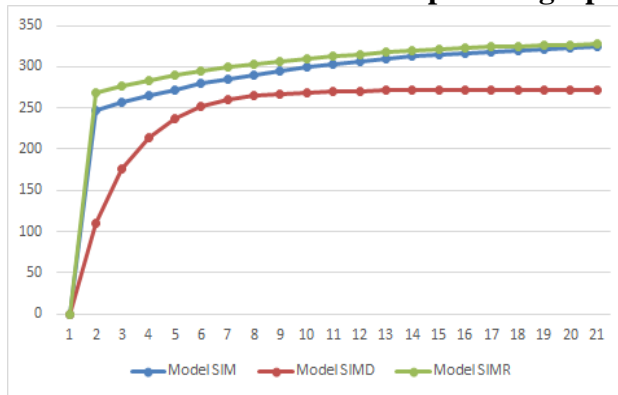


Table 9: Consumption Comparison Graph

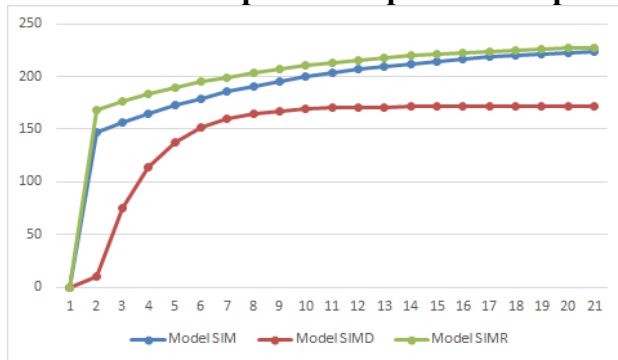
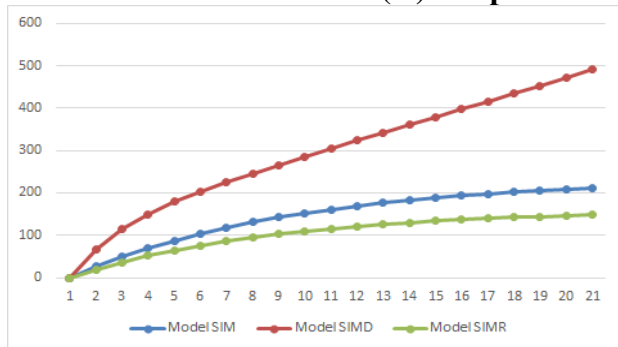


Table 10: Wealth Creation (H) Graph



Notice how for each of the graphs, national income, consumption, and wealth creation, Model SIM and Model SIMR are very similar even though they use completely different consumption functions. This is mainly because everything begins at the consumption function in which we substitute into the national income equation and from there generate our results. Even though the consumption functions are different, the rest of the process and many of the exogenous variables are the same, so it stands to reason that it is possible the results are similar. We assumed all follow the same diminishing returns, or in this case steady state, pattern. What stands out is that in Table 10, the change in money stock is increasing at a linear rate for Model SIMD. This is explained by the fact that H_h and H_s never reach zero in their steady state, so there is a constant addition to the money stock. As mentioned, the underlying reason why this is the case is that the consumption function in Model SIMD does not have a wealth factor. In effect, households are consuming less than their income but are accumulating savings and are not investing any of the accumulated savings.¹⁵ Another interesting aspect seen with the graphs is the almost identicalness between Model SIM and Model SIMR. It's surprising because the Keynesian consumption function used in Model SIM is very different than the relative consumption function provided by Palley.

3. Model ECONOMY Foundations

In this section, I'll outline the SFC model that I've created. While the Model SIM exercise was very useful in understanding the basics of SFC modeling, it does not go in-depth enough into modeling an economy like the United States. In order to do so, I rely heavily on established the established model of Zezza and Dos Santos SFC model as well as the SFC model

¹⁵ This is quite an unrealistic result stemming from an unrealistic assumption. Future models can be done with a wealth factor or other variables for improved accuracy.

created by the Bank of England. These two models are different in nature, with the Zezza and Dos Santos model being more theoretical in nature while the Bank of England's is more empirical. My aim in the initial creation of my model is to situate it between Model SIM and these two aforementioned models. In effect, my goal is to create an SFC model that is grounded in the Keynesian tradition, empirically consistent with the "real" world, yet not overly complicated where the results are lost in the excessiveness of variables. We will eventually use this model to test the effectiveness of some fiscal policies. Another caveat is that we will allow the computer program EViews to do the solving of the model, so we will not have to compute like we did in the Model SIMs.

3.1 Zezza & Dos Santos Model

To begin, we must try to create a SFC model that functions in a way similar to the economy. This means we must drop the assumption that the economy was "just created" as we did in Model SIM. We will also need to accurately model the production sector of the economy, as it is unrealistic to assume that they do not accumulate assets. In addition, we must distinguish between different types of assets because there are many different types besides cash such as securities, bonds, inventory, etc. in which different sectors of the economy can invest. Tobin wrote extensively about the importance of different asset classes. Another important question: Where does production acquire initial funding? Model SIM made the assumption that all money injected into the initial economy came from the government; however, in order to have a more accurate model, we must add additional sectors to account for financing and asset creation.

In order to do illustrate this concept, we will rely on the economists Gennaro Zezza and Claudio H. Dos Santos, who co-authored "A Simplified "Benchmark" Stock-flow Consistent (SFC) Post-Keynesian Growth Model" and who both provided many useful insights within the

field of SFC models with their work at the Levy Economics Institute. Shown below is a simplified Post-Keynesian SFC growth model with well-defined dynamic properties, which the authors use to “shed light on the merits and limitations of the current heterodox SFC literature.” (Zezza and Dos Santos 2007). It is important to note that this artificial economy created by Zezza and Dos Santos is still a closed economy. In Table 11, we can see the aggregate balance sheets of the institutional sectors.

Table 11: Zezza and Dos Santos SFC Balance Sheet

	Households	Firms	Banks	Gov't	Totals
1 - Bank deposits	$+D$		$-D$		0
2 - Bank loans		$-L$	$+L$		0
3 - Gov't bills			$+B$	$-B$	0
4 - Capital goods		$+p \cdot K$			$+p \cdot K$
5 - Equities	$+pe \cdot E$	$-pe \cdot E$			0
Net worth	$+Vh$	$+Vf$	0	$-B$	$+p \cdot K$
Note: pe stands for the price of one equity					

In this model, all the different private finance institutions are under the umbrella of Banks, while the Gov't is comprised of both the government and central bank. Like all SFC models, there are additional assumptions. For instance, households are shown to hold their wealth in the forms of deposits and equities, while also assuming that they do not take out bank loans or other assets like treasury bonds. Another important assumption that the authors point out is that the government is always in debt, specified as $B > 0$. The authors also impose three main assumptions on banks: “Banks are also assumed to: (i) always accept government bills as means of payment for government deficits; (ii) not pay taxes; and (iii) to distribute all its profits, so its net worth is equal to zero.” These assumptions help simplify the model in order to focus on the main theories underpinning it. Lastly, firms are assumed to finance production through the use of loans and selling of equity. The end result after each period, can be shown in the net worth row. As you can

see, this is a very post Keynesian-type model, which can be more easily seen in the next two tables. In Table 12, we can see the current transactions in the artificial economy that Zezza and Dos Santos have created.

Table 12: Zezza and Dos Santos Transaction Flow Matrix

	Households	Firms		Gov't	Banks	Totals
		Current	Capital			
1 - Consumption	$-C$	$+C$				0
2 - Gov't expenditure		$+G$		$-G$		0
3 - Investment in fixed K		$+p \cdot \Delta K$	$-p \cdot \Delta K$			0
4 - Accounting memo: "Final" sales at market prices = $p \cdot X \equiv C + G + p \cdot \Delta K \equiv W + FT \equiv Y$						
5 - Wages	$+W$	$-W$				0
6 - Taxes	$-Tw$	$-Tf$		$+T$		0
7 - Interest on loans		$-il_{t-1} \cdot L_{t-1}$			$+il_{t-1} \cdot L_{t-1}$	0
8 - Interest on bills				$-ib_{t-1} \cdot B_{t-1}$	$+ib_{t-1} \cdot B_{t-1}$	0
9 - Interest on deposits	$+ib_{t-1} \cdot D_{t-1}$				$-ib_{t-1} \cdot D_{t-1}$	0
10 - Dividends	$+Fd + Fb$	$-Fd$			$-Fb$	0
11 - Column totals	$SAVh$	Fu	$-p \cdot \Delta K$	$SAVg$	0	0

This is clearly a more complex version of the Models SIM, SIMD, and SIMR that we had created earlier. However, the matrix operates in the same way in that the simpler models by having all the rows sum to zero even if there are more assumptions associated with the rows¹⁶. In addition, the "+" and "-" in each column represent whether the transaction is received or paid by the sector. For example, the Gov't receives taxes from households and firms, while banks receive interests from firm loans and government bills but have to pay interests on household deposits and dividends to households. As one can see, Zezza and Dos Santos create SFC models slightly different than Godley and Lavoie, and later we will see the same with the SFC model created by the Bank of England. In addition, economists will sometimes create variations of matrices within their own work. It all depends on the author and the economic phenomena that is being modeled.

¹⁶ For example, in this model "We simplify away household debt and housing investment." (Zezza and Dos Santos 2007).

In Table 13, Zezza and Dos Santos created a matrix that shows the change in stock values at the end of the period.

Table 13: Zezza and Dos Santos Matrix of Stock Flows

	Households	Firms	Gov't	Banks	Totals
1 - Current saving	$+SAV_h$	$+Fu$	$+SAV_g$	0	$+SAV$
2 - Δ Bank deposits	$- \Delta D$			$+ \Delta D$	0
3 - Δ Loans		$- \Delta L$		$- \Delta L$	0
4 - Δ Gov't bills			$- \Delta B$	$+ \Delta B$	0
5 - Δ Capital		$-p \cdot \Delta K$			$-p \cdot \Delta K$
6 - Δ Equities	$-pe \cdot \Delta E$	$+pe \cdot \Delta E$			0
Totals	0	0	0	0	0
Net worth (accounting memo)	$V_h = SAV_h + \Delta pe \cdot E_{t-1}$	$V_f = Fu + \Delta p \cdot K_{t-1} - \Delta pe \cdot E_{t-1}$	$+SAV_g$	0	$SAV + \Delta p \cdot K_{t-1} + p \cdot \Delta K + \Delta p \cdot K_{t-1}$

The authors write that “While it is true that beginning of period stocks necessarily affect income flows, as depicted in Table 2, it is also true that saving flows and capital gains necessarily affect end of period stocks, which, in turn, will affect next period’s income flows”(Zezza and Dos Santos 2007). Zezza and Dos Santos choose to include this matrix to show the end of period change. We can see the underlying assumptions made through this matrix, such as household savings is linked with the change in bank deposits or equities, while government deficits are financed by the issuance of government bills. Firms are financed by either loans, equity issuance, retained earnings or a combination of these according to Zezza and Dos Santos. Most importantly, in the Zezza and Dos Santos model, changes in price (for goods and equity) are the only gains in this artificial economy.

As emphasized before, behavioral equations are the differentiating feature in SFC models which holds true for this model as well. For example, the consumption function that Zezza and Dos Santos use is

$$C_t = W_t - Tw_t + \alpha \cdot V_{h,t-1}$$

This assumes that after-tax wages are exhausted completely and that “capitalist households” spend a portion of their lagged wealth, denoted by $V_{h,t-1}$, on consumption. However, unlike the simpler models we dealt with earlier, more complex models have many more endogenous variables, which helps create a more dynamic model. In this case:

$$W_t = (1-\pi) * p_t * X_t,$$

This shows that wages are linked to the wage share, price level, and output. Intuitively, this means that wages are dependent on the success of business and by extension so is consumption. We will not go into more depth of the behavioral equations of the Zezza and Dos Santos model because they are unique to their model and we will have an extended section of equations for the model created for this paper. The main purpose of describing this model in depth is to see how the new added sectors work within the economy, as well as showing how SFC models can differentiate themselves.

3.2 Bank of England SFC model

In this section we will briefly examine an SFC model created by the Bank of England. This is important because it is more closely linked to the model I have created for my analysis. The Bank of England created a SFC model to do a scenario analysis of the United Kingdom’s economy from 1987 to present¹⁷, which means that they had to use available data, as I plan to do. This model has definite roots to Godley’s SFC models but included seven sectors of the economy: households, firms, government, banks, a central bank, insurance companies and pension funds (ICPFs), and the rest of the world. The transaction flow matrix is shown below in Table 14.

¹⁷ Burgess et. al 2016

Table 14: Bank of England Transaction Flow Matrix

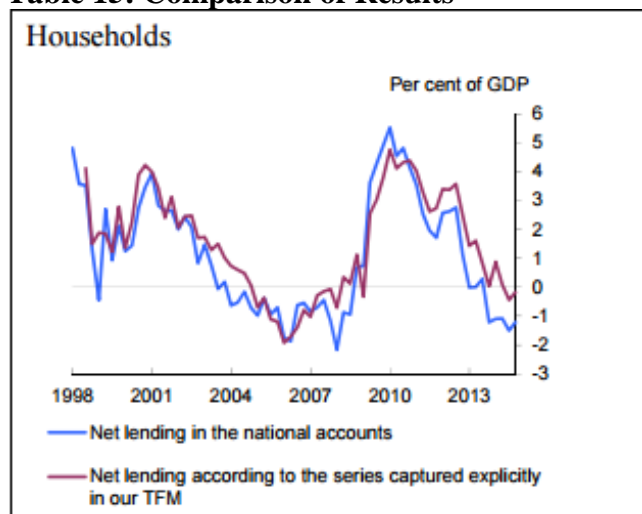
	Households	PNFCs	Government	Banks	ICPFs	Bank of England	Rest of the world
Consumption	-ccp	ccp					
Investment		-ikcp + ikcp					
Housing investment	-ihcp	ihcp					
Govt expenditure		gonscp	-gonscp				
Exports		xcp					-xcp
Imports		-mcp					mcp
Wages	wages	-wages					
Annuity payments	annpay				-annpay		
Pension contributions	-penscont				penscont		
Taxes	-taxhh	-taxnfc	tax				
Transfers	transhh	transnfc	-trans				
Dividend flows	Banks			-divbank			divbank
	NFC		-divnfc		divnfc_icpf		divnfc_row
	ROW				divrow		-divrow
	ICPF				-divicpf		divicpf
Interest flows	Deposits	i_dephh* dephh					
	Mortgages	-i_mort*mort					
	Govt bonds					i_dgovt* dgvot_icpf	i_dgovt* dgvot_cb
	Bank bonds					i_dbank* dbank_icpf	i_dbank* dbank_row
	ROW bonds					i_drow*drow	-i_drow*drow
	NFC loans		-i_loannfc* loannfc				
Net lending	-nlp	-nlnc	-nlgg	-nlbank	-nlncpf		-nlrow

Once again this transaction matrix works in the same way by showing receipts and expenses.

