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# DEMONIAC Macroeconomic Simulator

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macro, excel, macrosimulator, macro-simulator, macroeconomics, open economy, closed economy, macroeconomía, simulador, ISLM, ADAS, national income

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#### Abstract

The University of Seville conducted a study with a macroeconomic simulator in the 2009/2010 school year to test whether using such a program would help economics students achieve a higher pass rate in Macroeconomics courses. The results were clear and proved definitively that the simulator itself increased learning and produced not only a higher pass rate, but also higher average grades. The macroeconomic simulator to be introduced now is much more advanced in its interface, capabilities and educational quality than other macroeconomic simulators such as that of the study, and may soon advance Economics education all around the world.

#### Abstracto

La Universidad de Sevilla realizó una investigación con un simulador macroeconómico en 2009-2010 para determinar si al utilizarlo, podía conseguir un mejor resultado de aprobados en las asignaturas de macroeconomía. Los resultados fueron claros, y han demostrado definitivamente que el simulador aumentó la calidad de aprendizaje y logró tanto mejores notas como más aprobados por sí mismo. El simulador económico que se introducirá ahora es más avanzado que otros macro simuladores como lo de la investigación en su interfaz, capacidad y su calidad educacional, y se puede utilizar para avanzar la educación en economía en todo el mundo.

## Introduction

### Background

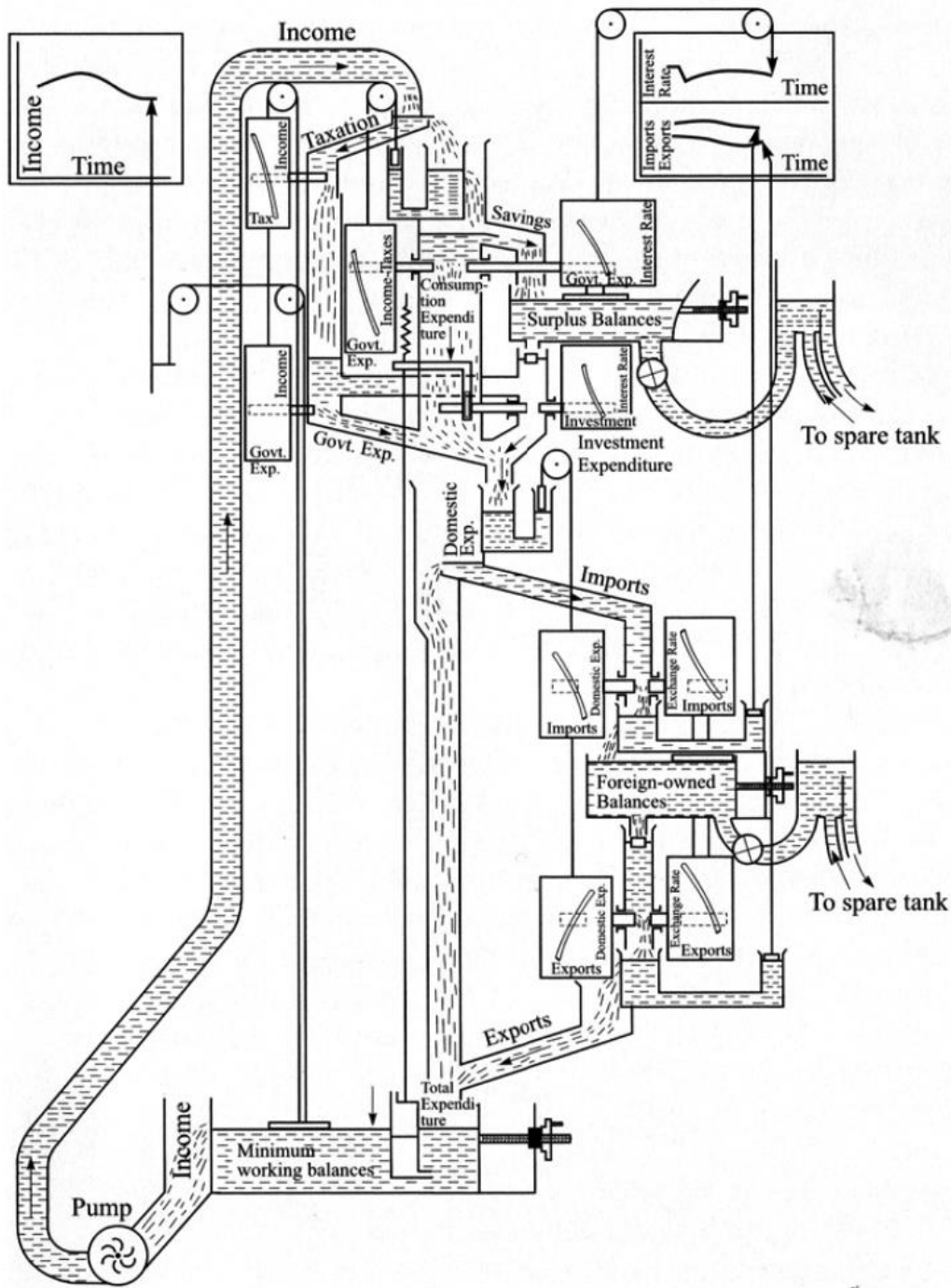
From the bartering and inventories of grain storehouses of early human societies by verbal agreements, to the papyrus parchment and royal decrees of the Babylonians and Egyptians and later the Greeks and the Romans, human trade and exchange has always had its inherent importance to mankind. From the early philosophers and historians such as Plato and Ptolemy, and early economic thinkers such as Hesiod and Xenophon to Thomas Aquinas and Duns Scotus all the way to Thomas Mun and Sir William Petty, and from the Jesuit School of Salamanca to John Locke and Dudley North, the subjects of economics and politics have been intrinsically intertwined and analyzed. Later, from Adam Smith to Karl Marx and on to Alfred Marshall and Leonid Kantorovich, to John Maynard Keynes and Friedrich Hayek, many great minds have dedicated their time and ultimately their lives to the mysteries of the economic realities, which existed in their time and continue in various shapes and sizes now. It is impossible to walk into a coffee shop or a bar and not see a newspaper containing political and socioeconomic events unfolding or hear two or more people discussing the most recent news about how properties will be taxed, their wages cut or raised, their new bosses hiring or old bosses firing them, their children's welfare at school and all in all a summary of how their lives will be impacted by such decisions.

### Objective

Between Easter in 1949 to November of the same year, William Phillips and fellow economist Walter Newlyn together designed and constructed a machine later known as the MONIAC, or Monetary National Income Analogue Computer, which was a hydro-mechanical device that, after slight revisions, could calculate the national income (or GDP), imports, exports, consumption, taxation, capital flows abroad, flows to an international monetary fund, and domestic funds deposits.<sup>1</sup>

In 1976, Apple Inc. (at the time, the Apple Computer Company) founded by Steve Jobs and Steve Wozniak produced and sold the Apple 1 Computer, with the idea of bringing powerful calculation technology and digitalization to the masses at an economic price.<sup>2</sup>

In 1966, Joan Ganz Cooney and Lloyd Morrisett conceived the idea of creating a program on television that would have bring an educational element to children who were intellectually malnourished.<sup>3</sup>



Schematic description of the MONIAC.

Image 1: The Concept of MONIAC in 1949<sup>4</sup>

So what do these three specific cases have in common? All three have the same intent: bringing education and access to technology to the masses. Many people talk about 'what the government should do about' this or that, and propose many ideas very verbosely and for whomever to hear. Most often these policy changes are conceived out

of a selfish nature, whether directly beneficial or altruistically beneficial to the speaker, and almost always with a loud voice and passion behind the statements.

So, why spend hundreds of hours learning Macroeconomics and teaching oneself Visual Basic in Microsoft® Excel®? (Microsoft Corporation, Inc.) The result to such a question is that the digitally enhanced version of the 1949 monetary flow machine is based on the ISLM (Hicks-Hansen) and ADAS (Ackley) models, and even though similar type programs are in existence and many more sophisticated models are used by central banks and private companies, this macro simulator takes Macroeconomics teaching to the very edge of existing theory and practice. What if students could decide whether Economics is for them or not earlier in their studies at a university rather than in their fourth year? What if someone with a personal computer at home (thanks to giants like Steve Jobs, Bill Gates and IBM) wants to understand how an upcoming political decision is going to affect his retirement savings or 401K? What if someone wants to know how a decision made by a central bank, or a reduction in oil output in Iran, or a massive earthquake in Italy will affect how much she earns every month or whether or not she'll have a job?

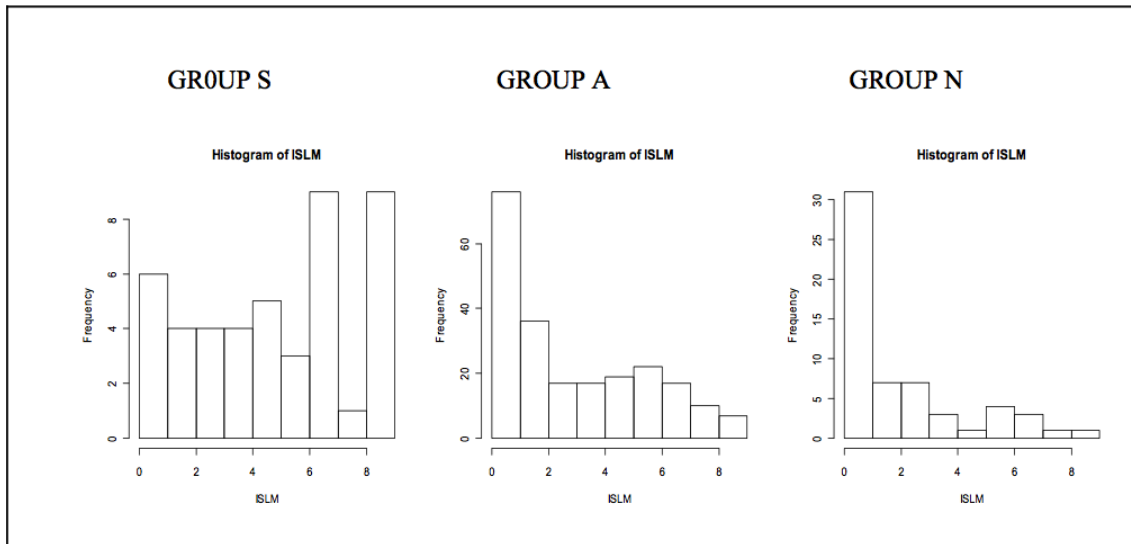


Image 2: Picture of a first edition Apple 1 Computer<sup>5</sup>

#### Anticipated Results

A study published in 2011 by the University of Seville, Spain shows improvement in student learning in Macroeconomics by employing a control group and various test groups using a rudimentary ISLM macroeconomic simulator.<sup>6</sup> The students were randomly selected to participate during the 2009/2010 academic year and out of the study of 324 students, 221 of which (Group A) came to class without access to the simulator, 45 employed the macroeconomic simulator (Group S) and 58 were enrolled but neither attended classes regularly nor had access to the simulator (Group N), but had attended classes during the previous year. The results are as expected. The mean grades for each of the groups were scored from zero to ten and averaged to 5.2, 3.21, and 2.06 respectively. Students who visually and graphically see results are less likely to become frustrated with the algebra and calculus behind the models, and thus become more motivated to study and learn macroeconomics. Not only does this publication demonstrate that there are starkly vast differences between group scores, but further

analysis through ANOVA and other econometric tools demonstrate that it was the mere use of the simulator itself that produced the pronounced spike in grade improvement. This is the light at the end of the tunnel.