This one is notable for also denoting interest flows, which are very important because it will help model the effect interest rates have on the economy. Like all transaction matrices, the rows sum to zero. The five economists who made the model included a housing component, which is quite beneficial due to its large role in the economy. However, the five economists themselves working for the Bank of England acknowledge one of the cons to their model is that “The models are complicated, which makes it hard to explain the main economic mechanisms at work”(Burgess et. al 2016). Over sixty variables are needed for the estimation and the forecasting of the model. This makes it extremely difficult to find root causation or even correlation. With that being said, this model provides interesting variations on behavioral

equations, some of which are more suitable given the available data than the Godley and Zezza equations. In the Bank of England's SFC model, they provide a very detailed account of how households earn income. They write that households consume out of their disposable income, YD, which is composed of wages plus government transfers, interest received on deposits, any income from annuities, less taxes, pension contributions, and payments related to their mortgages. Taxes are levied in a fixed proportion to the wage bill, and pension contributions are a fixed proportion of expected household disposable income. From here, they use behavioral equations for components of YD such as ones to determine deposits, housing investment, etc., thereby effectively tying the different sectors of the economy together through these equations. Similar to our explanation of the Zezza and Dos Santos model, we won't go into further depth into the behavioral equations in order to avoid repetition, as we will use some of the equations in our models.

Table 15 is very useful because it will be similar to what I'll be doing for my model. The Bank of England economists created what is shown in Table 15 as a way to provide legitimacy. The purpose of SFC models is not to solely depict an economy, but also provide useful forecasts. In order to have an accurate forecast, a model must be proven to have correctly predicted the past, so in this case, the authors compared the actual net lending data to the simulated data created by their model over a time period in the past. This is done by taking the first year of data and use those values for the behavioral equations and simulate future results. These simulated results are compared to actual historical data over the same time period. The results for the household sector in the Bank of England model can be seen in Table 14.

Table 15: Comparison of Results

As we can see, the Bank of England model did a very good job modeling the household sector¹⁸, which means it is practical to use their model for guidance in creating my own. Another interesting caveat in this SFC model building is that because we have historical data, we can be extremely accurate when it comes to parameters. For example, we have historical data on consumption and income, so instead of estimating the propensity to consume out of disposable income, we have the actual data for each year, so a simple regression would provide us with a usable parameter. Table 16 is the results of the OLS regressions for all the parameters used in their model.

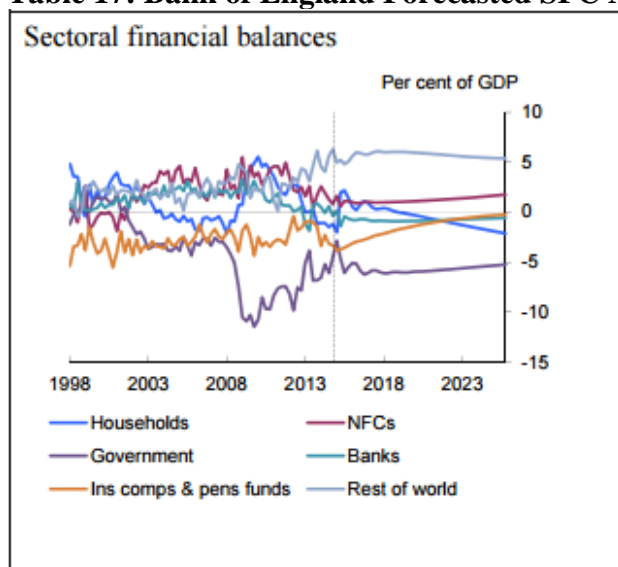
¹⁸ The rest of the results can be found in “*A Dynamic Model of Financial Balances for the United Kingdom*” by the five economists for the Bank of England.

Table 16: Bank of England OLS Regression for Parameters

Dependent variable	Parameter values
Consumption	$\alpha_1 = 0.793, \alpha_2 = 0.008$
Housing transactions	$\varphi_1 = 283, \varphi_2 = 8.6$
Mortgage repayments	$\varepsilon_1 = 0.011, \varepsilon_2 = 0.51$
Housing investment	$\vartheta_1 = 4200, \vartheta_2 = 0.11, \vartheta_3 = 37.2$
Growth rate of capital	$\gamma_y = -0.07, \gamma_u = 0.08, \gamma_r = -0.3$
Government bond yield	$t_1 = 0.055, t_2 = -0.027$
Annuity payments	$\zeta_1 = 23064, \zeta_2 = 0.003$
Mortgage interest rate	$\chi_{0,mort} = 0.0056$
Loan interest rate	$\chi_{0,L} = 0.0025$
Deposit interest rate	$\chi_{0,D} = 0.0052, \chi_{0,D} = 0.0033$
Bank bond yield	$\sigma_1 = 0.023, \sigma_2 = -0.02$
Rest of the world bond yield	$\varsigma_1 = -0.079, \varsigma_2 = 0.077, \varsigma_3 = -0.064$

Notice the α_1 parameter for consumption is .793, which is similar to the .85 used in our Model SIM, SIMD, and SIMR, but not exactly the same. This is a viable method for estimating the parameters because since we are using historical data, we want one parameter that best represents the yearly parameters for use in our simulation, which is done through regression analysis. In the model created for this paper, we will be using a similar methodology to accomplish these results.

Once a model has been established to accurately predict the past, we can then use it to forecast future values which is the main point of these type of models. The Bank of England's forecasted model is shown below in Table 17.

Table 17: Bank of England Forecasted SFC Model

It is important to notice the light vertical line which distinguishes between the actual historical data and the forecasted section of the model. As discussed in Model SIM, the forecasted section trends towards a long-run stationary state, which can also be seen in the Bank of England Model. While nearly impossible to accurately predict the future, these forecasted values are important as establishing a baseline for the SFC model. Once this baseline is established, we can introduce shocks, which is a very important feature of SFC models. For example, The Bank of England had calculated the propensity to consume out of disposable income to be .793 (see Table 16) and that value was carried forward in the forecast. Now what happens if the quality of goods being produced has dramatically increased, thus resulting in households beginning to consume an even greater share of their disposable income? This would clearly affect the overall economy, not just the household sector due to the interrelated behavioral equations. But to what extent? SFC models can show this effect of the shock compared to the baseline. Once the SFC model is clearly defined by the parameters and equations, it is fairly simple for computer programs to create forecasts and shocks that can be used for analysis. Overall, the Bank of England model

was extremely helpful at visualizing the process of SFC model creation and without further ado, I will create an original SFC model.

3.3 Model ECONOMY Framework

While it is important to provide relevant variables, I believe we can simplify the model so that it not only provides accurate forecasts, but is easier to see causation and correlation among variables. With that being said, we will also check the accuracy of this simplified model and compare it to a VAR model. I have created Model ECONOMY that relies heavily on the *Zezza* and *Dos Santos* behavioral equations, while following a similar approach as the Bank of England model.

This SFC model will consist of three sectors of the economy: households, firms, and government. In order to incorporate interest rates in the model, we will assume that the government will not only have the responsibility to issue bonds to satisfy the budget deficit, but also set the interest rates. In effect, the government sector will combine both the duties of the government but also the Federal Reserve. Because we do not have a financial sector, we will assume that households hold their assets in the form of cash and bonds, which is similar to what we did for Model SIM. The exact number will be determined by a growth rate as well as finding the average ratio between households and firms owning bonds. Firms will use their profits to pay dividend, but will invest the entirety of the remaining profit back into the firm. This is a closed economy, so there are no imports. While there is a lack of banking sector, the goal of this particular SFC model is to be more of an applied model similar to the Bank of England, as in I still believe it can be an analytical tool when it comes to studying the economy, specifically the degree of how particular fiscal shocks affect the economy. Below is Table 18 which is the transaction matrix for our Model ECONOMY.

Table 18: Transaction Matrix for Model ECONOMY

	Households	Firms	Government	□
Consumption	-C	+C		0
Government Expenditures		+G	-G	0
Investment		+I, -I		0
Wages	+W	-W		0
Taxes	-T _h	-T _f	+T	0
Interest on Treasury Bills	+i _{b-1} *B _{h-1}		-i _{b-1} *B _{h-1}	0
Profits of Firms	+p ^d	+p ^u , -P		0
Δ Treasury Bills	-ΔB	-ΔB	+ΔB	0
Σ	SAV _h	P ^u	SAV _g	0

Notice the Investment row; firms have both a “+I” and a “-I”. What this is demonstrating is that the positive flow of funds that firms receive from investment originates from the investment of their retained earnings back into the firm. This is necessary because since there is no banking sector to give loans, there has to be some way to denote investment. The same is true for “p^u” and “P”. Profits is an expense because the firms do not keep it, instead choosing to either pay dividends or have retained earnings, which is invested back into the firm. In addition, we will also model a government that invests a fixed ratio of their expenditures into firms. This model relies heavily on Zezza and Dos Santos to model the behavioral equations of firms.

Behavioral Equations

To begin defining our model, we must determine the disposable income equation, which we will write as

$$YD = W - T + \text{div} + i_{b-1} * B_{h-1}$$

This is traditional with much of the SFC literature, where YD stands for disposable income, W equals wages, T is taxes on households, div represents dividends¹⁹ from businesses, and i is the interest received from B, bonds. It is also an abbreviated version of the income equation in the Bank of England model²⁰. From this, as we have seen in the Godley and Lavoie models, we will create an equation for tax on households, in this case: $T_h = \theta * (W + \text{div} + i_{b-1} * B_{h-1})$. We will assume an average tax rate (θ) on the income, even though the taxes on wages and interest are different. This is a logical step, as it follows in the procedure of Godley and Lavoie and their dealing with interest income (Godley and Lavoie 2012). In addition, we will assume that bonds will grow at a constant rate based on past data as well as in relation to the government deficit.

From here, we move onto the consumption function. For our model, similar to the Godley and Lavoie models, we shall define consumption as

$$C = \alpha_1 * YD + \alpha_2 (NWH_{-1})$$

This equation states that C equals consumption, NWH is net worth, and α_1 and α_2 are the propensities to consume. In the following section, we will be estimating our parameters based on historical United States data. We will spend extra time on α_1 and α_2 because one of the explorations in this paper has been that of the role of the consumption function, which can be seen in the comparisons between Model SIM, SIMD, and SIMR. We have already created an equation to calculate disposable income, so now we will need an equation to calculate net worth. For this, I propose to simplify this into the simple equation $NWH = NWH_{-1} + Sav_h$ where net

¹⁹ We assume that households are the sole recipient of dividends. Dividends will be calculated as a percentage of firm's profits and added to the household's disposable income.

²⁰ $YD = WB - tH - iMort - 1Mort - 1Pens + iD - 1DH - 1 + TH + Ann$

worth is equal to the previous year's net worth plus the previous year's savings.²¹ The savings of households (Sav_h) is calculated exactly like it is on the balance sheet, incomes minus the expense:

$$Sav_h = YD - C - \Delta B_{-1}$$

It is important to note that we must also subtract the change in bonds at this time. We assume that the changes in bonds for households is not due to increasing value (like a stock), but rather that they purchased more of them. This is due also to the fact that the aggregate price of bonds do not change in value and that the change in a sector's holdings of bonds is the purchasing of additional bonds. In effect, this is the financial component of the household's portfolio. While it is not as accurate as the real household portfolio (consisting of deposits, stocks, etc.), it allows us to add a financial component without having to add a financial sector.²² While it may be an unrealistic assumption, the crucial thing to remember is that our goal is create a useful model of the economy and that all SFC models use assumptions.

Next we must model the firm sector, which has not been present in the previous models we created. However, Zezza and Dos Santos outline a very theoretically sound procedure to do so in their paper "A Simplified, "Benchmark", Stock-Flow Consistent Post-Keynesian Growth Model." They begin by creating an equation for capital (K), since all firms need capital in order to produce, so we use the equation $K = K_{-1} + I$ ²³, which says that capital is equal to capital from the previous year plus investment (I). But now we must calculate I, which was alluded to when

²¹ Originally, I was going to use the actual variable net worth from the Federal Reserve Board and create a parameter for the growth rate in order to be more accurate. However, this would mean our model would have unaccounted flows, since the savings of the household must go somewhere. We assume that they are added to the net worth in a non-interest earning capacity. However,

²² In addition, we will be comparing the actual net savings from the Federal Reserve Board and ours to see if this is a legitimate procedure.

²³ We will ultimately alter this equation with a percent modifier, but this is the basic equation.

discussing investment within the transaction matrix. We modify the Zezza and Dos Santos equation to fit our model, so instead of $I=F+P^u$ where I is investment, F is funds from the government²⁴, and P^u is retained earnings which are invested back into the firm, our new investment equation is $\log(I)=\log(\alpha_3*\text{consumption})+\log(\alpha_4*P^u)$. These alphas are derived from a regression based on the historical data²⁵. We are doing this because it will tie investment to consumption and retained earnings, which have been shown as key components of investment for the private sector. The profit equation is one of the most important equations for the model:

$$P=Y+i_{b-1}*B_{h-1}-W-T_f-\Delta B$$

This reads profit (P) is equal to total output (Y) plus interest received from bond holdings and subtracting wages paid (W), taxes (T), and additional bonds purchased ΔB ²⁶. From this profit equation, we divide it into two equations:

$$p^d=(s_f)*P-1 \quad p^u=P-p^d$$

This represents a firm gives (p^d) at a fixed percentage (s_f) of profits, and which shows that a firm's retained earnings (p^u) are equal to profits minus dividends paid out to households. Lastly we use an equation to define wages.

$$W=(1-\gamma)*Y$$

²⁴ In the original Zezza and Dos Santos Model, they use F for external funds from banks. Since we do not have this sector, we modify it to include funds from the government, which is useful in linking the sectors together.

²⁵ See parameter table for exact results.

²⁶ Due to the absence of a financial sector, we assume that the firm sector and the household sector divide up the government bonds supplied by the government. Part of their profits is spent purchasing bonds, so therefore the change in bonds is the additional bonds purchased by firms.

This states that wages are equal to a fixed percentage $(1 - \gamma)$ of total output.²⁷ This is an important equation because it ties the household and the firm sector together by having wages being determined by total output.

Lastly, we will describe the equations used to determine the government sector. Government spending (G) is determined by its previous year's expenditure multiplied by a constant growth rate (β) ²⁸. We leave government spending as more exogenous because it is something that can be controlled but also examined during the shock phase of our modeling. Government spending, combined with household consumption (C) and investment (I), is equal to the total output (Y) of the economy.²⁹ As described in the transaction matrix, the government earns income from taxes. In our model, the two sources of tax income are taxes on disposable income and production, which is written as $T = \theta_h * YD + \theta_f * Y$. We assume two tax rates, one for each sector.³⁰ Next, we will describe the equation that determines the amount of bonds given out by the government. For this model, we will combine the functions of the Federal Reserve and the government, so the government not only issues bonds, but also sets interest rates.³¹ We write our equation for bonds as bonds issued by the government (B_g) is equal to the previous year's amount plus the government deficit (DG), which is written as $B_g = B_{g,-1} + DG$ ³². This is similar to the equation found in the *Zezza* model and is important because of the inclusion of the

²⁷ In addition, Burgess et al. write that "We assume a flexible labour market and a Cobb-Douglas production function. In this case, the labour share is constant"

²⁸ The full equation is $G = G_{-1} * (1 + \beta)$

²⁹ Total output and GDP in our economy are the same due to the absence of exports and imports, so both are written as $GDP = Y = C + I + G$.

³⁰ While capital gains taxes are different than income tax, we assume one tax for simplicity.

³¹ We are able to do this because the interest rate in this model is an exogenous parameter. We get a baseline from historical data, but we are also able to set it at

³² One additional caveat is that the total bonds issued by the government (B_g) is equal to the bonds held by households (B_h) and firms (B_f)

government deficit. Because there is no financial or rest of world sector, we have to have a way for the government to pay for its spending, so we assume that the government finances its deficit by the issuing of bonds. The government deficit equation is written as $DG=T-G-(i_{b-1}*B_{-1})$, where the government deficit is equal to government spending plus interest paid on bonds minus tax receipts. The interest on the bonds (i_b) is $i_b=i_{b0}$ where i_{b0} is an exogenous parameter. Lastly, we must include a savings equation for the government sector, which is created similarly as the savings equations for households. This is necessary in order to compare the actual savings of the government sector (Sav_g) from the Federal Reserve Board to ours. For our equation, it is similar to the way we calculate the deficit, but we flip the signs around for the equation: $Sav_g= T-G+\Delta B-(i_{b-1}*B_{-1})$. We have now defined behavioral equations for Model ECONOMY.

Parameter Calculation

Once the behavior equations are established, the next step is to determine values for the parameter values. The best way to do this³³ is to use historical data in order to get a value and use that for forecasting purposes. For most of the equations used in Model ECONOMY, we are able to calculate an average for the parameter. For example, in the equation for government spending, $G= G_{-1}*(1+ \beta)$, we have to calculate the value for the growth rate. We use historical data of government spending to calculate the rate of change and then take the average to find beta. For our model, we use a mixture of data from the Bureau of Economic Analysis and the Federal Reserve Board.^{34 35}The time frame we are using is from 1990-2015 and we will be using quarterly data in order to increase our observations for accuracy. If an equation has more than

³³ This was the method used in the Burgess et. al. paper.

³⁴ The majority of the data is from the Board of Governors of the Federal Reserve Board Financial Accounts.

³⁵ The data from the Federal Reserve board is notated by IMA in the graphs, which represents the International Monetary Accounts.

one parameter in it, then we must use regressions to find the values. In more complicated models, there are more equations requiring regressions, but for our model we only need to use a regression for the consumption function and the investment equations. The values can be seen in the table below.

Table 19: Model ECONOMY Parameter Values

α_1	.90
α_2	.01
α_3	.78
α_4	.25
β	.009
γ	.24
S_f	.02
θ_h	.131
θ_f	.095
μ	0.08578689
$r_{\beta nwh}$.007

There are some notes on the findings. α_1 and α_2 do not equal one. This may be explained by the possibility that households consume out of other sources besides disposable income and their net worth.³⁶ For the dividend yield rate (s_f), we assume a 2 percent payout³⁷, as that is consistent

³⁶ This is one area of improvement that can be done on this model. For full list of improvements see section 3.3

³⁷ Daniela Pylypczak-Wasylyszyn writes that “The majority of the companies in the S&P 500 index feature a yield between 1% and 2%.”

with the literature. We assume this exogenous rate because dividend yield rate varies not only year to year, but also firm to firm. Lastly, it is important to point out that while Zezza and Dos Santos use the wage bill (w) and labor productivity (\bar{w}) as parameters, we will not be including them. Based on our equations and assumptions, they do not serve a purpose in our model.

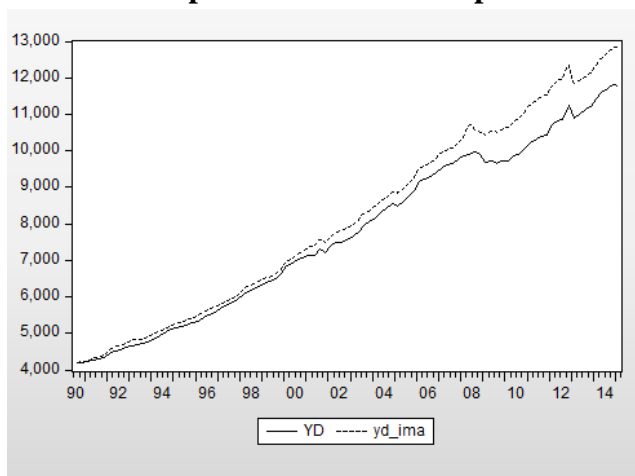
3.4 Equation Result Comparisons

In this next section, we will show the comparisons between our model and the historical data supplied by the BEA and Federal Reserve Board. For example, we will check the precision of our consumption function with actual consumption from 1990 to 2015. In order to have a model that has some hope of forecasting the future, it must be reliable in measuring the past. It is important to note that these are individual equation comparisons. While not perfect, they will give us a rough estimate to check the validity of our equations.³⁸ In addition, these formulated equations will naturally be slightly different than the ones created by the model because we are taking the equations in isolation instead of as a group like in a model solver. If anything, this is a test to check for parameter accuracy and basic accuracy of equations. Once established, we can then create a model with at least partial proven legitimacy.

Disposable Income

The first variable that we compare for accuracy is disposable income. We use the Federal Reserve's disposable income and the disposable income from our behavioral equation. The result can be seen below in Table 20.

³⁸ Due to the different solver methods and solving the model as a whole, the results of the comparison will not be as easy as just comparing one calculated equation to the historical data. This is because the equations are all interrelated, but as mentioned above, this will provide us with ballpark estimate.

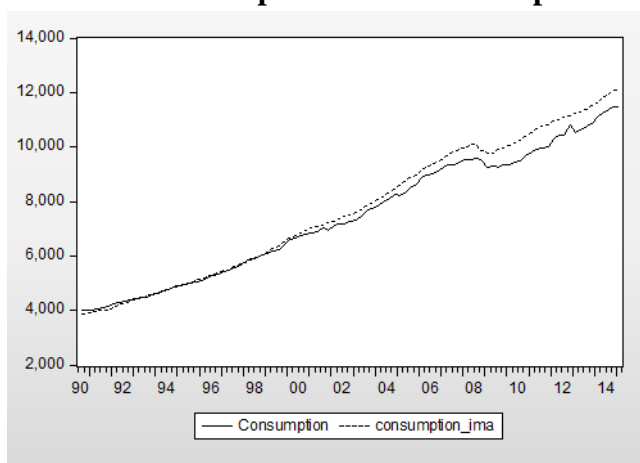
Table 20: Disposable Income Comparison

In this graph, YD is the disposable income from our equation and YD_IMA is from the Federal Reserve Board. Overall, it is a good fit, with the deviation coming after 2007 but staying at a consistent distance apart from that point onward. This may be because of the 2008 Financial Crisis but that is only speculation at this point. The most important part is that our disposable income equation follows the general trend of past historical data and can be relied upon as an accurate variable.

Consumption

From here, we can check the accuracy of our consumption function. This is important because one of the focuses of this paper³⁹ has been the consumption function in addition to the fact that we will examine it closely in Section 5 of this paper. The results of the comparison can be seen below in Table 21.

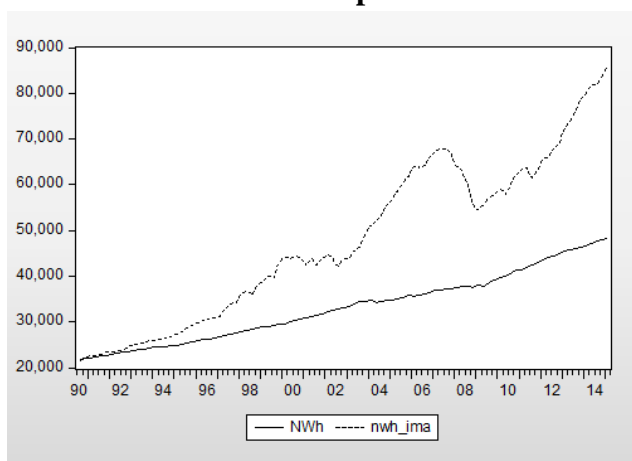
³⁹ We created Model SIMR and SIMD with different consumption functions and showed how it is a driving force in a simple Keynesian SFC model.

Table 21: Consumption Function Comparison

The Consumption represents consumption of households from our equation and C_IMA represents historical consumption data from the Federal Reserve Board. As it could be inferred, the consumption function is a good fit with slight deviation coming after 2007 but staying consistent. Not only does this tell us about the validity of our consumption function, but also the parameters we used for α_1 and α_2 in our behavioral equation. This allows for the possibility of creating shocks by altering the parameters in the consumption function.

Net Worth Comparison

The next variable we must check is net worth because we opted to use household savings as the growth rate instead of a parameter. We did this in order to ensure there was no leakages in our model, which meant that household savings was used as a growth rate in the equation $NWH = NWH_{-1} + Savh_{-1}$. We know that this will not be as accurate as using the historical growth rate of NWH, especially because we do not have a financial sector. The results can be seen below in Table 22.

Table 22: Net Worth Comparison

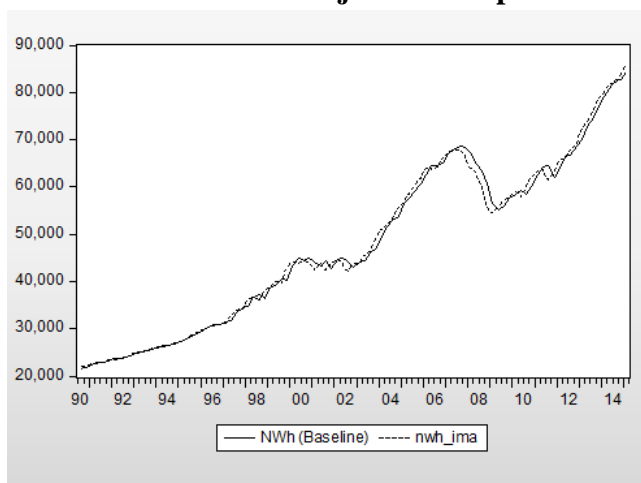
As can be seen by the graph, it is not a very good fit. Not only does the data deviate, but it does not follow the trends. This could be expected due to not using historical growth rates, but more likely is the exclusion of the financial sector, since much of a household's wealth is tied up in financial assets such as stocks, pension plans, mortgages, etc.⁴⁰ While in future models we can add a financial model, we are not going to do so in this version of Model ECONOMY. Instead we are going to add a parameter for growth rate, similar to that parameter for growth rate of government expenditures. As one can see from the table, our net worth of households (NWH) severely undershoots the growth of net worth consistently across time. This means that net worth is increasing by more factors than just additional savings, which is consistent with the literature⁴¹ such as the rapid growth of the housing market, consumer credit, etc. Therefore, I propose to add

⁴⁰ This can be seen in the current release of the Financial Accounts of the United States published by the Federal Reserve Board of Governors. The link to this page is <https://www.federalreserve.gov/releases/z1/Current/z1.pdf>. What one can see is that vastness of the financial sector, including deposits, stocks, loans, etc.

⁴¹ One such example of this is in the paper "Household Wealth Trends in the United States, 1962-2013: What happened over the Great Recession" by Edward N. Wolf, where he writes that "After a period of robust growth, median wealth continued to climb by 19 percent from 2001 to 2007, even faster than during the 1990s (and 1980s). Median income, on the other hand, rose only 1.6 percent. Then the Great Recession hit. From 2007 to 2010, house prices fell by 24 percent in real terms, stock prices by 26 percent, and median wealth by a staggering 44 percent. Median income also dropped but by a more modest 6.7 percent and median non-home wealth plummeted by 49 percent. The share of households with zero or negative net worth rose sharply from 18.6 to 21.8 percent." This shows the variance in the growth rate of net wealth. Therefore it is beneficial in our model to include savings as well as a parameter of growth rate based on the real world.

savings to household net worth, in order to keep the model consistent, AND have an equation with a growth rate parameter based on historical data⁴². These two equations will complement each other in order to have an accurate net worth. Our goal is to create the most accurate NWH value, because we are not necessarily concerned about the equation for NWH, due to the missing financial sector, but rather we are more focused on consumption and fiscal policy. Because of its role in the consumption function, we need an accurate NWH value. The resulting graph can be seen below in Table 23.

Table 23: Net Worth Adjusted Comparison



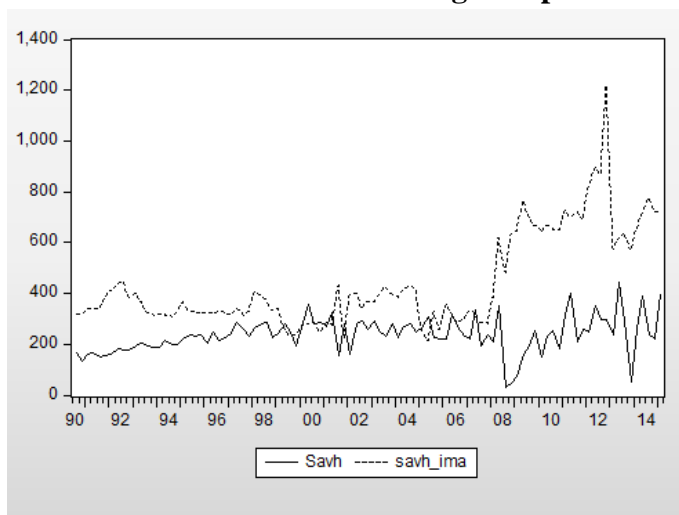
This is an almost identical representation of net worth. It is important to note that by adding the beta, we are essentially making part of this equation exogenous, but we are able to keep the model consistent by having savings of households flow into the net worth stock.

Household Net Lending

After making the correction to the net worth, we can now compare the overall household sector.

Using the same method as Burgess et.al. in their Bank of England SFC model, we will now compare the household net lending in our model to that of the actual data from the Federal Reserve. The results can be seen in Table 24.