*Figure 4. Histograms of scores obtained on the IS-LM question*

Image 3: Graph of Test Results from Seville Study<sup>7</sup>



## The Simulator

### Macroeconomic Background

This simulator draws on the ideas first conceived by John Maynard Keynes in his then controversial book, "General Theory of Employment, Interest and Money" (1936)<sup>8</sup>, and later expanded upon and formulated into a mathematical model by Hicks and Hansen (1937)<sup>9</sup>, and revised by a long trail of other economists including Ackley (1961)<sup>10</sup>, Fleming (1962)<sup>11</sup>, Mundell (1963)<sup>12</sup>, Barro (1974)<sup>13</sup>, Goodhart (1975)<sup>14</sup>, Lucas (1976)<sup>15</sup>, Laffer (1979)<sup>16</sup>, Solow (1984)<sup>17</sup>, Yun (1996)<sup>18</sup>, Blanchard (2000)<sup>19</sup>, Mankiw (2003)<sup>20</sup>, and many more. Even though the model has theoretical conundrums that do not quite function exactly the same in real life, such as the fact that the IS curve relies on consumer preferences in the goods market and a more long term interest rate, while the Money Market (LM) relies on a short term interest rate and moves much faster with capital flows and risk primes, the model has serviced economists in their thinking and relating of ideas to the rest of society. The bottom line is that even though the model has visible flaws, it demonstrates fairly specific market direction and is widely used as a valuable tool to mass-produce the economists of tomorrow in secondary educational institutions worldwide.

## Program Description, Background and Methodology

This simulator has been designed three times, with the first two being lost by damaged USB drives, and the third version rose from the ashes with much more clarity and forethought involved. The first two versions were very simple Microsoft Excel worksheets, and while worked to perform the algebraic calculations instantaneously for each scenario, required continuous calibration. On the third attempt, more than 300 hours have been invested in both programming using Microsoft Excel, Visual Basic from the 'Developer' tab in Excel, and hand drawn algebraic manipulations of the formulas in order to avoid circular reasoning loops and not require Microsoft Excel's Solver® assistance.

The formulas involved in the programming of this macroeconomic simulator nicknamed the D.E.M.O.N.I.A.C., which stands for Digitally Enhanced Monetary National Income Analogue Calculator (in honor of Phillips and Newlyn), started as very elementary IF/THEN statements using active screen updating to automatically solve each equation or system of equations. As more scenarios were added and the complexity of the simulator grew in size from 15 kilobytes to now over 5.5 megabytes, the formulas became much more advanced and required skills in Visual Basic that were not acquired formally, neither prior nor during the programming process. That is to say that one who has studied Informational Engineering or has advanced knowledge of programming platforms might have been able to program the simulator in around two weeks, but without that knowledge it could be compared to learning a new language and teaching classes in it during the learning process.

One book was used frequently during programming this simulator, but one could hardly say that much credit of the programming is due to the information taught in MrExcel Library's "*VBA and Macros: Microsoft® Excel® 2010.*"<sup>21</sup>(Jalen and Syrstad, 2016) It was more like a general book on mechanics for one trying to put together a '67 Mustang Convertible. Bits and pieces of code were imitated from mostly anonymous users on message boards around the internet community, but mostly in the fashion of taking home a piece of steel and trying to make a sword by oneself. Not a single code found in the simulator could be used without model adaptation and rewriting the code until it worked. To those programmers who were not anonymous, but responded to message board queries or YouTube® video posts with more precise code that required less refining to be implemented in the simulator or rather could be seen as 'good ideas,' due thanks will be given in the 'acknowledgements' section.

The DEMONIAC employs easily over one thousand IF/THEN statements and even more lines of more specific code. The idea of opening the graphs in a 'user form' rather than using a regular worksheet was to make the simulator user-friendlier and also help protect the code of the simulator from being tampered. After opting for the user form route instead of using a regular worksheet like many other Excel simulators where there are many ways to accomplish the same end result, once inside a user form, there are maybe two or three. This small distinction elevated the programming language knowledge requirement to a new and much higher level.

Upon opening the simulator, the user is required to enable the use of Macros, which are usually short, self-contained programming codes that facilitate the calculations in Excel. Without these macros enabled, the simulator will not function at all.

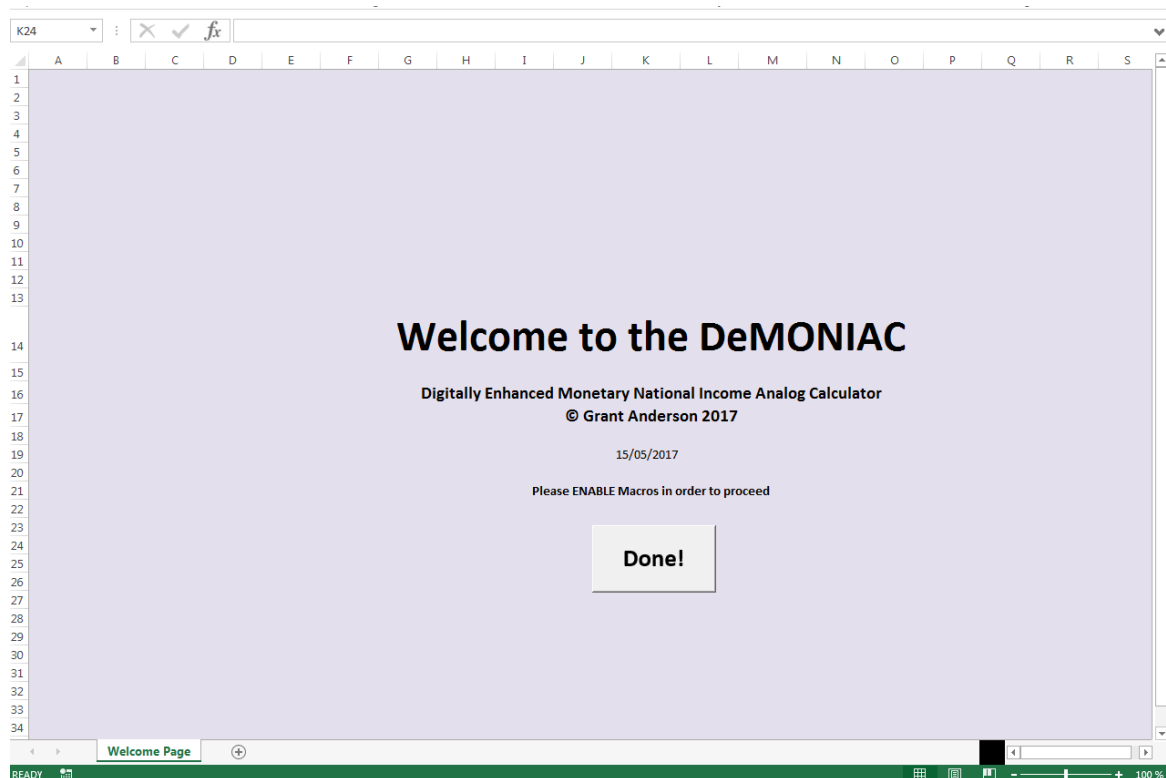


Image 4: Welcome Screen in the DEMONIAC

Once macros have been enabled, a message box pops up welcoming the user to the simulator. In order to proceed to the simulator itself from the welcome screen, the user must click on the button with the label stating, 'Done!' Upon execution of this macro, the user is taken to the 'Intro' screen, whereby entering exogenous data into the appropriate fields, the simulator can calculate the initial equilibrium values for national income, the interest rate, household consumption, business investment, the federal government

budget deficit/surplus, and in the case of the open economy model, the totals for exports and imports for fixed and flexible exchange rate countries. When activated, the user form in the simulator allows users to enter policy changes and reflects those changes in short-run equilibrium values. Moreover, for each short-run policy change scenario, there is a minimum of two graphs that reflect the policies enacted demonstrating to students what happens and when for each policy change based on each 'country' scenario. There are five closed economy scenarios and two open economy scenarios that allow the study of the effects of each policy on the short-run equilibrium.

There is also one scenario programmed for the long-run equilibrium of a closed economy included in this version of the simulator. In the future and depending upon its reception and acceptance, this simulator will include a Large country model, where a country like the United States or China and capable of affecting worldwide trade levels in foreign prices, capital flows and interest rates could be studied, and simultaneously show the effects on a smaller 'Price-Taker' like Algeria after a policy change is implemented in that large country. There will also be a Monetary Union scenario with both a closed economy and open economy capability, so that a student or laymen could study the effects of a 'Brexit' or a Monetary Union collapse scenario, or the effects on Germany and Spain individually after China revalues its currency. Also on the list of possibilities is adding long-run equilibrium effects to each and every one of these scenarios, and then later adding an inflation model as well, so that a student may decide to study prices and real wages in absolute terms and attempt to use the formulas to mimic a specific country's economy, or opt to study period over period change and 'Taylor Rule' policies. There is also space available to add more 'price setting' variables, so as to calculate the price equal to the markup over costs multiplied by the sum of real wages plus material inputs such as Oil or Coltan, and optional inputs for specific tax changes such as requiring more tax contributions by employees extracted from nominal wages. If each and every one of these scenarios is added to the simulator over time as planned, then the eight current scenarios would be more than one hundred and ninety-two.