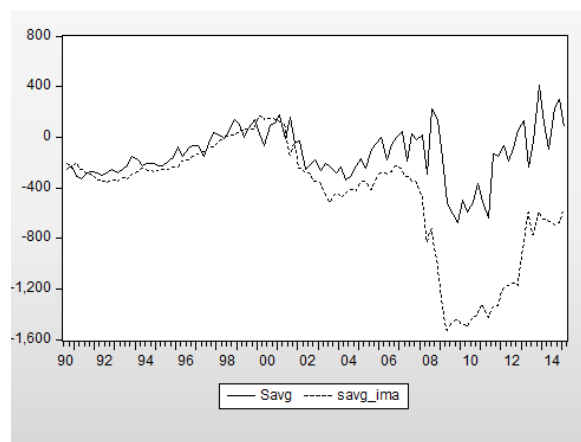
⁴² The new equations will be $NWH=(NWH_{-1}+Savh)*(1-\beta_{nwh})$ and $\beta_{nwh}=\beta_{nwh-1}-r\beta$

Table 24: Household Net Lending Comparison

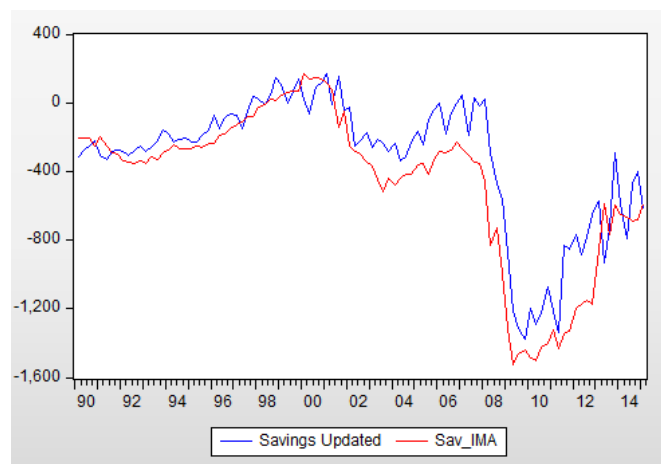
Overall, this isn't the greatest fit, with our household savings (Sav_h) appearing to be much more variant than the Federal Reserve's household savings. However, we are going to keep this because we have good fits on our disposable income and consumption functions. We will leave this for now and later do a check after the model. This is justifiable because this discrepancy stems from the lack of the financial sector. In addition, the periods 1990-2007 do an adequate job of capturing the trends and values. We can do some modifications in our model to account for the randomness during the 2008-2015 but our behavioral equations are adequate for the model.

Government Net Lending

Just as we had done for the household sector, we must look at the savings of the government sector. As we could expect, most of these values are negative, so technically it is the lending of the government sector. The results can be seen below in Table 25.

Table 25: Government Net Lending

Overall, it's a pretty good fit considering the circumstances. From 1990-2007, our model is very comparable to the historical government. This has been a common theme throughout the comparisons. The 2008 crisis was a financial crisis, and therefore cannot be accurately mapped in this model. We are able to achieve some success by using bonds as well as our correction method of altering, but for the most part, it is extremely difficult to show a financial crisis without a banking sector. However, from 2008 onward, it follows similar trends, growing at roughly the same rate. In effect, only one small period of time is misrepresented in the model. Therefore, I propose to make a graph with one slight adjustment to the data. I am going to propose to show an exogenous government net lending expenditure of 700 billion dollars in order to correct this model. This is just to show the government net lending with this one small adjustment is almost identical to the historical values. The result can be seen below in Table 26.

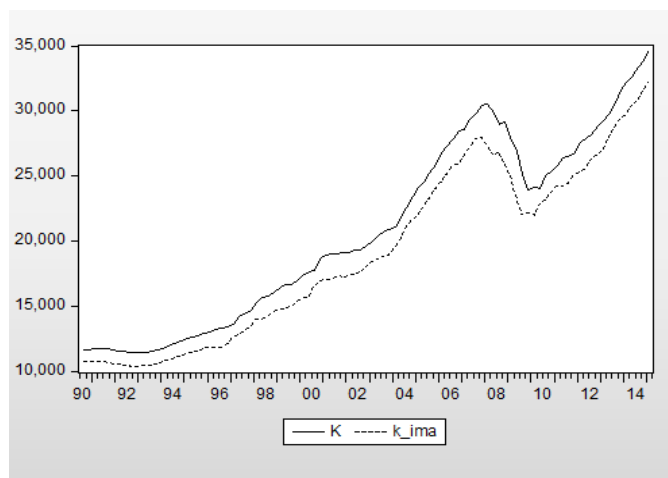
Table 26: Government Net Lending Updated

Notice how the one small adjustment is able to make our model fit much better. We did not arbitrarily choose 700 billion, but rather chose it because that was the amount the government had allocated for their bailout.⁴³ The fact that our equation models the trends accurately is ultimately what makes the SFC model good for predicting future events.

Business Capital Data

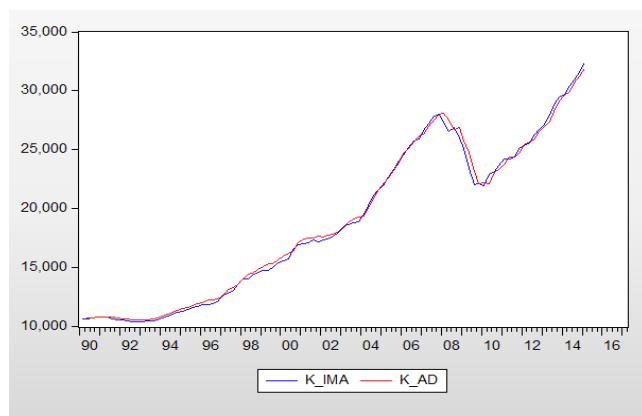
Now that we have examined the household and the government sector, we must now turn our attention towards the firm sector. For firms, they need capital to produce their goods, so we must look at how accurate our model is when it comes to capital. In the table below, we compare our capital (K_B4D) to that from the Federal Reserve Board.

⁴³ We get these numbers from the New York Times article “Tracking the \$700 Billion Bailout.” It must be noted that this may not be the only reason why the government had a much larger deficit than our original model predicted. However, for the sake of the model, it is not of the greatest significance the reasons of where it was spent.

Table 27: Business Capital Comparison

This is a great fit, which is a good sign for our model. Notice how not only the raw data is similar in value but also that it follows an almost identical pattern as the historical data. While we could technically leave it like this, I propose to include a deflator in our model. In effect, the new equation will be $K=(K_{-1}+I)/(1+\mu)$ with μ being the average rate that our data is off. As one can see from Table 26, there is a consistent deviation from the line that follows the trend. After looking at our calculations, we are off by about 8 percent⁴⁴, which could be because of a variety of reasons stemming from a lack of financial side or the fact that it is a closed economy. The results of this new parameter can be seen in the table below.

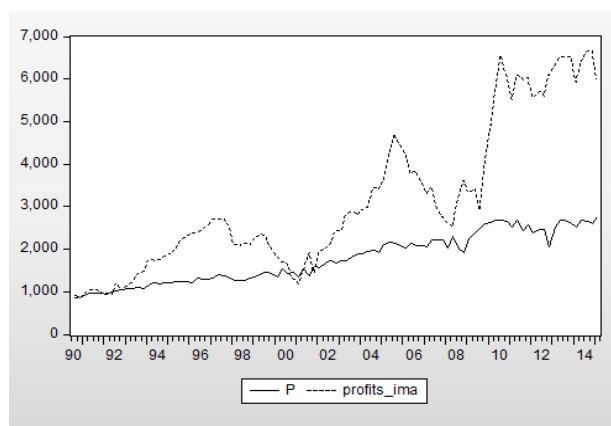
⁴⁴ See Table 19 for exact parameter value

Table 28: Business Capital Comparison Corrected

After this modification, we now have an almost perfect fit to the line. Ideally we would not need to do this modification, but due to the limitations of our model, we will be improving the overall accuracy for forecasting. While the actual model simulation may not be this accurate, by cleaning up the individual equation comparison, we put ourselves in a position to have a more accurate model.

Business Savings/Profit Comparison

After this modification, we must now analyze the firm sector's profits, also known as net saving. For this we will compare our profit equation to that of the actual net saving of firms according to the Federal Reserve. The results can be seen below in Table 29.

Table 29: Firm Profit Comparison

As one can see by the table, we are able to capture the starting point and several years at different points but unable to capture the peaks. This may be explained by the increased financialization of the economy during this time period.⁴⁵ As Stephen G Cecchetti and Enisse Kharroubi conclude “First, the growth of a country's financial system is a drag on productivity growth. That is, higher growth in the financial sector reduces real growth.” (Cecchetti 2015). This may explain why there is as much more sporadicness in the actual net saving of the business sector, which was acquired from the Federal Reserve Board. However, we have accurate data for wages, output and investment. In addition, due to the role that banks play in the business sector, it should come as no surprise that since our model does not include a true financial sector, it does not capture the business profits as well.⁴⁶ Because the economy is closed, it does not take into account exports and imports. Even with this being said, we will leave this equation alone because the other two sectors our mapped more accurately. This means that we will assume that the variation in this sector are from external issues that our beyond our control based on our assumption. In Model SIM, and by extension all two-sector economies, the savings of the household sector and the government sector should sum to zero. One of the key concepts of these models is having sectoral balances, where for every credit there is a debit.⁴⁷ In addition, if we are to use the heterodox view of money, it will also support this idea of money as the government’s liability and a household’s asset. However, this is complicated as we add additional sectors, such as a business sector or a financial sector. This is because these sectors add value through either

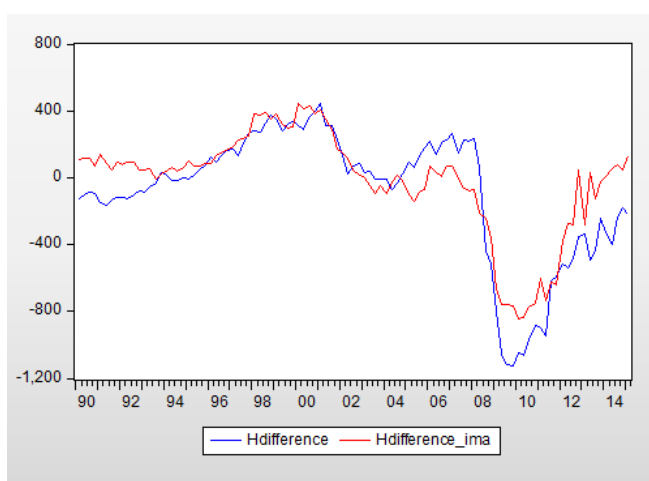
⁴⁵ We can see this in most of the literature. Cecchetti and Kharroubi is one example but other economists are discussing this idea such as Minsky, Tori, and many others.

⁴⁶ Notice how the Federal Reserve Board’s net saving follows a similar trend as that of the stock market.

⁴⁷ J. Fagg Foster explains that households are able to accumulate wealth at the expense of the government. This is because the government’s liability is money. Instead of trying to limit liability, the government is willing to be in deficit so the household sector.

production (firms)⁴⁸ or interest/growth rates (financial sector). Therefore, we can check the validity of the model by measuring the accuracy of the combined savings of households and governments. If our model accurately represents the relationship between the two sectors, then we will be able to assume that whatever our firm's profit function doesn't capture is the result of the exclusion of a financial sector, rest of world sector, or some unknown variable. The result can be seen below.

Table 30: Justifying the Savings Equations of the Household and Government Sector



For this graph, we used our government savings and household savings and added them together and called it Hdifference. We did the same thing using the historical data from the Federal Reserve Board and compared it to ours, which can be seen in Table 30. As we can see, our model does a very good job of modeling the combined savings equations. This means that we can move forward with our three sectors, as they do a quality job of mapping the economy.

⁴⁸ This can be seen in the previous section outlining the Zezza and Dos Santos model where the balance sheet shows the increase in net wealth for firms is based on the change of capital from the previous year and the price of their stock.

3.5 Justification and Improvements for Future Models

As can be seen by the previous section, are model does a quality preliminary job of mapping the economy. The previous section was critical for providing validity to our model because it shows the accuracy based on historical data. It is even more critical for a model like ours to prove its accuracy due to simplicity of the model. In effect, I needed to show that a three-sector model could do an adequate job of representing the economy in order for the conclusions from the model to have any legitimacy. However, there are several areas where we could improve for future models. This is by no means invalidating our model, but by relaxing some assumptions and adding key components, we could create an even better model.

First and foremost, adding a financial sector would add much more predictive power to the model. One of the reasons Godley's model was able to predict the 2008 crisis was the addition of a financial sector and using sectoral balances. In addition, adding a financial sector would interrelate the sectors better because households need banks for mortgages, and firms need loans from banks to finance production. By extension, adding a financial sector would allow the SFC model to incorporate the housing market, loans (interest rates), and sector portfolio theory. These additional variables would increase the predictive capacity of the model. While we were able to capture some of this by the inclusion of bonds, we were by no means able to capture the entire financial system. This can be seen most prominently in the profit equation comparison.

In addition, by having a financial sector we would be able to not have as many exogenous correction parameters. While we would not need to be as exhaustive as the Bank of England's model, having a financial sector would allow for the inclusion of equations for financial assets instead of how our model uses correction parameters. As mentioned before, we showed that by altering the government savings equation in order to account for their jump in expenditures

during the crisis, we could have a better fit. While we showed this by exogenously subtracting 700 billion dollars⁴⁹ from the government equation, there could be a theoretically more accurate way of accounting for this in the actual model. However, it is important to note that the trends were the same, so in terms of future predictions we may not be able to account for the nominal values, but we would be able to accurately capture the trends. Along these lines, more equations means more variables which means more data. This would allow for our comparison data to be more accurate.

Another improvement would be the inclusion of more equations requiring regressions. For many of our parameters we just took the average from the historical data. However, when we add more equations for a financial sector, and by extension all the other sector, it would be much more accurate to create regressions from the historical values. We have initially done so with the consumption function and the investment equation to a good deal of success. By continuing with this method, we would have not only a more accurate model, but also one that is more interrelated, which is a good benefit of this model.

4. Model ECONOMY Simulation Results

After completing these comparisons, the next step is to solve the model we have created. The computer software program that will be used is EVIEWS, which has built in features that are perfect for solving SFC models. We will be using all the equations mentioned above as well as the slight alterations to them that we saw fit. One important note is that we have slightly modified the consumption function. Instead of doing the traditional Keynesian consumption function, we have modified it to include the logs. The results will be the same but for the purpose

⁴⁹ See previous sections justification on the reasoning behind this number.

of model building in EVIEWS, we have made this slight change. The full list of equations can be seen below in Table 31.