## Formulas used in Development

The ideas behind the ISLM-ADAS model are simple. The equations for the closed economy are the following:

$$Y = C_o + b * (Y - tY + TR) + I_o - gr + G_o \quad \text{IS "Goods Market"}$$

GDP = Consumption + Investment  
+ Government Spending

$$\frac{M}{P} = kY - lr$$

### LM "Money Market"

Money Supply relative to Consumer Price Index (M/P) = percentage of National Income in cash (kY) - market demand sensitivity to the interest rate (lr)

While the open Economy adds Net Exports as:

$$X_o + v_x R - (I M_o - v_{im} R - qY)$$

where:

$$R = \frac{P^*}{e^* P}$$

Net Exports = Initial Exports + Exports' sensitivity to the Real Exchange Rate - [Imports - Imports' sensitivity to R + the amount of national income spent on imports (qY) ]

And in the Long Run equilibrium with salaries and productivity

$$\frac{W}{P^E} = Z - du$$

or

$$\frac{W}{P^E} = (Z - du) * \varphi$$

and

$$P = (1 + \mu) * \frac{W}{\gamma}$$

Real Exchange Rate (R) equals foreign prices P\* / (indirect exchange rate e\* multiplied by national prices (P)

In the Wage Setting (WS) equation, Real Wages of Nominal Salary divided by expected price (W/P<sup>E</sup>) are determined by Syndicate Pressure (Z) - salary rigidity (or sensitivity to the unemployment rate du)

Another option in the simulator offers the real wage to be multiplied by productivity in the WS to negate productivity as a factor in the unemployment rate since it has not been shown statistically that improvements in productivity lower the NAIRU or

Non-Accelerating Inflation Rate of Unemployment

WS occurs first in the ADAS Model, then once wages are determined, the price is set to employee cost (wage)/ average productivity ( $\zeta$ ) \* [Price + a markup ( $\mu$ )

$$u = 1 - \frac{N}{AP}$$

$$Y = N * \zeta$$

The unemployment rate is a percentage, thus, between 0 and 1, and is equal to 1- [the number of employed agents (N) / the total Active Population (AP) ]

The Long Run National income is equal to the number of employed agents (N) \* their average productivity ( $\zeta$ )

$$u = 1 - \frac{Y}{AP * \zeta}$$

By employing algebraic calculations and some simple calculus tricks, one can solve for each of the endogenous variables

With these seven basic equations and their variants, one has all he needs in order to solve the system of equations by hand and calculate the national income, interest rate, price, indirect exchange rate, nominal and real salaries, and levels of exports, imports, investment, and consumption. The real struggle is to take a forty-five minute per problem task and turn it into a five second machine capable of not only doing the task, but visually depicting the results for the student or laymen.



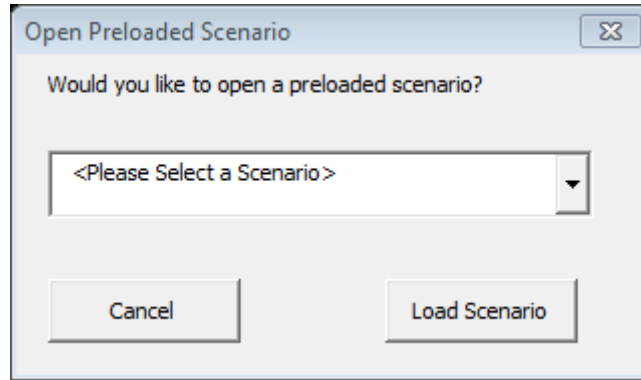


Image 6: Opening a Preloaded Scenario

That is to say that the user can follow along with the book and learn macroeconomics at home using the simulator with the 'red book' as a manual for operations. It is highly recommended that if any errors are produced, that the user clicks the button below 'Stock Scn' named 'Reset Graphs.' This button clears any policy figures and previous charts generated off prior data or from other scenarios and ensures that the simulator will not only load properly, but that it will work more quickly and effectively as extra charts that do not get removed with a proper close out procedure of the user form window will not obstruct the user from achieving his objective. Also, all variables entered into blanks provided must be numeric (no letters or symbols are permitted), and none of the numbers may be negative, as this will impair the calculations of the simulator, which is based on all positive values.

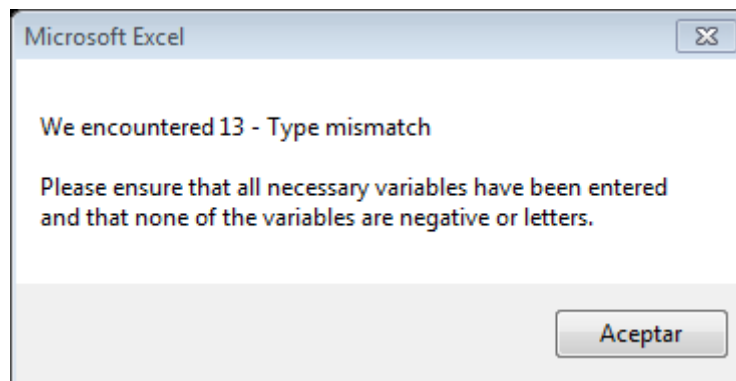


Image 7: Incorrect Data Entered

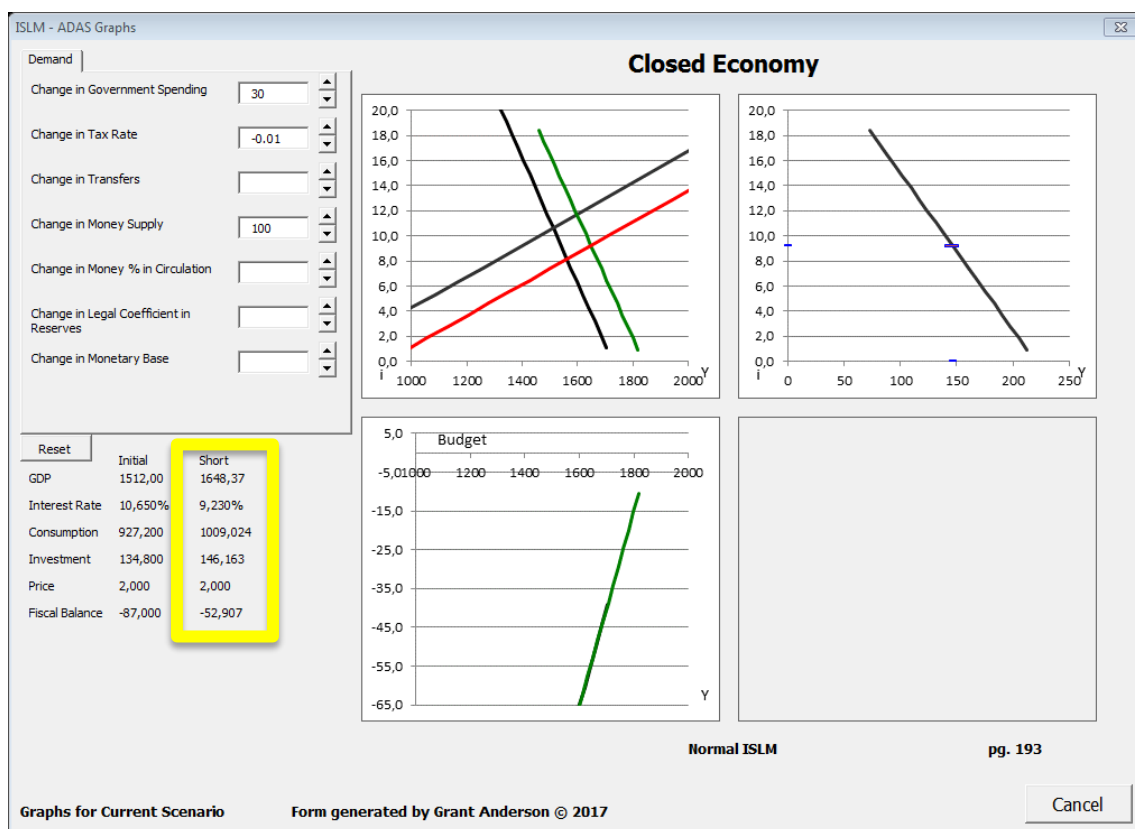
Once a scenario has been loaded, or the exogenous data has been entered manually, the user needs to click, 'Graph.' This will generate the corresponding graphs and takes the user to the simulator's graphs and charts inside of a large user form, where policy changes can be made based on the scenario loaded, and the graphs dynamically change every time a change is made so that the graphs almost appear to be animated.



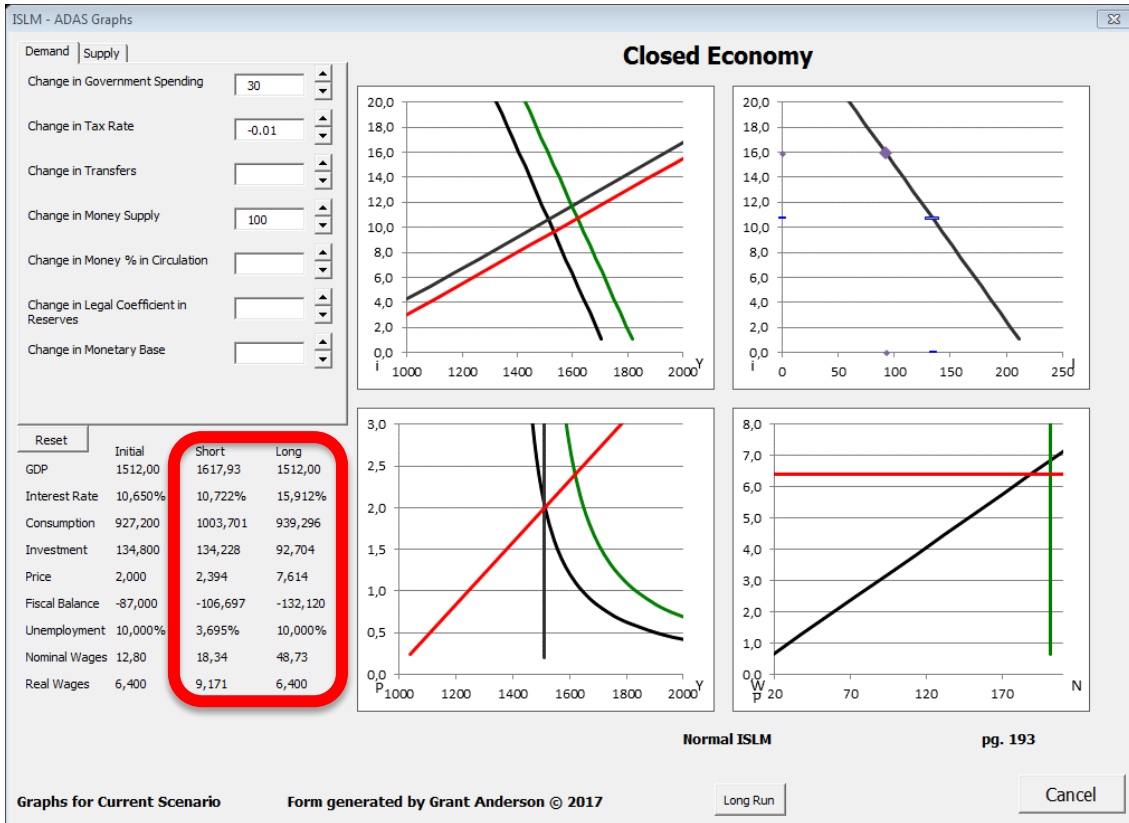


tax revenue (despite the reduction in the tax break), and it seems as if everyone is happy. By clicking cancel in the bottom left corner of the user form, the user returns to the 'intro' screen where he can now remove the 'demand side only' option and click 'Graph' again. Now what appears by making those same policy changes is a different picture.

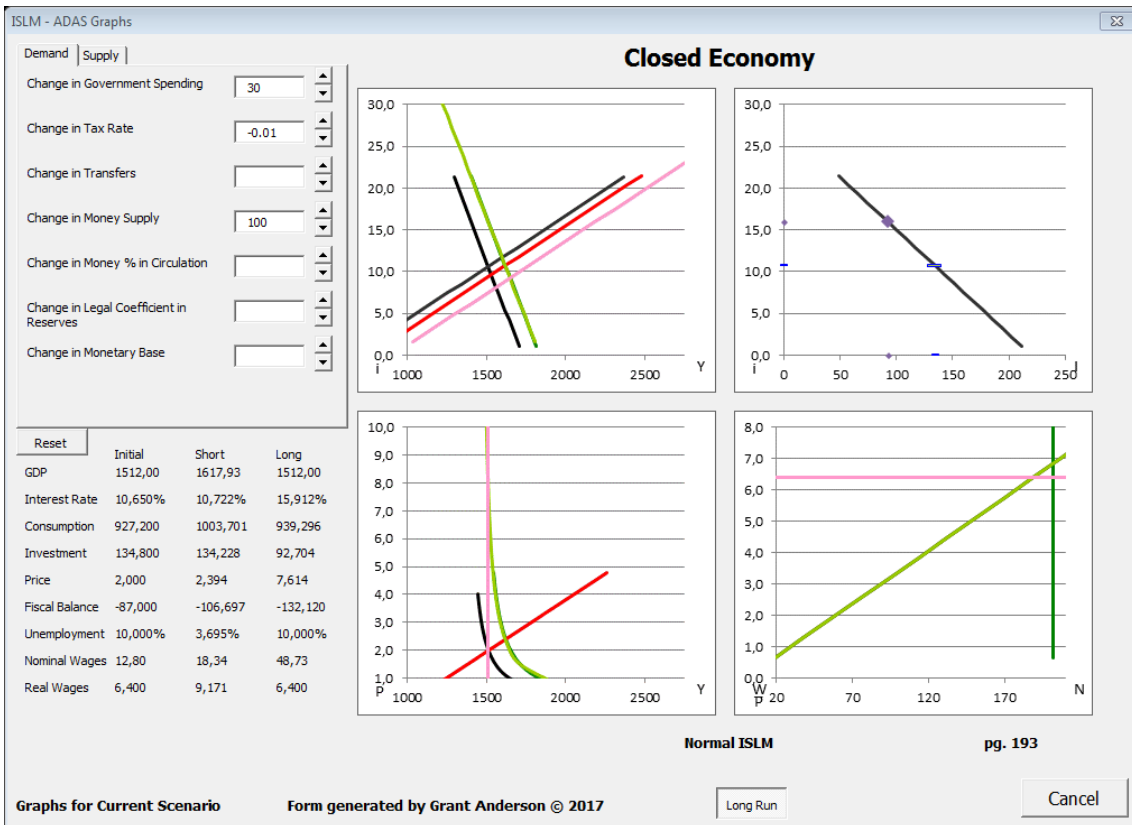
The price goes up in the short run and much higher in the long run which affects the buying power of the employees, who request higher wages and drive prices upward as the employers are forced to charge more in order to maintain profit margins. The extra government spending also increases the interest rates, which cause businesses to lower investment. If the user clicks the button on the bottom of the user form that says 'Long Run,' new lines appear on the graphs indicating a third series of lines representing the curves in the long run equilibrium. So as seen by this one demonstration, short-sided thinking by politicians can have serious blowback effects and wreak havoc on the economy.



User Form Image 1: Normal ISLM – Short Run Fixed Prices



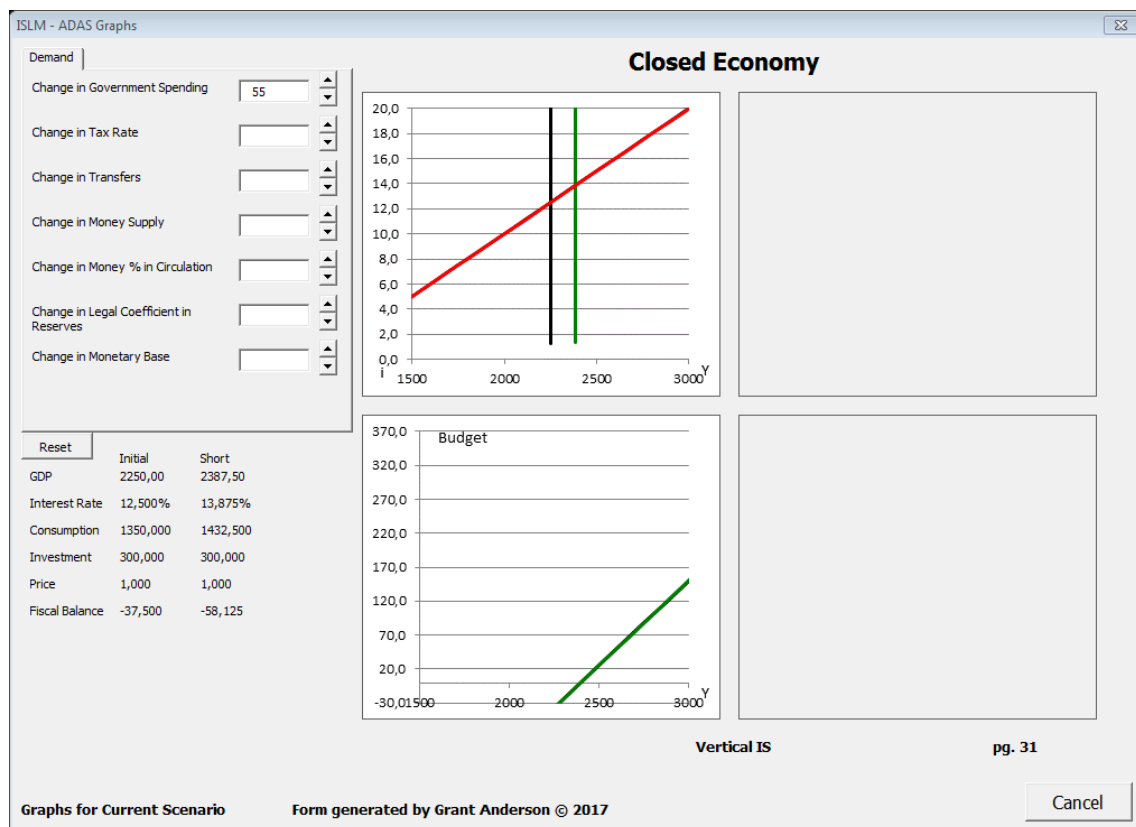
User Form Image 2: Normal ISLM Supply Side included