Table 31: Model ECONOMY Equations

Households	Firms	Government
$YD = W - T + \text{divd} + i_{b-1} * B_{h-1}$	$K = (K_{-1} + I) / (1 + \mu)$	$G = G_{-1} * (1 + \square)$
$T_h = \theta_h * (W + i_{b-1} * B_{h-1})$	$\text{Log}(I) = \log(\alpha_3 * C) + (\alpha_4 * P^u)$	$Y = C + I + G$
$\log C = \log(\alpha_1 * YD) + \log(\alpha_2(NWH_{-1}))$	$P = Y + i_{b-1} * B_{h-1} - W - T - \Delta B$	$T = \theta_h * YD + \theta_f * Y$
$NWH = (NWH_{-1} + \text{Savh}_{-1}) * (1 - \beta_{NWH})$	$p^d = (1 - s_f) * P_{-1}$	$B_g = B_{g-1} + DG$
$\text{Savh} = YD - C - \Delta B - 1$	$p^u = P - p^d$	$B_g = B_f + B_h$
$B_h = B_g * \alpha_5$	$W = (1 - y) * Y$	$DG = G + (i_{b-1} * B_{-1}) - T$
$\beta_{NWH} = \beta_{NWH-1} - r\beta$	$B_f = B_g * \alpha_6$	$ib = ib_0$
	$T_f = \theta_f * Y$	$\text{Sav}_g = T - G + \Delta B - (i_{b-1} * B_{-1})$

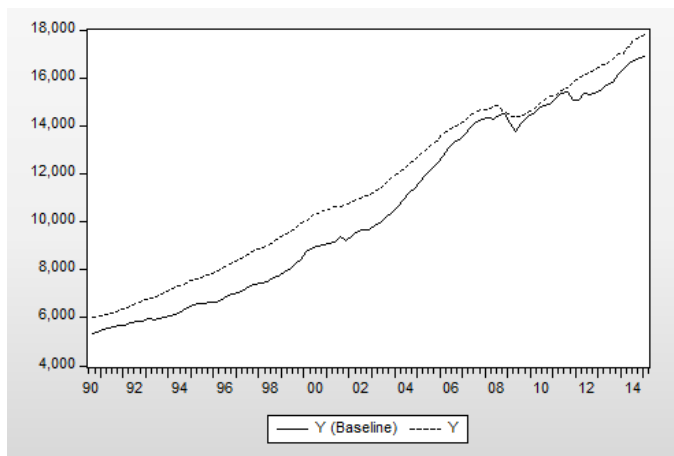
While EVIEWS requires a slight variation in names, these are the equations that will be entered into the model. We will solve the model with the model solver in EVIEWS set as a deterministic static solution. This will map our model equations from the years 1990, quarter 3, to 2015, quarter 1. This will create our baseline scenario, from which we will make changes to the parameters in accordance to fiscal policy decisions and compare the results.

4.1 Baseline Results

In this section we will be discussing the baseline model results. Some of the graphs will be nearly identical to that of the comparisons completed at the end of chapter 3, but others will

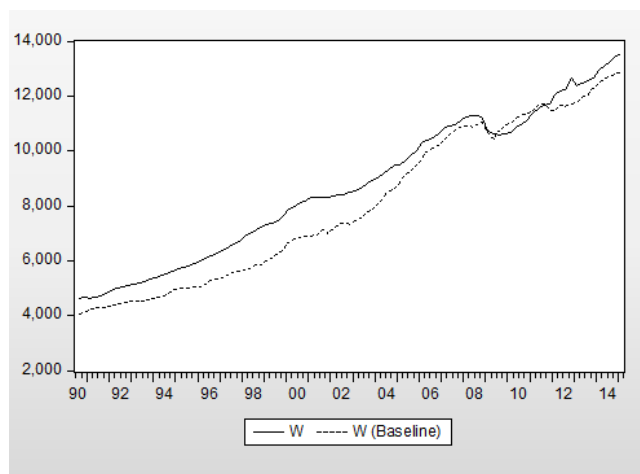
differ, although it shouldn't be too dramatically different. The first set of data that we will examine will be the GDP equation, or what we call Y for national income. The results can be seen in Table 32.

Table 32: Model ECONOMY Baseline National Income Comparison

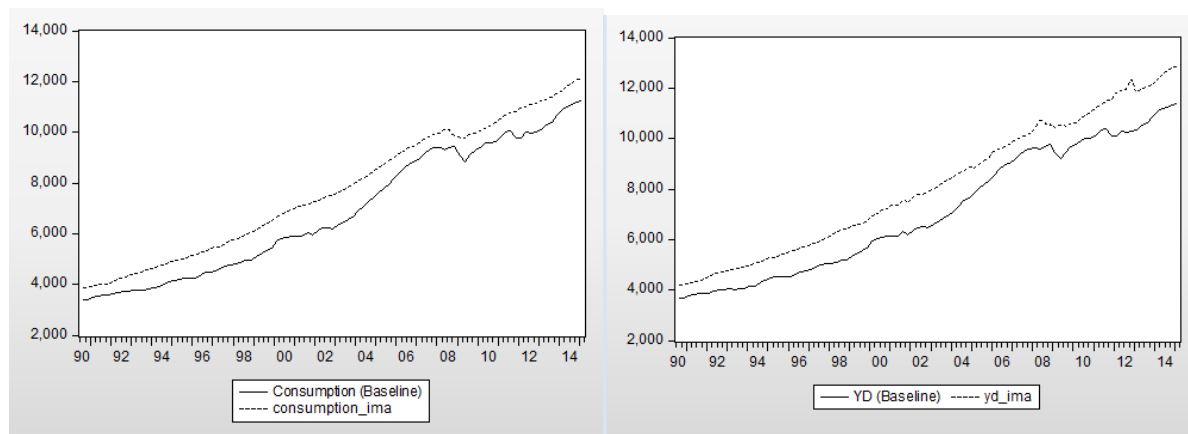


As we can see, our model does a very good job of modeling the national income⁵⁰, with it actually getting more accurate from 2008 to 2014, which is normally a trouble period due to the 2008 Financial Crisis. By having an accurate national income, it means that there is a greater likelihood of having other accurate equations because of its multiple appearance in the other behavioral equations. One such example is the wage equation, which is a parameter for profit share multiplied by Y. The result can be seen below in Table 33.

⁵⁰In this case, the Y (baseline) is created from our model and the Y is from the Federal Reserve, or as we normally label it, `_ima`.

Table 33: Model ECONOMY Baseline Wage Equation

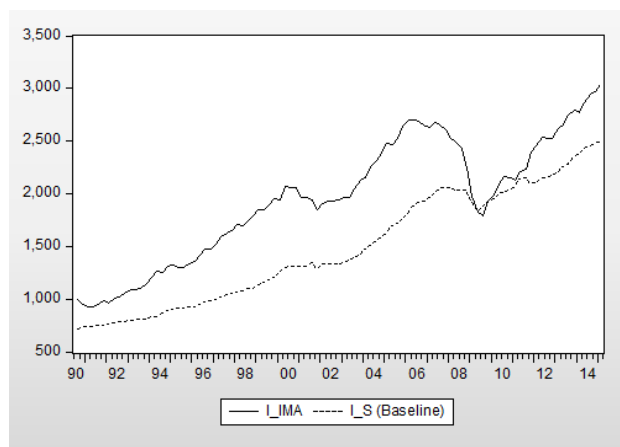
As we would have expected from the national income equation, the wage equation follows the same trend. This is important because in our model, wages make up a large portion of disposable income, which in turn makes up a large percentage of consumption. The results for disposable income and consumption can be seen below in Table 33.

Table 33: Model ECONOMY Baseline Disposable Income and Consumption

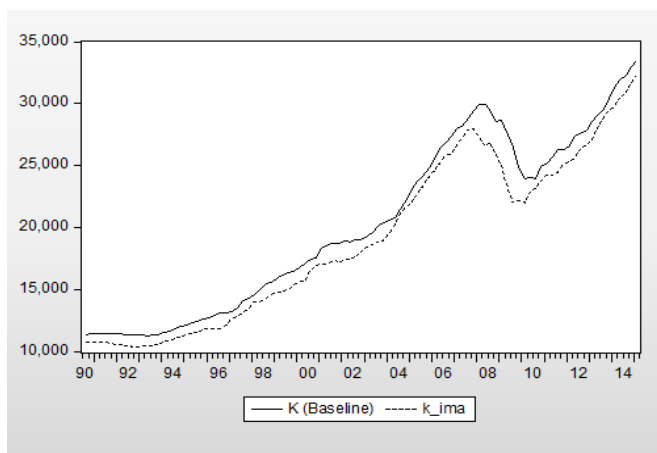
As we can see by the table above, the results are very good, with both disposable income and consumption following a similar pattern as the Federal Reserve's during this time period. All that is off is a percentage, but the trends are nearly identical, which is important for the model.

From here, we will examine the firm sector of the economy. The first equation that we will examine will be the investment equation, which we had achieved from a regression of profits and consumption. The results can be seen in the table below.

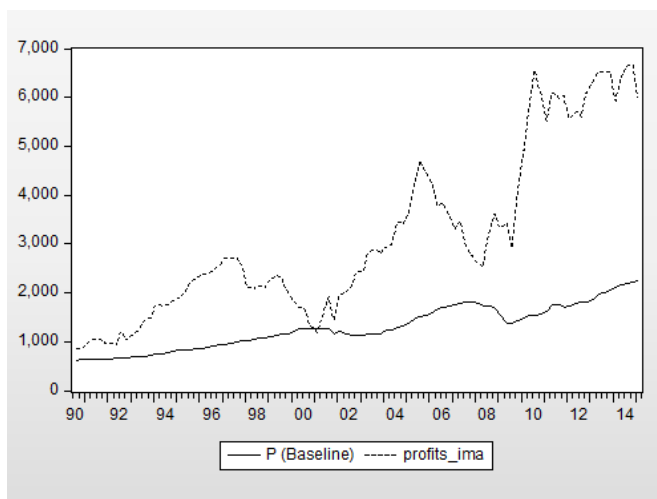
Table 34: Model ECONOMY Baseline Investment Equation Comparison



Overall, this is an adequate fit, mostly because it follows the trends. In addition, it is the most numerically similar in the more recent years, which will be useful for predictive purposes. It is also important that we are able to have an accurate investment equation, as that is one of the key components of not only our national income, but also an important equation for analysis of fiscal policy. The next equation that we will examine will be the capital equation, which will be shown in the table below.

Table 35: Model ECONOMY Baseline Capital Equation Comparison

Due to our model correction μ , we are able to have a very accurate capital equation. After analyzing investment and capital, the last equation we must check is the profit equation. The result can be seen below.

Table 36: Model ECONOMY Baseline Profit Equation Comparison

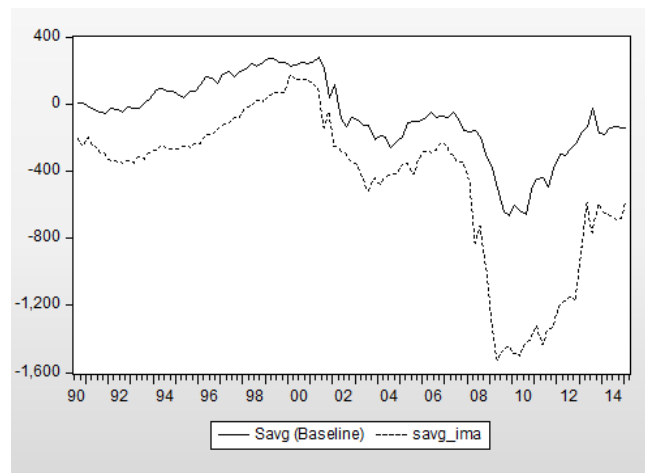
While this is not the most ideal fit, it is nearly identical to the profit comparison at the end of chapter three. This is important because in that section, we were able to prove the validity of the equation even though it is not the greatest fit. At the very least, it at least follows the trends from 2000 onward.

Next we will check the savings equations for the government and the household sector.⁵¹

These are important as they demonstrate the net balance of each sector at the end of each period.

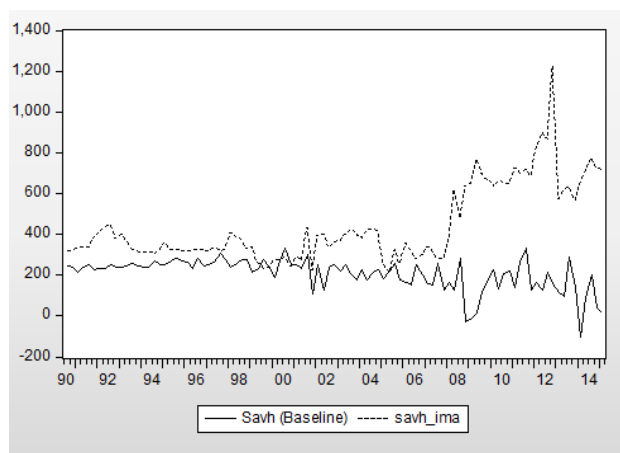
The results can be seen below in Table 37 and Table 38.

Table 37: Model ECONOMY Baseline Government Savings Comparison



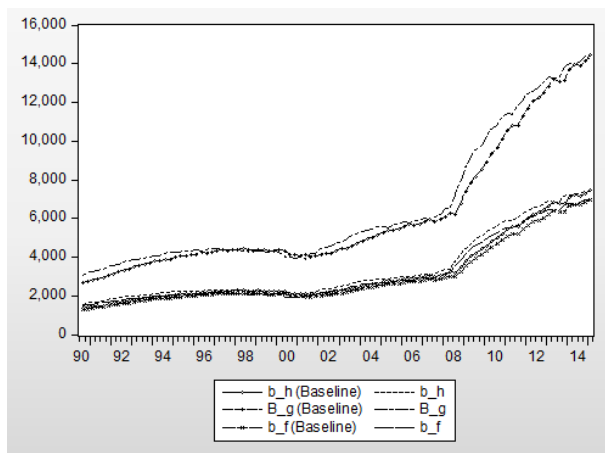
We can see in the table above that our model's government savings follows a nearly identical pattern as the previous chapter's equation comparison. As we have mentioned several times, it is crucial that we are able to model the trends, which our savings equation for the government does a very good job. The only discrepancy is there is not as sharp of a decrease in the 2008-2009 range. However, we can see that our model is closed in the sense that there is no leakages from the model by next looking at the savings equation of the households. This can be seen below in Table 38.

⁵¹ We do not have a savings equation for the firm sector because that is the retained earnings equation, which is just the profits minus the dividends.

Table 38: Model ECONOMY Baseline Household Savings Comparison

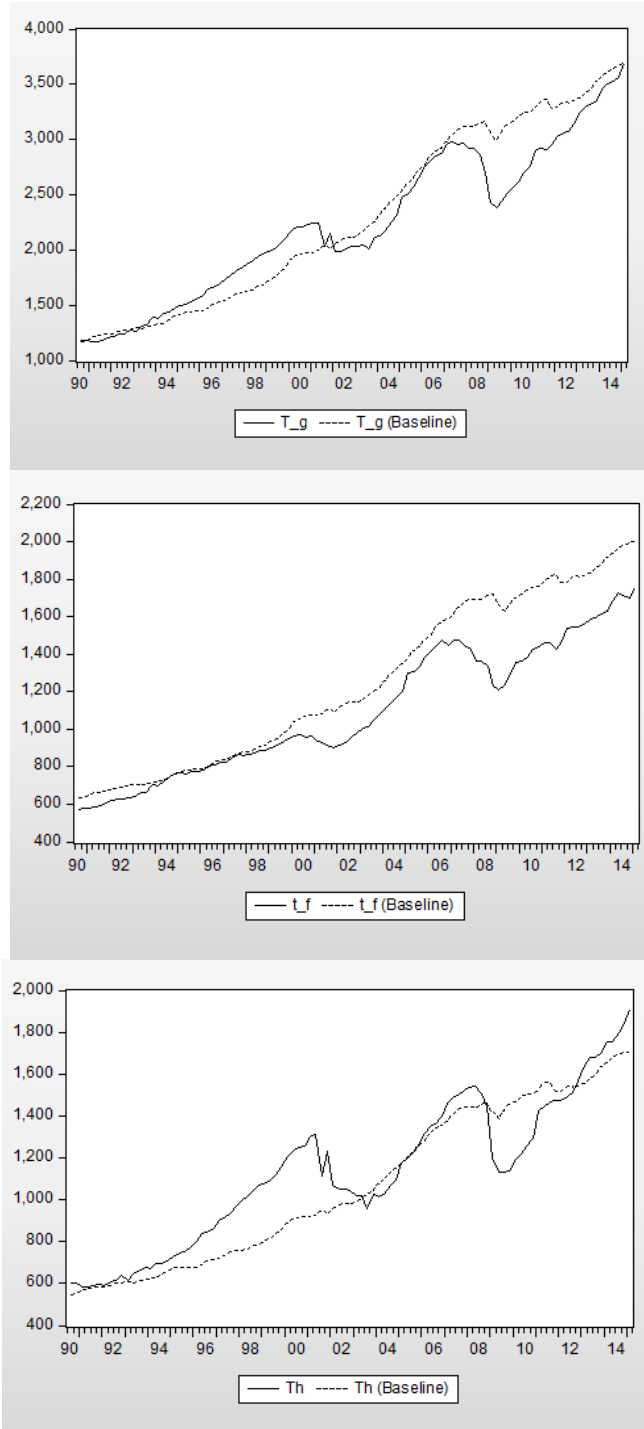
Once again, we can see that our model does a pretty good job of accounting for the savings of the households. In addition, we can also see that it appears to be an inverse of the government savings equation. Where the government's savings did not go as negative, the household's savings did not go as positive. In effect, there is more of a steady-state with regards to the savings equations. This is consistent with the literature and the boom-bust nature of financialization.

Now that we have a basic proof of the authenticity of the model, we will look into some of the underlying equations in the model. First, we will ensure that the bond market is consistent with the historical data. While not a big component of the model, it is important because we assume that the government covers its deficit. The result can be seen below in Table 39.

Table 39: Model ECONOMY Baseline Bond Comparison

The underscore letters (i.e. $_h$) represent which sector of the economy that holds the bonds. As defined by our equations, b_h and b_f will equal B_g . This is important because the household and firm sectors cannot hold bonds that the government gives out. The baseline bonds are the values created by our model and B_g is based on the Federal Reserve data.

The last area of our baseline model that we will examine will be the tax receipts. This is an important section because they are integral to tax rate policy, which is a common fiscal tool. The results of our model's tax receipts can be seen below.

Table 40: Model ECONOMY Baseline Tax Receipt Comparison

In the table above, it depicts the tax receipts/expenses of the three sectors of the economy. The first graph in the table shows the government tax receipts, which is the most important of the

three graphs, since household taxes and firm taxes must equal this number. As we can see by the three graphs above, our model does an adequate job of modeling taxes. This is impressive because we are only using one average tax rate for each of the sectors. This concludes the section on describing our baseline model. As mentioned before, the goal of this model is to situate its place with solid theoretical equations without being overly complicated and also being able to describe and model an economy. So far, our baseline model has done an adequate job in achieving this goal.

Note on Simulations

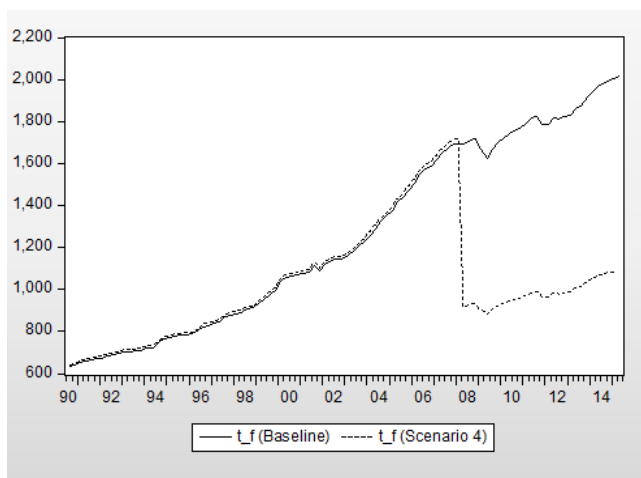
In the next 6 sections, we will be conducting simulations on our model, altering the parameters in order to see the effects of fiscal policy. We will be changing these parameters from 2008, quarter 2, onward to 2014, and seeing what the United States economy would have looked like. We chose 2008 to begin the simulation because it was the 2008 Financial Crisis. Our simulations provide a rough idea the effect fiscal policy would have had, in effect an alternate history. However, because we were able to check the soundness of our model, some of the conclusions can be used for future policy proposals. The goal of these simulations is to see how the economy as a whole reacts to a particular change in assumption. The interrelatedness of an SFC model is very useful for doing this.

4.2 Shock #1: Firm Tax Rate Reduction

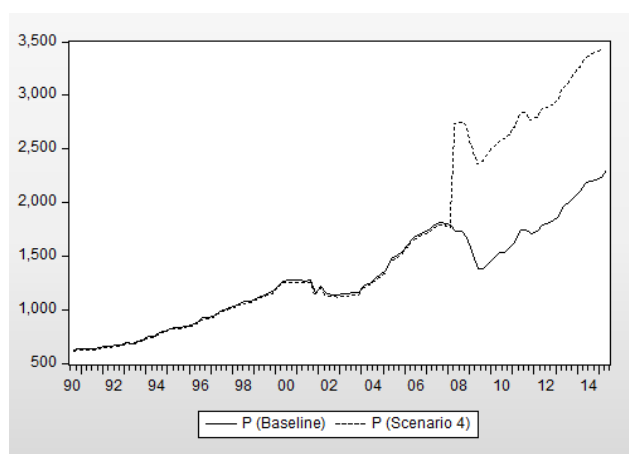
Our first simulation will examine the effects of both a household and firm tax rate cut. Since the late 1970's, there has been an obsession with a particular portion of the population for cutting taxes. Elizabeth Popp Berman and Nicholas Pagnucco write that "In particular, the cuts in the late 1970s and early 1980s that followed the "tax revolt" and the Reagan Revolution have been seen as ushering in a new political era" (Berman 2010). Conservatives claim, as disciples of

Adam Smith and neo-classical economists, that a reduction in taxes would be beneficial towards an economy as a whole. Some economists still find this to be true, with Young Lee writing that in her study that “In fixed-effect regressions, we again find that increases in corporate tax rates lead to lower future growth rates within countries”(Lee 2005). This is also a very contemporary debate, and was an issue in the 2016 election, where part of presidential candidate Donald Trump’s platform was the reduction of taxes. After winning the election, his plan was to “Reduce tax rates and simplify the tax code for workers (brackets at 12%, 25% and 33%) and for businesses (reducing corporation tax from 35% to 15%); encourage multinational enterprises (MNEs) to repatriate capital held offshore” (Morgan 2017).

Our model is set up so we are able to change our parameters and analyze the result of such a reduction. However, we have different parameters than the ones listed. This is because our parameter is not only an average over the course of 20 years, but also it is a conglomerated tax rate of all household income, in our case wages and interest payments, where normally there would be differentiated tax rates for income, sales, capital gains, etc. The same is true for firms. However, we can make the change to our parameter proportionally. For example, going from 35 percent to 15 percent business tax rate as Trump proposes is a 57 percent reduction in the tax rate. Therefore we will reduce our tax rate parameter by 50 percent of its value in order to achieve similar results. The decrease in taxes paid by the firm sector can be seen below.

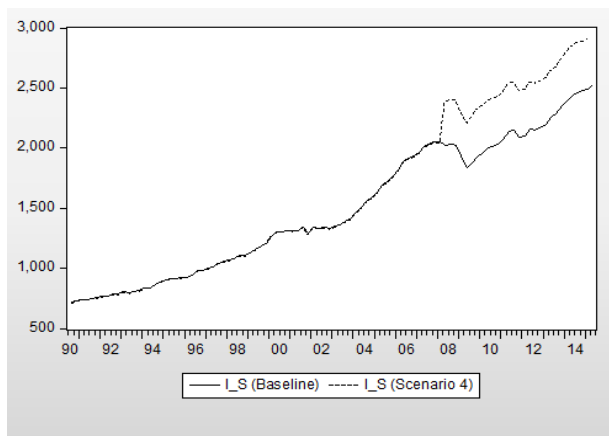
Table 41: Model ECONOMY Shock #1 Tax Expense Comparison

As we can see by the table above, there has been a dramatic decrease in the taxes paid by the firm sector.⁵² This will clearly have an effect on profits. These results can be seen below in Table 42.

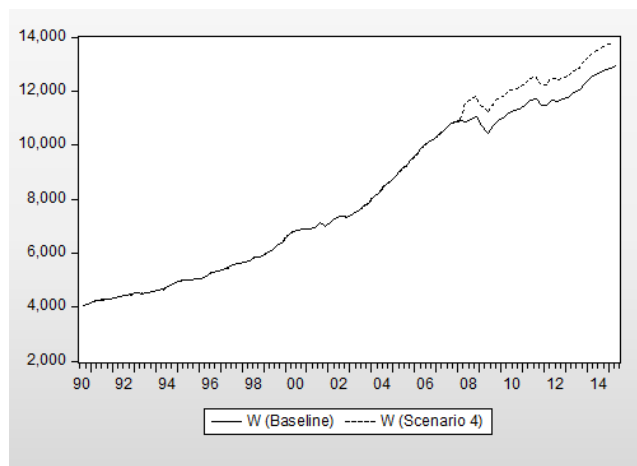
Table 42: Model ECONOMY Shock #1 Profit Comparison

Profits has shot up dramatically from our baseline. Even though it did not increase by 50 percent, there was still a substantial increase. From here, we will examine the effects of this tax decrease had on investment. We assume that there will be some effect because we defined our investment equation as dependent on consumption and profits. The results can be seen below in Table 43.

⁵² The 50 percent decrease in taxes will be labeled as scenario 4 going forward.

Table 43: Model ECONOMY Shock #1 Investment Comparison

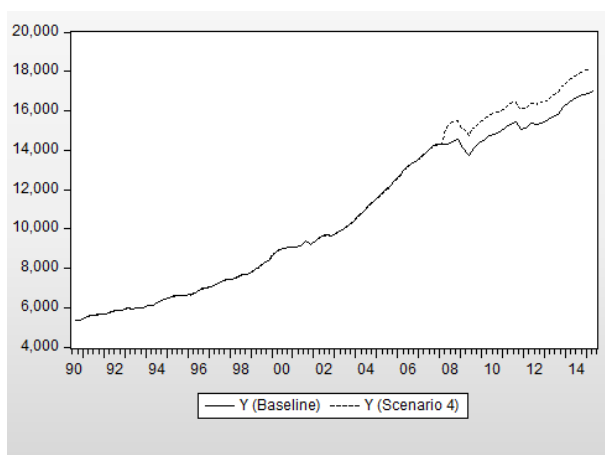
Once again, we can see an increase in investment due to an increase in profits. While not a 50 percent increase, it is still a substantive increase in investment. In politics, tax cuts are seen as beneficial because if firms reduce costs, they will hire more people in order to maximize profits. We will be able to see if this is true in our model.⁵³ The effects of a firm tax rate reduction on wages can be seen below in Table 44.

Table 44: Model ECONOMY Shock #1 Wage Comparison

⁵³ This is by no means a definitive test, either for validating or disproving the model.

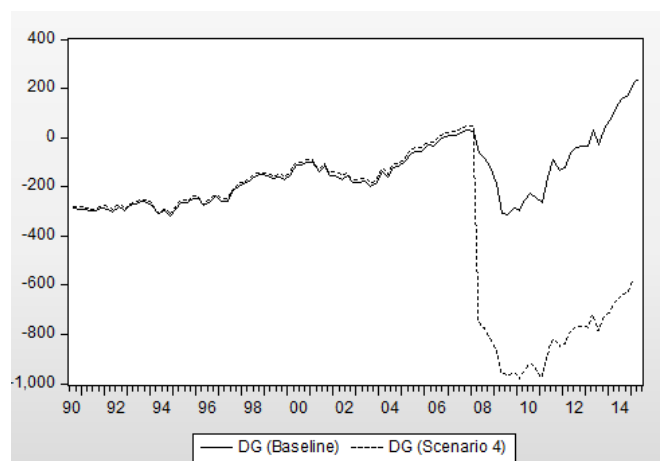
As we can see, there is a small increase in wages. Interestingly, this dramatic decrease in taxes has adjusted the wages and appears to make it follow the trends from the previous years. Because we model our wage equation as a fixed percentage of output (Y) / national income, the national income equation appears similar to this trend. Because our model is a closed economy, this is also the GDP equation, which is the standard measure of a country's economy.⁵⁴ The result can be seen below in Table 45.

Table 45: Model ECONOMY Shock #1 National Income Comparison



In terms of a fiscal policy standpoint, decreasing the firm sector's tax rate does improve the economy as a whole. An increase in Y leads to an increase in wages, which in turn leads to an increase in disposable income and consumption. However, cutting the firm's tax rate in half will decrease the government's revenue. Without reducing government spending, it would be anticipated that the government would increase its deficit. The results can be seen below in Table 46.

⁵⁴ However it must be noted that an increase in GDP does not necessarily mean an increase in standard of living.

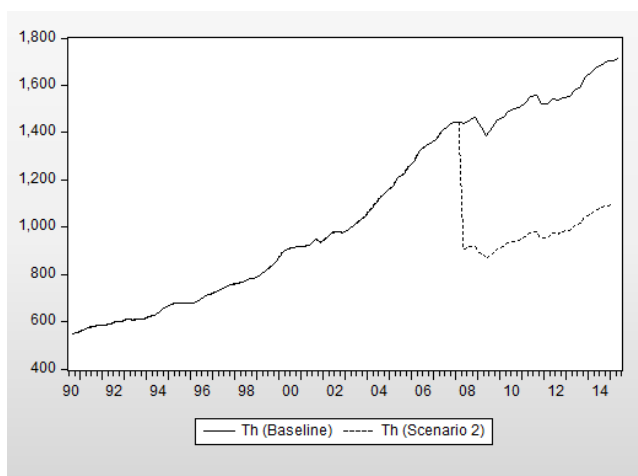
Table 46: Model ECONOMY Shock #1 Government Deficit Comparison

This is a dramatic increase in the government deficit. This would be an unintended consequence for those who typically advocate cutting taxes on businesses. In effect, cutting the firm tax rate by 50 percent would increase national income by 6.8 percent while increasing the government deficit by more than 700 billion dollars. Overall, a Trump-style tax cut in this model would marginally stimulate the economy but would put the government in a much larger deficit.