User Form Image 3: Normal ISLM Supply Side Long Run Curves Graphed

## Example 2 - Closed Economy: Vertical IS Normal LM

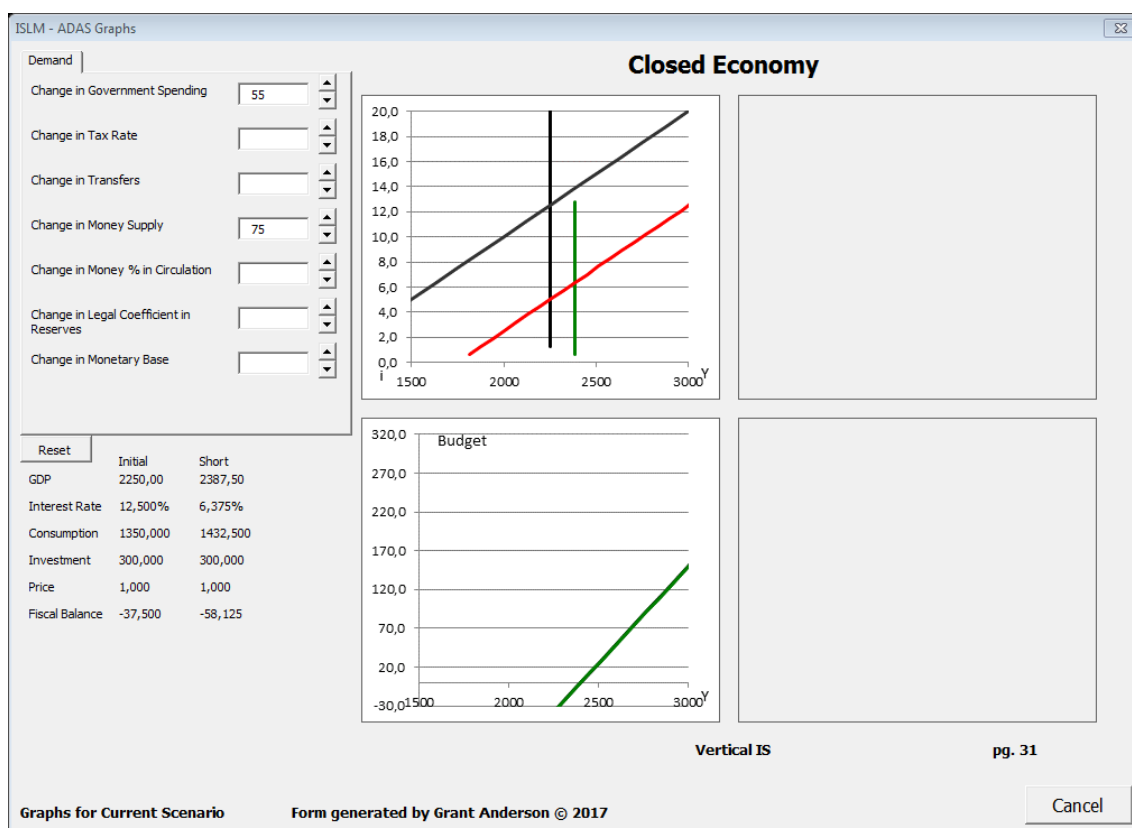
This scenario (pg. 39) is based on an economy in serious growth mode where regardless of what the interest rate is, investors are dumping everything into the country and the investment does not depend on the interest rate. This is not entirely a plausible scenario, but since considering the fact that it's a closed economy model, if a country were to close its borders to trade, and the country were growing internally despite a lack of trade with the outside world, the businesses might decide to take out loans without regard to the interest rate. In any case, this scenario works really well in order to teach the concept that the more inelastic a variable is with respect to an endogenous variable such as the interest rate, the more power it has to move the values of the other axis, or in this case,  $Y$ , the national income (GDP).



User Form Image 4: Vertical IS

Since Investment doesn't change, the investment graph is not included in this scenario since it is 100% vertical and doesn't change whatsoever. When increasing government expenditure to 55 for example, the user can see the green IS' curves shifting to the right of the initial equilibrium and increasing consumption, which increases the GDP, but makes the government balance sheet worse. Furthermore, by then deciding to increase

the monetary supply by lowering the interest rate, investment still doesn't respond, and even though the interest rate drops, investment is already at its max.

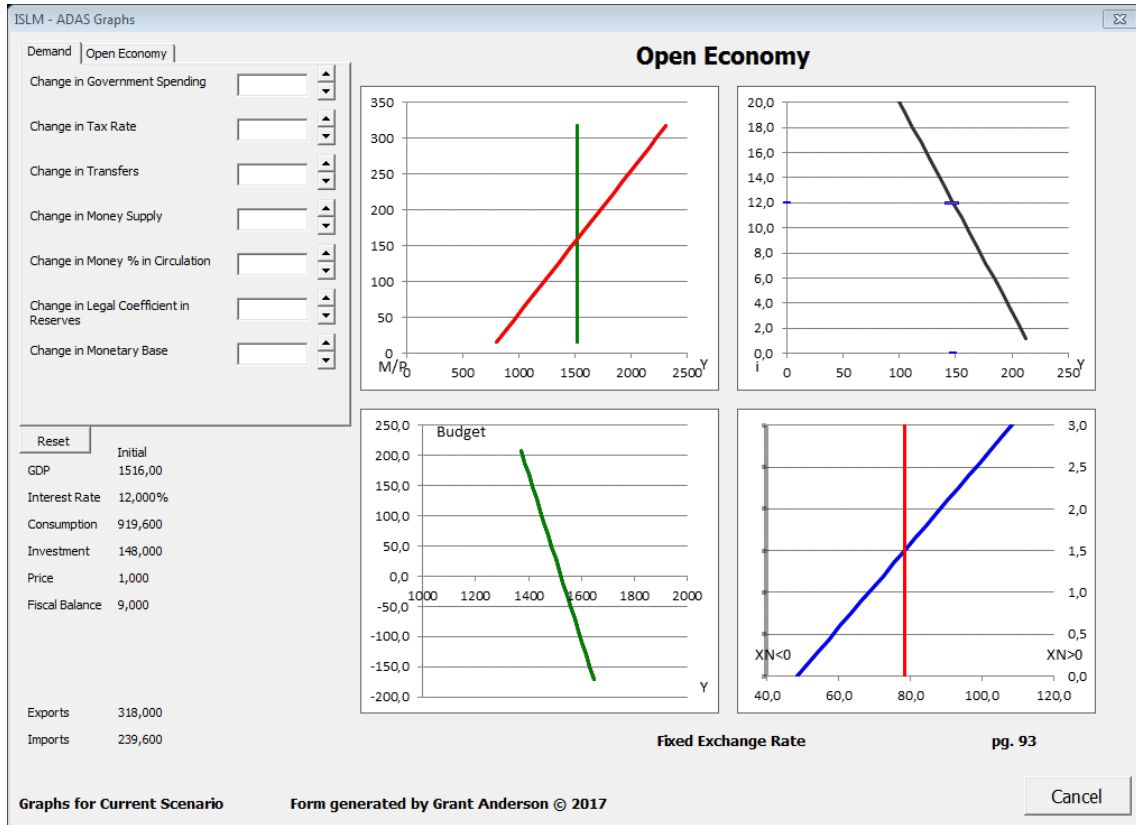


User Form Image 5 Vertical IS with Monetary Policy

### Example 3 - Open Economy: Fixed Exchange Rate

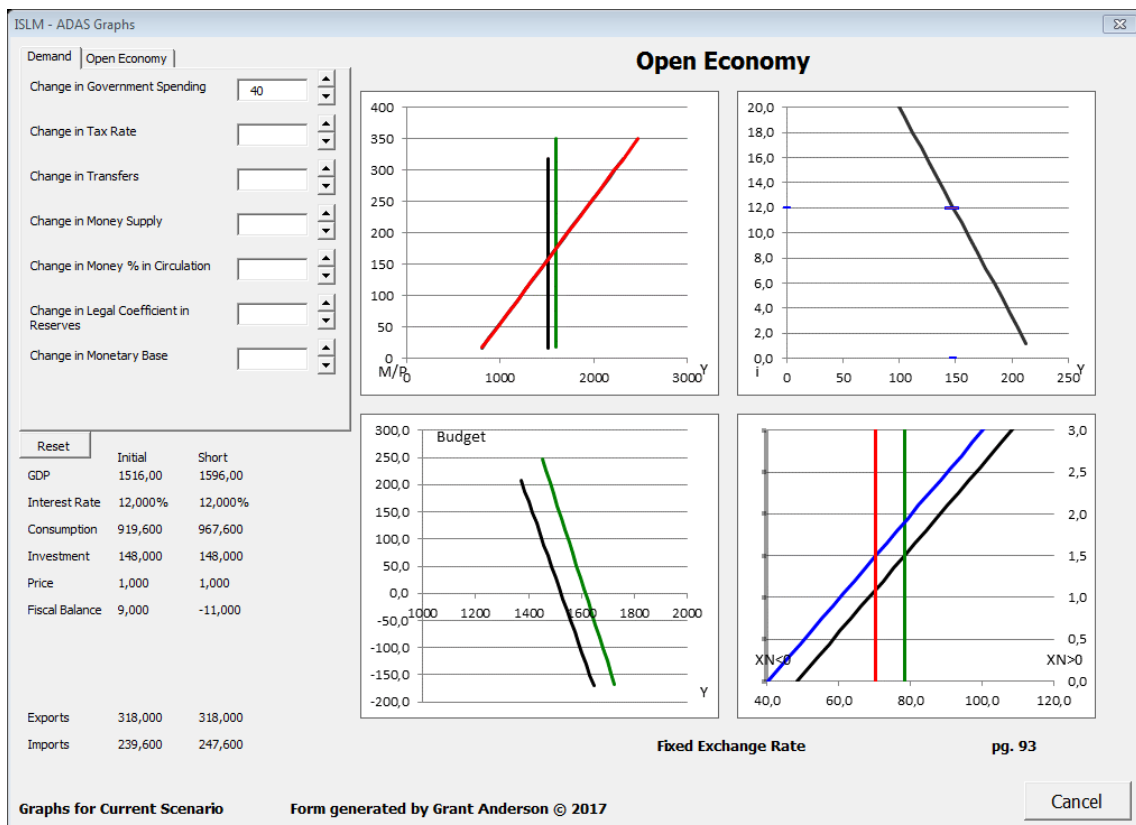
Back on the intro screen, by clicking on the combo box that says 'Closed Economy,' the type of economy can be change to 'Open Economy,' where the closed economy type scenario combo box disappears from view and another appears allowing a fixed or flexible exchange rate to be selected. By opening the scenario 'pg. 93,' after deciding on a fixed exchange rate, then by clicking 'graph,' the user form appears again with 'Open Economy' as its title and initial Exports and Imports can be seen on the lower left-hand side of the user form. As a side note, the slope for the Budge line indicating the relationship between the government budget deficit and national income is positive when it should be negative, and at least at the time of writing this document the line has not been fixed yet to reflect the positive, upward trend rather than the opposite, which is currently reflected. The values are correct however, and slide in the correct direction. The graph on the top left is also different. Now, what is seen is not an ISLM graph, but rather the positive trend between monetary liquidity relative to prices (M/P) and national income (Y). The idea for this graph belongs to Javier Capó, and this graph was adjusted

because it shows the real variables which need to be studied in the fixed economy 'price taker' model (since with the balance of payments,  $r=r^*$  and doesn't move).