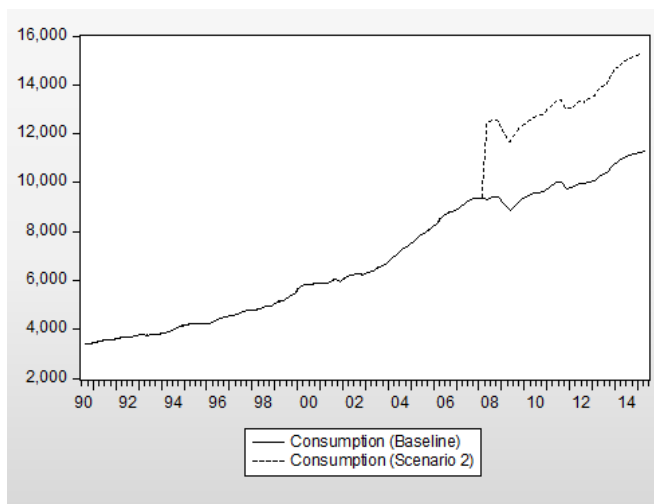
4.3 Shock #2: Household Tax Rate Reduction

Even though we can see that reducing firms' taxes had a positive effect on the economy, we cannot assume that the same is true for reducing taxes on firms. Following the same economic theories behind giving tax cuts to firms, we will now examine the effects of reducing the household tax rate. In addition, we will follow the same methodology as the previous section where we will cut the household tax rate in half. The results can be seen in the tables below⁵⁵.

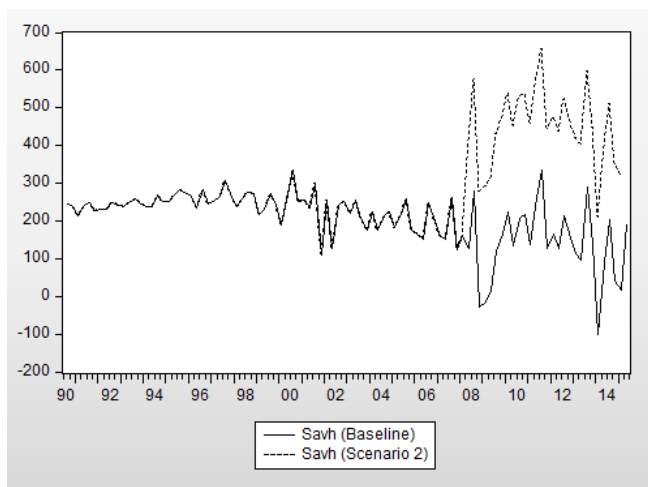
⁵⁵ For this section, scenario two represents the simulation where the household tax rate is decreased by 50 percent.

Table 46: Model ECONOMY Shock #2 Household Tax Rate Decrease Comparison

This table is very similar to that of the previous sections with the firm tax rate decrease. However because of our behavioral equations, it will produce different results. The first result we will examine will be consumption. We assume that a decrease in the taxes households pay will increase disposable income, which is the main contributor to consumption. The results can be seen below in Table 47.

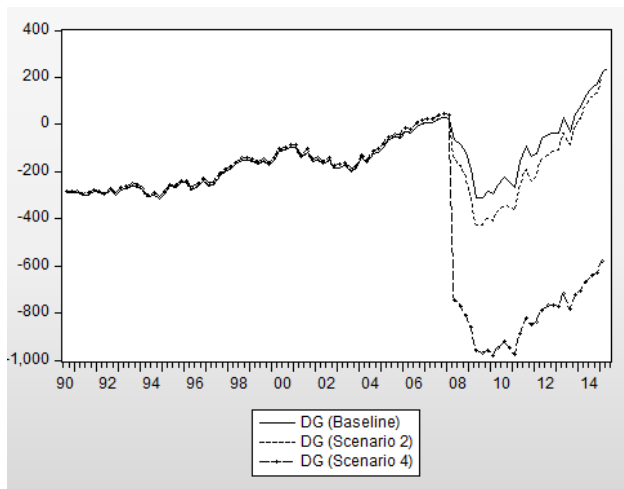
Table 46: Model ECONOMY Shock #2 Consumption Comparison

As we had predicted, there is a pretty dramatic increase in consumption. It has increased even more than the trend it was following before the 2008 financial crisis. From here, we will check the overall savings of the household sector. The results can be seen in Table 47.

Table 47: Model ECONOMY Shock #2 Household Savings Comparison

Similar to how the profit equation was affected, household savings were dramatically improved.

With that being said, we must now show what has happened to the government deficit with the tax rate decrease. However, in the next table, we will also show the effects of the firm tax rate decrease on the government deficit for comparison purposes⁵⁶.

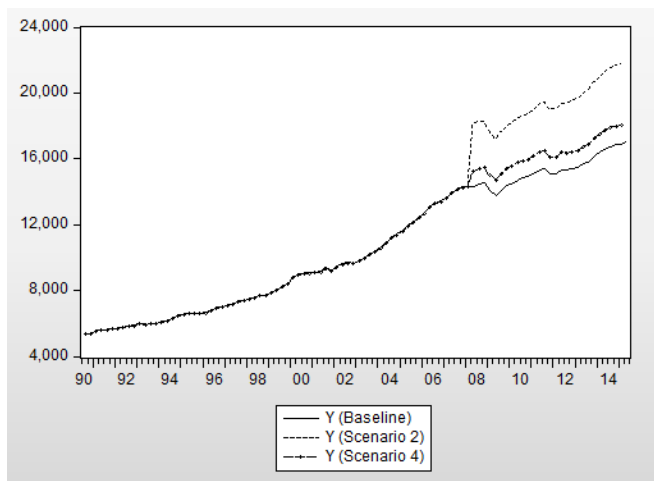
Table 48: Model ECONOMY Shock #2 Government Deficit Comparison

While both tax rate decreases had positive effects on their respective sectors, this graph is showing that the household tax rate decrease has less of a negative effect on the government

⁵⁶ As a reminder, scenario 2 is household tax rate decrease while scenario 4 is the firm tax rate decrease.

sector. We must now check the effect of this household tax rate decrease has on the economy as a whole. Once again, we will compare both tax rate decreases to show the comparison.

Table 49: Model ECONOMY Shock #2 National Income Comparison



An interesting result of this simulation is that the household tax rate decrease not only barely increases the government deficit but has a much greater positive effect on the economy.

4.4 Shock #3: Firm Tax Rate Increase

Similar to the reasoning of analyzing both a household and firm tax decrease, we must also check what happens when there is an increase in taxes, as some politicians advocate for⁵⁷. For example, Bernie Sanders advocates that “the wealthy and large corporations pay their fair share in taxes. Corporations must stop shifting their profits and jobs overseas to avoid paying U.S. income taxes” (Sanders 2015). On the other hand, some economists, such as Olivier Blanchard and Robert Perotti, conclude that “positive tax shocks as having a negative effect” (Blanchard and Perotti 1999). While we have not divided households into income brackets, we

⁵⁷ In addition, some economists advocate the use of tax increases to combat inflation. As Pitchford writes, “According to conventional macroeconomic theory, an increase in taxes will reduce demand, and thus be anti-inflationary” (Pitchford and Turnovsky 1976).

will still analyze the effects of a tax rate increase. The same is true for the firm sector, since we have not separated large and small businesses. We will first begin by completing a simulation where we increase the tax rate by half, so from 12 percent to 18 percent.

Table 50: Model ECONOMY Shock #3 Firm Tax Rate Comparison⁵⁸

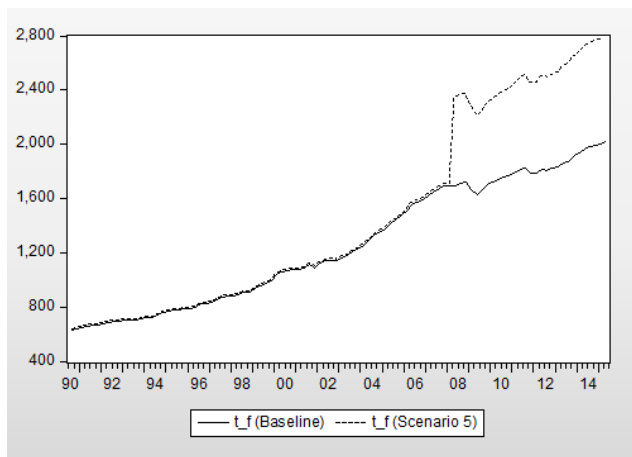
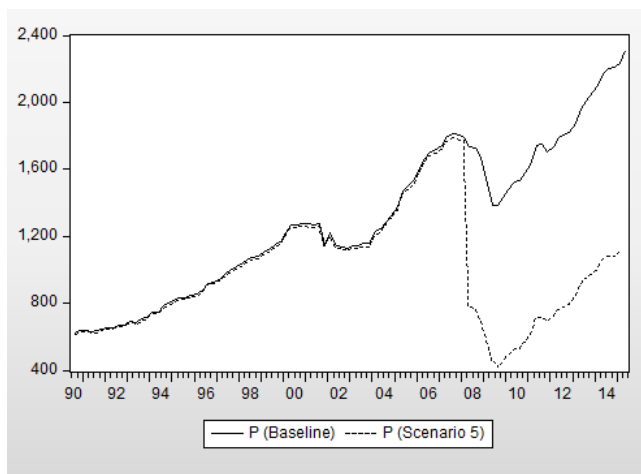
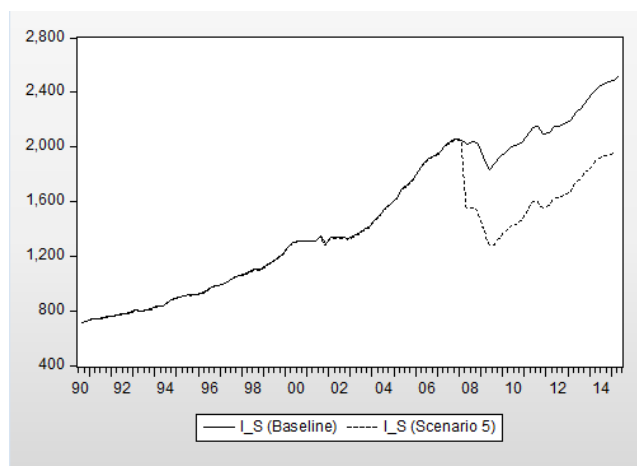


Table 51: Model ECONOMY Shock #3 Profit Comparison

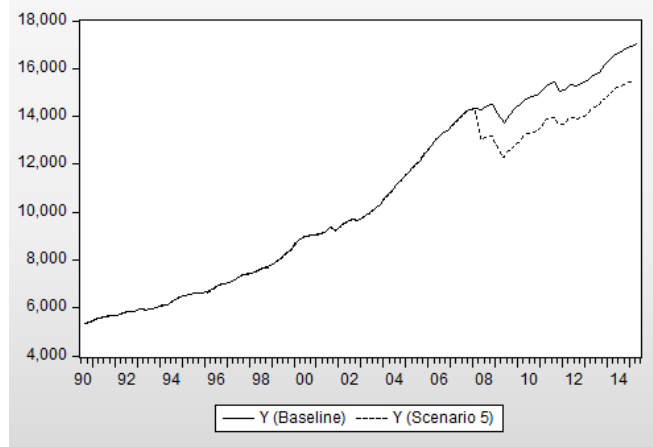


In Tables 50 and 51, we see the opposite effect that decreasing taxes had, with an increase in total taxes paid and a decrease in profits. This is very dramatic decrease in profits. From here, will analyze investment. The result can be seen below in Table 52.

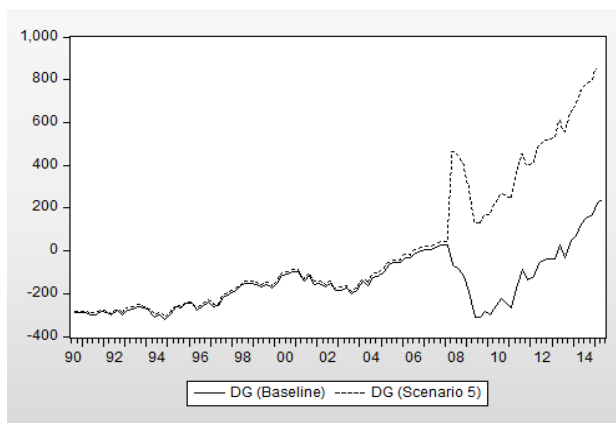
⁵⁸ For this simulation, scenario 5 will represent an increase in the firm's tax rate.

Table 52: Model ECONOMY Shock #3 Investment Comparison

We can see from the graph that there is a substantial decrease in investment. This will play a role in the national income, which can be seen in Table 53.

Table 53: Model ECONOMY Shock #3 National Income Comparison

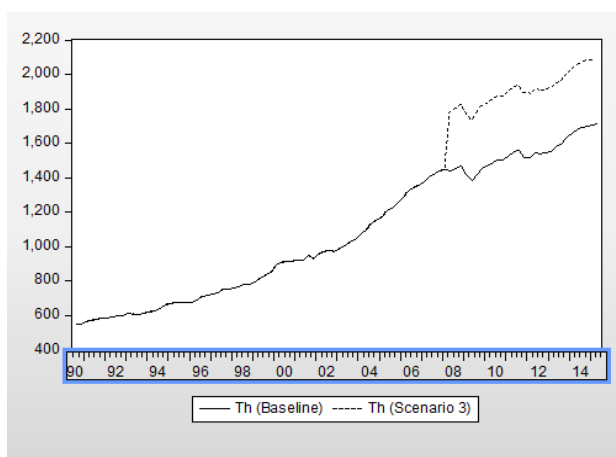
As we can see, there is a decrease in national income, which is consistent with the literature regarding tax increases and aggregate demand. From here, we can analyze the effects on the government deficit, which can be seen in Table 54.

Table 54: Model ECONOMY Shock #3 Government Deficit Comparison

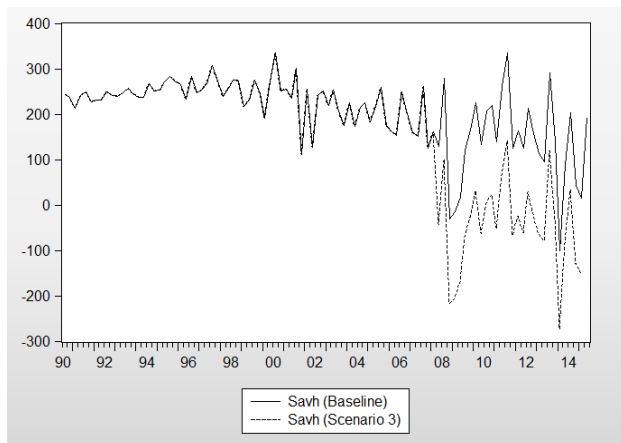
With such a large tax rate increase, the government in this model is able to run a surplus. It is interesting to note that one political philosophy is that a large government deficit is bad and that the best way to stimulate the economy is by reducing taxes; this philosophy is not supported by our model.

4.5 Shock #4: Household Tax Rate Increase

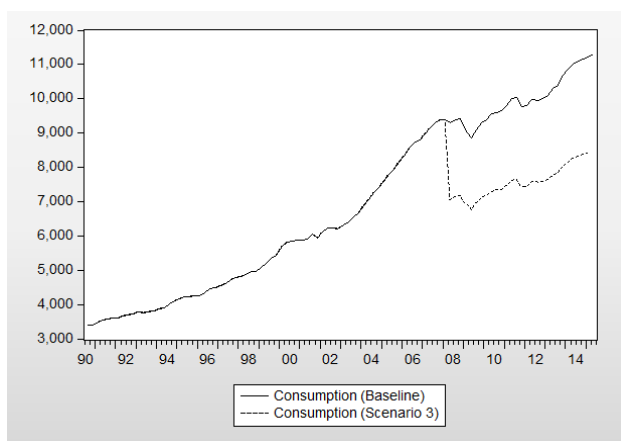
Just as we had done in the previous section, we will analyze the effects of an increase in tax rate at the household sector. Following the same methodology, we will increase the tax rate by roughly 50 percent, from 13.1 percent to 20 percent.

Table 54: Model ECONOMY Shock #4 Household Tax Rate Increase Comparison⁵⁹

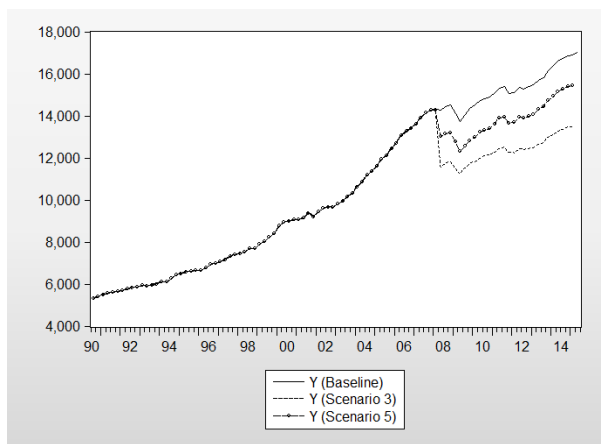
⁵⁹ In this simulation, scenario 3 represents an increase in household tax rates.

Table 54: Model ECONOMY Shock #4 Household Tax Rate Increase Comparison

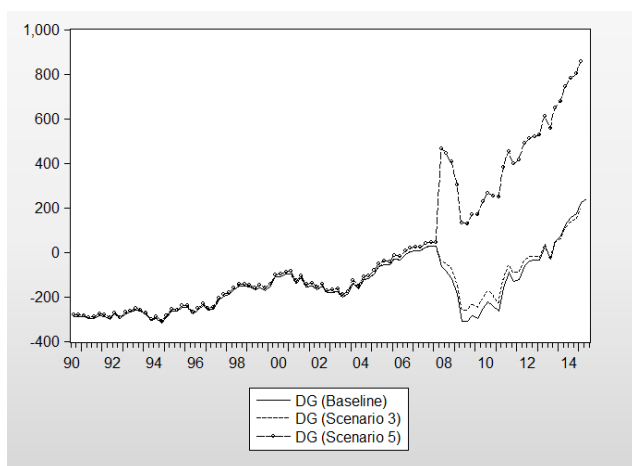
Similar to what we had seen with an increase in the firm tax rate, taxes paid by households increases and the savings of the household sector decreases. This has a negative effect on consumption which can be seen in Table 55.

Table 55: Model ECONOMY Shock #4 Consumption Comparison

As one would expect, this sharp decrease in consumption will have a negative effect on national income. The results can be seen below in Table 56. Once again we will include the firm tax rate increase numbers for the purpose of comparison.

Table 56: Model ECONOMY Shock #4 National Income Comparison⁶⁰

Just as the economy benefitted most from a household tax rate decrease, it is harmed the most from a household tax rate increase. It is important to know that since this is an aggregate tax, it does not take into account the different types of taxes and income brackets. Clearly there are ways to increase taxes in certain segments to minimize the government deficit while not minimizing consumption. However, increasing taxes on households does not decrease the government deficit substantially. The results of this comparison can be seen below in Table 57.

Table 57: Model ECONOMY Shock #4 Government Deficit Comparison

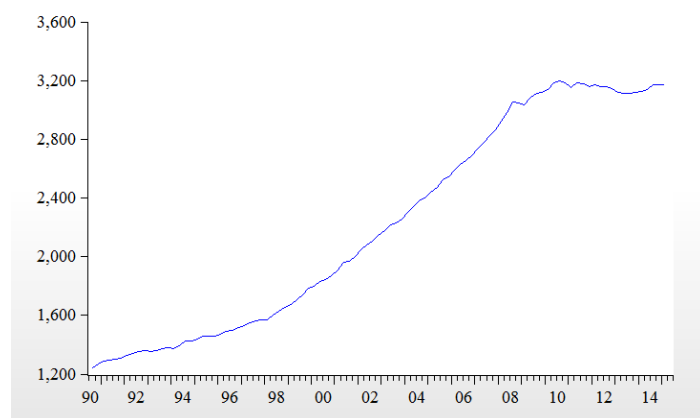
⁶⁰ As noted before, scenario 3 is household tax rate increase and scenario 5 is firm tax rate increase.

While increasing the firm's tax rate created a government surplus, increasing the household tax rate barely decreased the government deficit. This is most likely due to the reduction in consumption and investment, leading to decreased disposable income and profits, which in turn leads to less taxes.

4.6 Shock #5: Increase in Government Spending

The next shock that we will include will be an increase in government spending. We will do this by altering the growth rate increase of government spending. So in the equation $G = G_1 * (1 + \beta)$, we will change β from .007 to an increasing rate of .015. In effect, from 1998-2008 government expenditures was growing at a 1.5 percent rate. Since 2008, there has been virtually no increase in government expenditures. This can be seen in the table below.

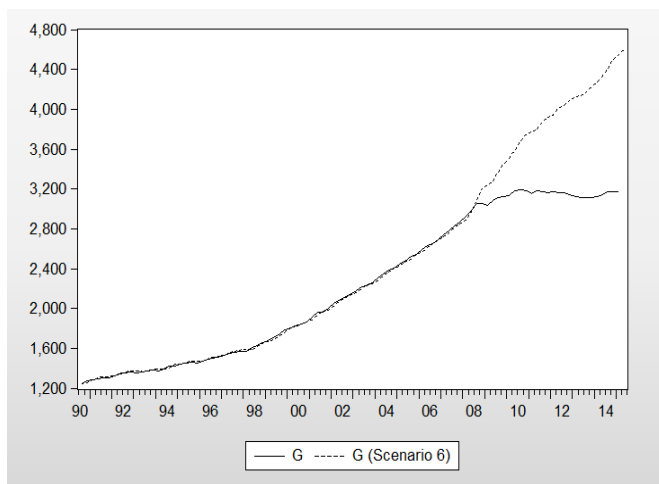
Table 58: Historical Government Expenditure Data



As one can see, from 2008 onward, government expenditure begins to flatline. For this simulation, we will reverse this trend and have government expenditure grow at 1.5 percent, essentially making government expenditure a straight line. This will be a substantial increase in government spending. The literature is mixed on the results of this increase. From the Blanchard and Perotti paper, which also used an empirical model test, the conclusion was that “The multipliers for both spending and tax shocks are typically small...Both increases in taxes and

increases in government spending have a strong negative effect on investment spending” (Blanchard and Perotti 1999). While one may argue that this paper is old, the same effects were found in the Cogan et. al. paper “New Keynesian versus Old Keynesian Government Spending Multipliers,” which found that “Government spending multipliers in an alternative empirically estimated and widely-cited new Keynesian model are much smaller than in these old Keynesian models” (Cogan et. al. 2010). However, the classic Keynesian argument is that government spending has a positive effect on the economy. Even non-Keynesians sometimes agree, with “our model it is still likely to generate a positive response of private consumption for plausible parameter values. This result is due to a consumption–leisure substitution channel which, if public and private consumption are complements, can be strong enough to reverse the fall in private consumption due to the standard wealth effect” (Ganelli and Tervala 2009). The results from our model can be seen below, based on our large change to the growth rate beta in our government expenditure equation.

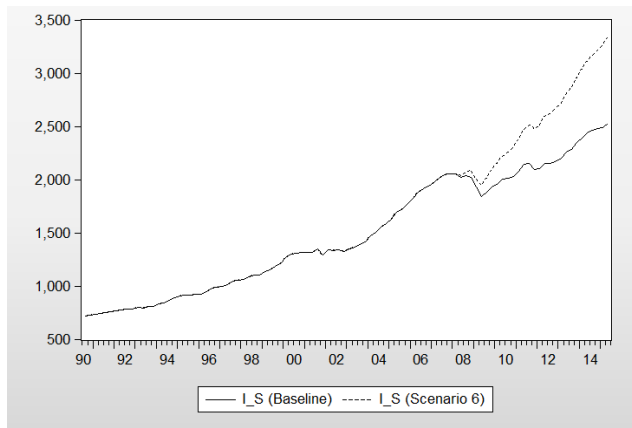
Table 59: Model ECONOMY Shock #5 Government Expenditure Comparison



As one can see, our change in parameter did an exceptional job in continuing the trend seen from 1998-2008. From here, we can analyze the components of the United States economy. First, we

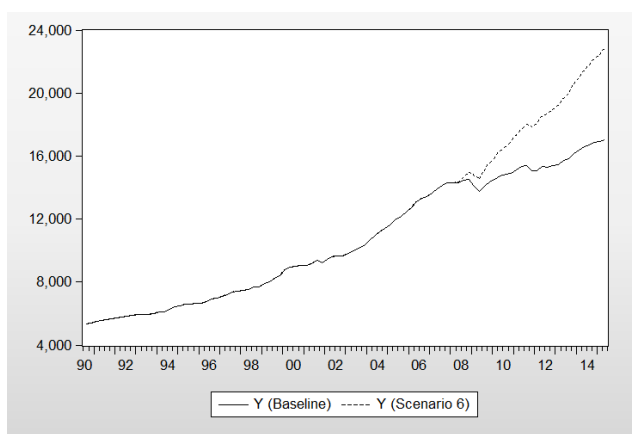
will examine whether this increase in public expenditure crowds out private investment.⁶¹ The results can be seen below in Table 60.

Table 60: Model ECONOMY Shock #5 Investment Comparison



Contrary to popular belief, our model shows that an increase in government expenditure also increases investment. This should have a positive effect on the economy as a whole. The results can be seen in Table 61.

Table 61: Model ECONOMY Shock #5 National Income Comparison

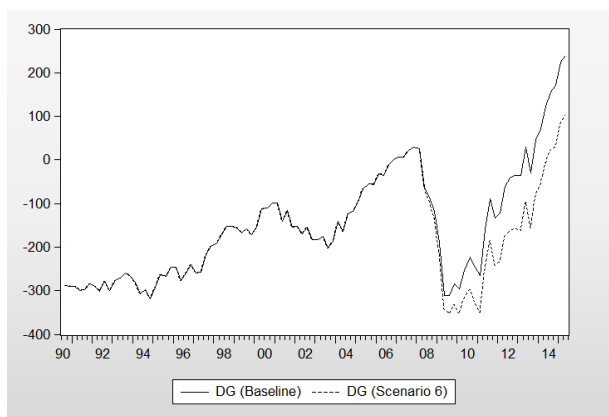


Following a similar pattern as government expenditure, the national income has increased dramatically. In effect, it continued its trend instead of being affected by the 2008 Financial

⁶¹ As David Aschauer explains about the common belief that “Higher public capital accumulation raises the national investment rate above the level chosen by rational agents and induces an *ex ante* crowding out of private investment” (Aschauer 1989).

Crisis, so one could argue that an increase in government expenditure would have helped alleviate some of the effects. Some would argue that increasing government expenditure would create a huge deficit. The results from our model can be seen below.

Table 62: Model ECONOMY Shock #5 Government Deficit Comparison



As we can see from our simulation, the government deficit initially gets larger. However, it follows the trend and eventually increases into a government surplus. This may be due to the increase in national income, which increases consumption and it becomes a virtuous cycle. Overall, government expenditure in our model created the largest amount of growth and did not increase the deficit by too much.

5. Conclusion

This paper has explored the history of not only SFC models themselves, but also the theoretical foundations like the work of Copeland, Tobin, and Kalecki. Wynne Godley, with the additional insight of Marc Lavoie, guided us through the basic understandings of SFC models with their revolutionary textbook Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth. Model SIM provided us with the underlying structure of SFC models that are used in the majority of SFC models. However, we showed in Model SIMD and Model SIMD that different components of an SFC model can be altered to fit a

particular economic theory. This was also evident in the differences between the Zezza and Dos Santos SFC model and the one created by the Bank of England; both theoretically sound but structured differently. We rely on both to create Model ECONOMY, a three sector closed economy model that was used to analyzing fiscal policy proposals.

To believe that we can make definitive policy proposals from these simulations would be as incorrect as relying on neoclassical models that are based upon unrealistic assumptions. However, even with a simple SFC model, we are able to analyze the effects of fiscal policy because we can compare it to historical data. In effect, we are observing the different trend created by a change in fiscal policy and its effect on the economy.

Our model provides the following fiscal policy insights: 1. Increasing government expenditure **increases** national income but **does not increase** the national debt proportionally; 2. Increasing taxes on businesses has a much larger effect on reducing the government deficit compared to increasing taxes on households, which has little to no effect; 3. Reducing taxes on households has a much larger effect on increasing national income than reducing taxes on businesses. While these insights are dependent on our behavioral equations, they are nonetheless useful for future policy proposals. Because we can compare historical data to the model results side by side, it allows us to at least have a rough estimate. In effect, we will not achieve absurd results such as those found in supply-side economics because our model is grounded in the real world, simply measuring the flow of funds between sectors.

However, our model is not perfect. Future work with Model ECONOMY would be including the financial sector and an open economy. Additionally, fiscal policy analysis could include changing multiple parameters in one simulation, while blurring the causality, would be more accurate of real life policy proposals. For example, an increase in government spending

would usually also be accompanied by an increase in taxes. Our model showed that these two actions create opposite results, so further simulations would analyze the optimal values of each of these parameters. But these results are dependent on the equations used, so future research could be used to find even more accurate economic equations.

A business uses financial statements to measure its health, and financial analysts use these statements to predict future values. PE ratios, liquidity ratio, assets under management, and many other financial statistics are viewed as legitimate predictors. Why not carry this over into economics? As Minsky famously wrote, “an ultimate reality in [such] a capitalist economy is the set of interrelated balance sheets among the various units” (Minsky 1975). If this is the case, then models like stock-flow consistent models should be used as policy tools. While not without criticism, stock-flow consistent models, with continuing improvements, can and probably should be used as the model used by the major institutions like governments and banks due to their proven accuracy in crisis prediction as well as their grounding in the real world.

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