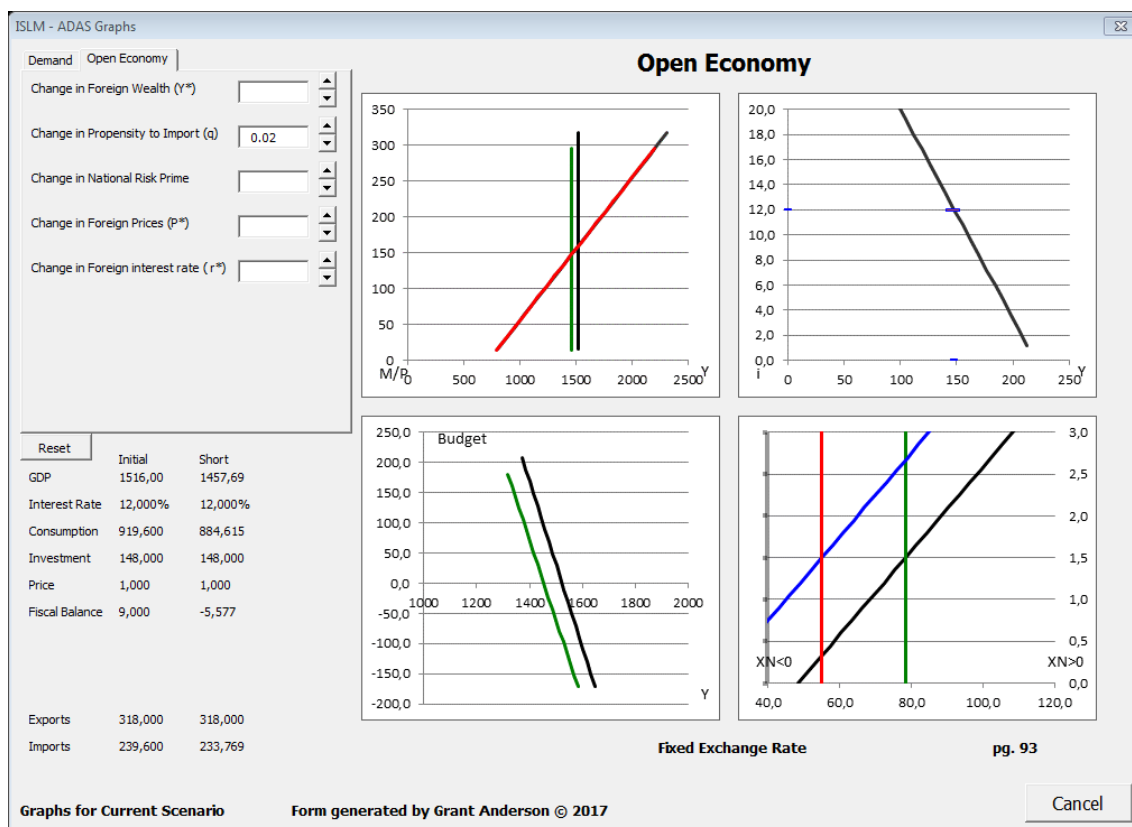
User Form Image 6 Above: Open Economy Fixed Currency Initial Screen

User Form Image 7 Below: Open Economy Fixed Currency Increase in Government Expenditure



As expected after seeing Example 2, the IS does not depend on the amount of liquidity in the market or the federal reserves of foreign currency. Investment does depend on the interest rate, but since this country is not able to influence world prices, in other words, since this country is so small, the interest rate is exogenous. When government spending is increased in the Fixed Exchange Rate Open Economy model, the price does not change in the short run, thus increasing government spending increases national income, which increases tax revenue and thus consumption increases as well as reducing the balance sheet for the federal government.

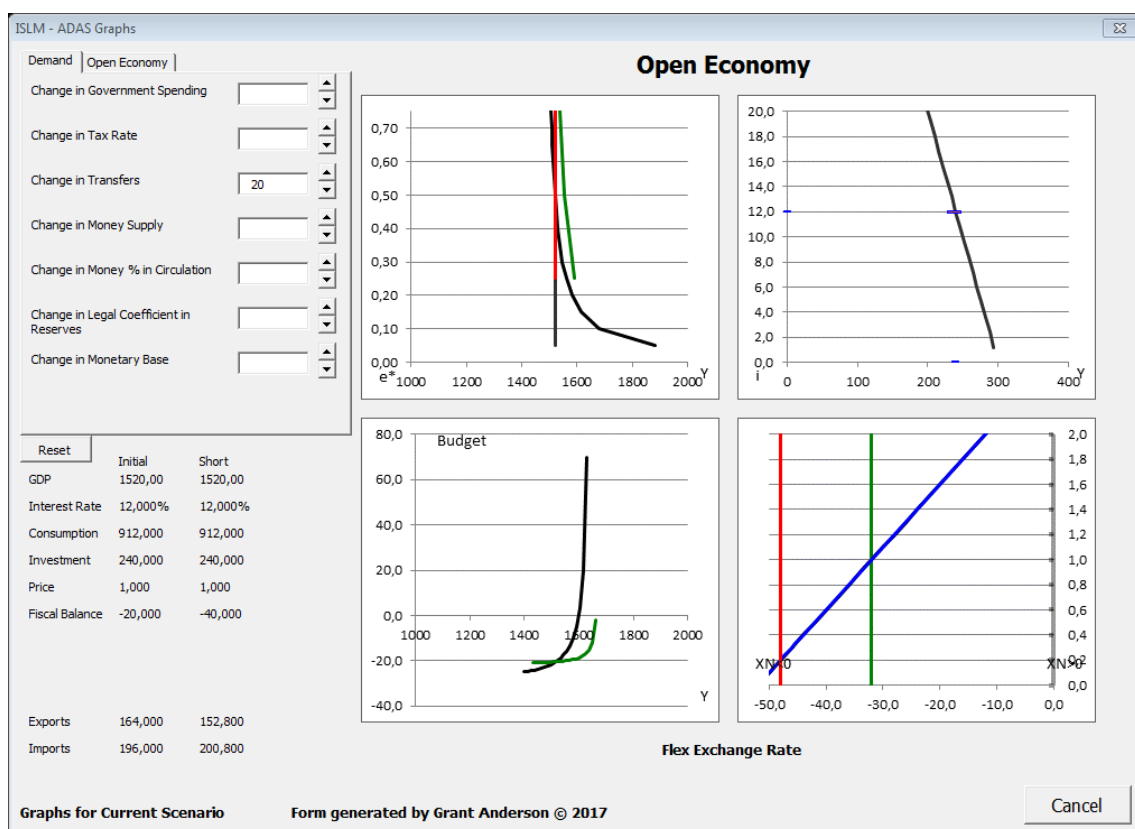
If the user clicks the 'Open Economy' tab at the top on the left, and increases the proportion of national income spent on imports, the exports trend line in the chart on the bottom right is displaced to the left, showing that imports are increasing while exports are staying the same.



User Form Image 8: Fixed Exchange Rate with a change in preferences to Import

## Example 4 - Open Economy: Flexible Exchange Rate

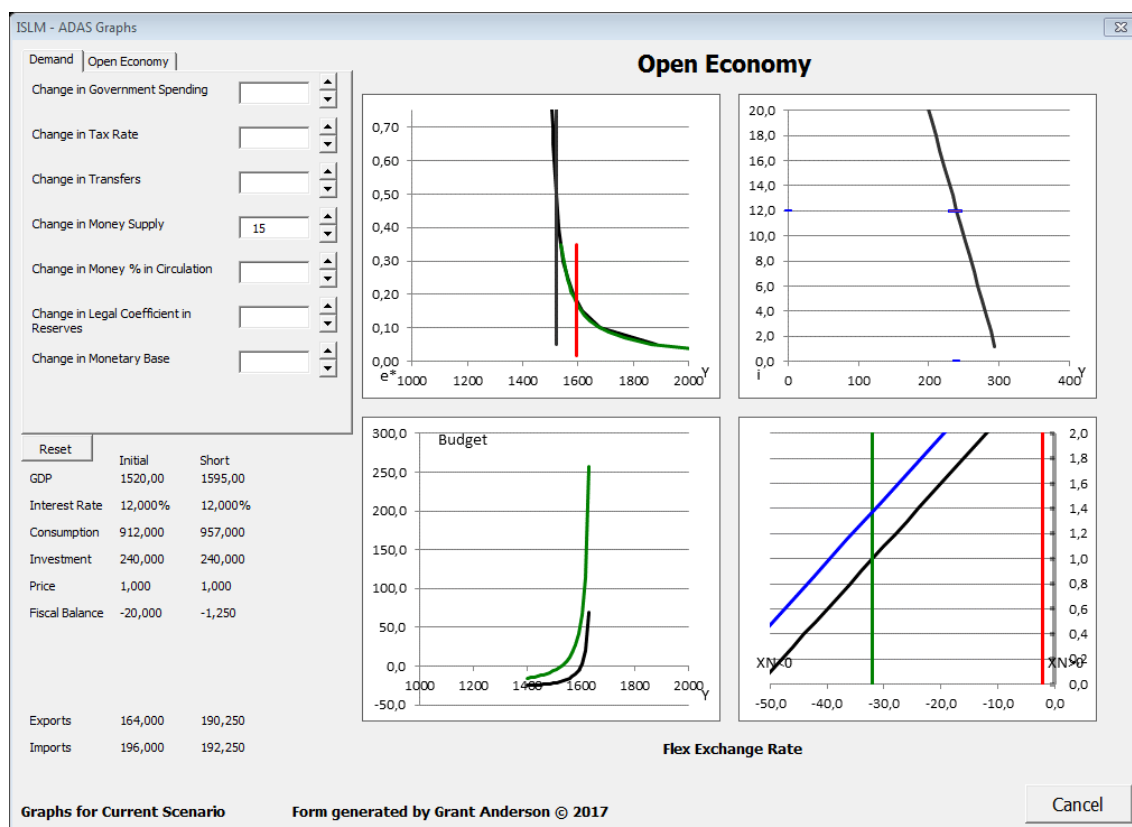
By comparing the graphs in the fixed economy scenario to the graphs in that of the flexible economy scenario, one can see a difference in the top left graph immediately. When studying the flexible exchange rate scenario, the endogenous 'indirect exchange rate' is more useful than the other two graphs used so far in that particular graph slot. When the user clicks on either government expenditure, government transfers or raises taxes and pushes a positive demand shock on this economy, the result is that it only serves to worsen the government balance sheet, and does nothing positive to make the general situation better for the population. Instead, it increases the demand for money liquidity in cash and checking accounts, and thus causes the indirect exchange rate to rise, and appreciating the national currency. This means that as  $e^*$  rises, the Real Exchange Rate  $P^*/(e^* \times P)$  goes down, since  $P^*$  has not changed but is now divided by a larger number. This makes it easier to acquire foreign goods, so agents take more trips abroad and buy more imports since everything foreign is now cheaper since the national currency is stronger and has more buying power. Without any kind of Keynesian multiplier, this policy directly negatively affects the fiscal budget deficit, further reducing the country's situation though albeit out of good intention.



User Form Image 9: Open Economy Flexible Exchange Rate with an Expansive Fiscal Spending Policy Change



However, although monetary policy was ineffective in an economy with a fixed exchange rate, with the flexible exchange rate a positive monetary policy change has maximum effect since it depreciates the national currency by making more of it, and thus increases exports. This increase can be seen in the bottom right graph as short run exports are in red. Since income goes up, imports automatically rise as a fraction of national income is used to pay for foreign goods, and thus the Net Exports (XN) trend line shifts to the left.



User Form Image 10: Flexible Exchange Rate with Expansive Monetary Policy change

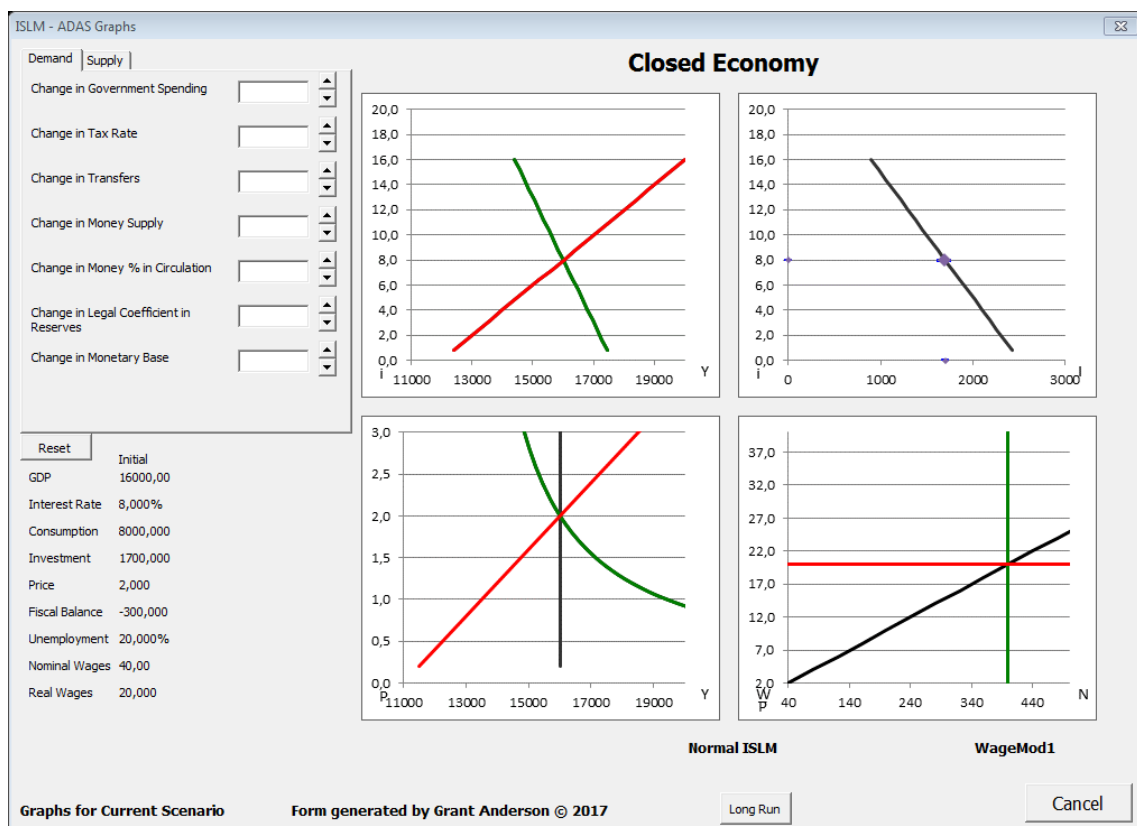
### Example 5 - Closed Economy: ISLM with Wage Modification

The reason that this modification was important to add into the simulator is twofold. The first reason, is that at the University of the Balearic Islands, a change in teaching methodology was recently implemented that affected the results of the exogenous data used in programming this simulator. The small change of adding the average productivity to the Wage Setting equation seems trivial, but it took several weeks to add to this simulator.

From  $\frac{W}{pE} = Z - du$  to  $\frac{W}{pE} = [Z - du]^*4$

The reason behind that is because of the amount of multipliers and calculus on every sheet that is required in order to produce the solutions to the system of equations. If changed, the old exercises would not calculate correctly, and there were not enough new exercises to support the simulator with the change implemented. The second reason why adding the modification was important, was that empirically, the rise of the average productivity may have effects on the economic growth of a country, but it does not have any effects on that country's unemployment rate in the long run. (Murphy 1999) Therefore, without implementing the change the simulator would not be realistic, but if the change were implemented, there were not enough algebraic exercises in existence to be able to test the full power of the simulator.

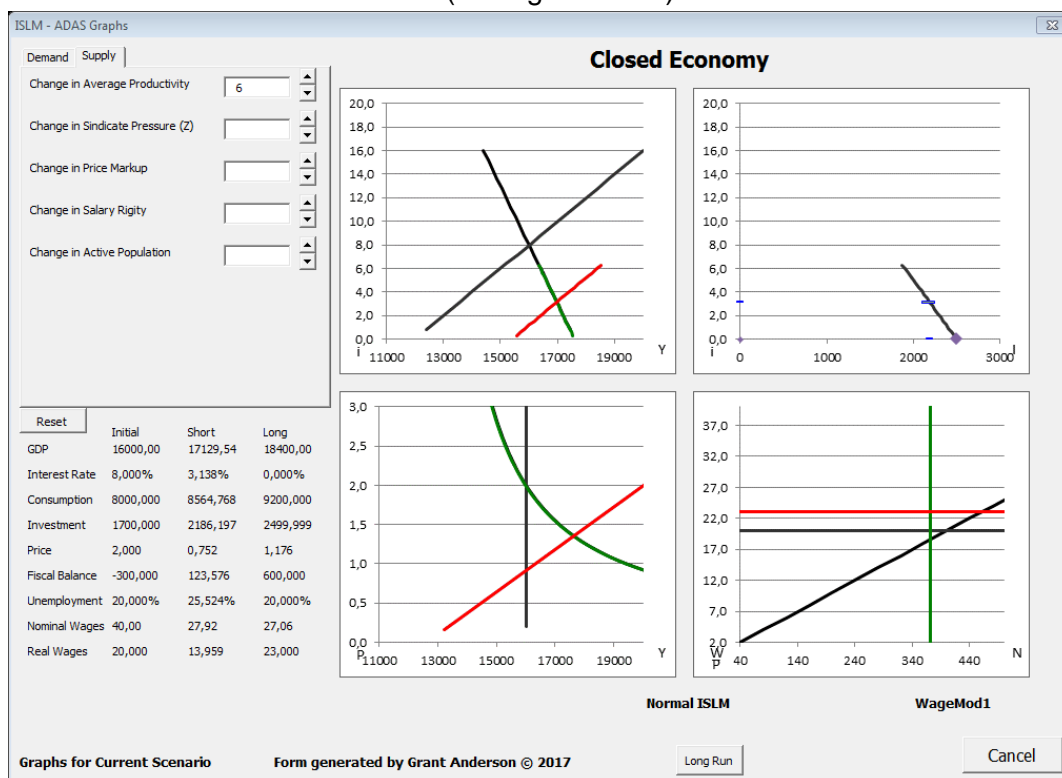
So the decision was made to do both, and an extra checkbox was added to the intro screen to implement this change. It does not work with every scenario, however, and each exercise has to be 'custom fit' or there will not be any equilibrium, even in the initial values. Without implementing the change, the simulator would still have had the capability to teach Macroeconomics to students in such a way that they will understand it more easily and pass the subject. The point is that it is also credible and the material is taught correctly.



User Form Image 11: Closed Economy with Aggregate Supply Side and Wage Modification

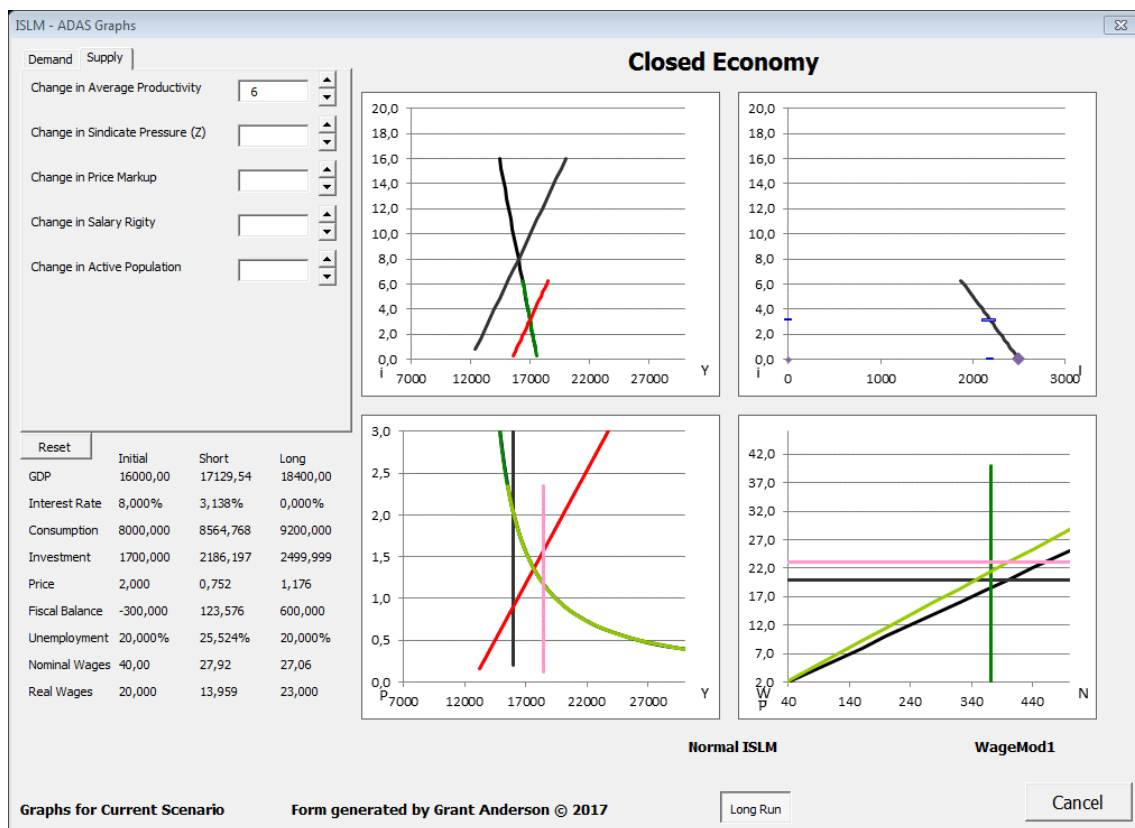
In the first exercise with the wage modification implemented, the initial equilibrium presents a value of 16,000 monetary units (€, \$, ¥, £, or whatever), which presents a huge problem graphically, because the initial values for all of the other exercises were around between a tenth of that and a fifth of it. Maximum and minimum values set for axes on graphs were not aligning and things did not seem to be improving. This hurdle was also overcome, and with the MROUND() function with rounds numbers off to multiples that the programmer specifies. That command paired with a few others and some IF/THEN statements, and things were fixed.

After clicking the supply tab, the user can increase the average productivity for example, which shows an increase in both short and long run GDP, a drop of the interest rate to near-zero in the long run, a rise in consumption and investment, and a drop in the federal budget deficit, and its reversal to a surplus (due to a gain in competitiveness in Supply and its increase of the GDP). In the gains made in price efficiency, the price drops in both time periods, and even though real wages slump in the short run, the long term gains are positive for the businesses (through investment increases and cost efficiency gains in the short run) and positive for the employees via Real Wage increases in the long run. The only dramatic effect of this overall positive change is that the workers experience a 25% rise in the unemployment rate in the short run while they become familiar with the new work conditions (or all get trained).



User Form Image 12: Closed Economy, ADAS with Wage Mod and Increase in Average Productivity

When the 'long run' button is clicked, the axes adjust to the new parameters to better orient the graphs, and the long run curves appear to the user. A screenshot has been provided to show the adjustments.



User Form Image 13: ADAS Closed Economy with Wage Modification in the Long Run

## Competition for this Macro Simulator

### The Others

Modeling mathematical sequences in various computer programs to automate results is nothing new, and has been the main purpose that computers were invented in fact. There are many other computer based macroeconomic simulators available, and there are many remarkable differences that exist with the DEMONIAIC. To begin, the earliest computer-based ISLM simulator found online was that of Masaru Uzawa (1990) of Otaru University of Commerce in Japan, who programmed a simplistic, yet effective tool in MS-DOS® that still works to this day<sup>23</sup>. ThinkEconomics has an interactive and animated chart based on fixed scenarios available on the internet that allows viewers to see how pre-defined, fixed scenarios look visually, but do not allow user-input or a more algebraic, instructive approach as a corollary.<sup>24</sup>

Javier Lozano from the University of the Balearic Islands' Applied Economics Department developed a simulator several years ago for Olivier Blanchard, and is not only very sophisticated and well crafted, but also has a wide range of use as it can model both open and closed economy models and demonstrate a high degree of predictive capacity in political and economic planning. The drawback to Lozano's simulator from the point of view of the author of this paper is that it requires a high degree of studying a prior knowledge of economics in order to be employed effectively. It was and is designed for economics students in their third year or later of their degree plan. It exceeds expectations for that audience, but would be difficult to demonstrate to first year students or laymen without prior economics education.

Humberto Barreto of DePauw University in Indiana has employed MS Excel for many years to advance and facilitate the learning of his economics students. He moves one step further, unlocking the simulators that he has designed and teaches students how they work, so as to 'demystify' MS Excel, a program that serves economists worldwide as 'bread and butter' in their profession. The simulators he has designed are very creative and easy to use, however he only has the ISLM ADAS model programmed for a large, closed economy, and he does not, to the author's knowledge, have an open economy model.

How the DEMONIAC macro simulator is different

The afore mentioned simulators incorporated either the ISLM or the ADAS model, or combined them in some form but only in a closed economy, or were too difficult for regular people without prior knowledge of Economics to use. The DEMONIAC not only accomplishes all of the above, but it does one thing that none of them can. All of the exercises used to produce this simulator are from the work of Javier Capó of the University of the Balearic Islands. All of the exercises were created to be done by hand, meaning that even a layman who has used the similar a few times, after seeing the end result can go back and practice his calculus by hand to achieve the same solutions as the simulator. This is not just an educational tool, it is a valuable resource that will allow Economics professors around the world to quickly invent their own exam problems without worrying if the math is correct. It is the robot designed not to replace, but to augment the capacity of the professor or the student entering through the gate of the economics world.

Beyond the points just stated and going back to previous aspirations as to expanding the capacity of this simulator, the DEMONIAC has a very distant but very bright horizon in

its reach, and the flexibility of this 80 year old economics model despite its ebb and flow of being championed in the scholarly economics world, the simplicity of the model allows itself to maintain a somewhat elastic nature. Since the DEMONIAC is based on these economic and mathematical models, it too can be flexible to adapt and analyze new economic challenges on the horizon.

## **Weaknesses in the DEMONIAC**

This simulator has been designed by someone without prior knowledge of Visual Basic and only an intermediate level knowledge of MS Excel's true potential. As the need arose, the capacity stretched to meet the goal, and this macro simulator has become an animal in and of itself. In order to fully grow, there are many important programming challenges that need to be met, and many theoretical issues that need to be addressed. Blanchard and other economists have developed modules or spinoffs of the ISLM ADAS model that help to explain a large country scenario, capable of 'price making' or influencing worldwide trade, but as far as theory is concerned, most abandon the model at the theoretical level or only explain the scenario fluctuations up to the short run equilibrium.

The question that is begged then, is what happens if the United States or China start heavily investing in Supply Side Economics similar to some of President Reagan's decisions during his two terms in the White House. Wouldn't a long run equilibrium result be desirable so that it could be studied and potential policies better estimated before implemented?

The Monetary Union scenario is still under work as well. Because of the sheer quantity of variables, both exogenous and endogenous in these calculus models, one of the most daring assumptions made in order to solve for the solutions through an inflation-based Taylor Rule type multi-government organism is that: both countries are going to be mirror images of each other. This goes against all logic, because even though certain general tendencies might be correctly predicted by the model, many results end up undetermined due to a lack of information on specific member states' elasticity's on trade and investment and even consumption preferences. Germany's natural unemployment rate is very low, while Spain maintains a very high structural unemployment level. The composition of the populations is different, and while both seem to have an aging population, Germany has a much higher level of average productivity. Germany has seven tenths of the land surface area that Spain has, however Spain has a population

that is five eighths the size of Germany.<sup>25</sup> How could anyone ever assume that studying these two countries within a model of assumed equality would produce a reliable result?

The answer is simple. Alleviate oneself of doing the algebra by hand, and mold the ISLM ADAS model into what it needs to be in order to do a side-by-side comparison between the two countries after symmetric and asymmetric shocks occur. The answer may be simple, but the ease in achieving that goal is quite difficult. One of the many ideas behind this simulator was allowing up and coming economists to play with new economic models and begin to turn the page in the ISLM ADAS book to bring the world into a more modern and flexible look at world events. To this point, the framework is in place, but many equations need to be tweaked and tested in order to launch these new case studies and scenarios in the DEMONIAC.

## Conclusions

If the author had known what sort of barriers he were up against both in his programming abilities, time management with other subjects, classes, exams and family, and in the face of the unknown frontier of several mathematical models, he may have considered choosing a final project that was easy to write and only the minimum level of innovative in order to pass, but only for the blink of an eye. The reality of this intense endeavor is that what small concepts were previously held of Macroeconomics and MS Excel by the author, soon became not just abstract ideas or basic notions, but rather something way different. What was experienced at an individual level from the process of constructing this simulator, was the discovery of a small string at the edge of the metaphorical fabric of a magic curtain, which once pulled, unlocked a wide range of understanding of the real interworking of the political structures that are formed, new insight into why certain prescriptions work for certain economies and why certain countries are doomed to lag behind the rest of the world, as well as a firm understanding of the human condition that seems to want to explain nearly everything people do *post hoc*.

With the sheer magnitude of what this simulator can do for the political economic world when fully developed, Macroeconomics could become a course taught at a high school level, and the world could observe a small shift toward Lucas' Critique with more foreword thinking agents and less people thinking and reacting like cattle while stirring panic driven crises. With an advance in the learning curves of the economists currently being mass produced, maybe the leaders of tomorrow will be better prepared to deal with the dying fish and coral populations in the seas of plastic, famine, earthquake reaction and response, tsunami forewarning and early preparation, global warming, species extinction from genetic manipulation and genetic homologation, transition to new fuel sources, trans-lunar or -world expansion and whatever other turn of events are in store. The need for smart thinkers and world leaders with the right ideas and moral courage is now.



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