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The Multiplier Effect: An Application

This paper introduces a web-based application designed to demonstrate the multiplier effect to introductory macroeconomics students. It illustrates traditional multiplier effects plus advanced scenarios involving leakages (e.g., income taxes), unequal changes in government spending and lump-sum taxation / transfers, and potentially heterogeneous households. Real-world applications and exercises are provided.

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1. Illustrating the Multiplier Effect

The impact of an initial change in government spending, lump-sum taxation, or government transfers resulting in a magnified change in economic activity (i.e., The Multiplier Effect), is a foundational tenet of Introductory Macroeconomics. The classic multiplier effect story is as follows: (i) An expansionary change in fiscal policy is observed (e.g., an increase in government purchases); (ii) The policy change results in additional income to recipient households (e.g., sellers); and (iii) These recipients spend a portion of their additional income, which becomes additional income for subsequent households. This process repeats itself for multiple rounds, where each recipient of income spends a portion of it providing new income for the subsequent round. The amount of additional spending, stated as a portion of additional income, is determined by the households' Marginal Propensity to Consume (MPC)[1].

This paper introduces an interactive, web-based application to illustrate the multiplier effect. It illustrates how the MPC determines the amount of spending in each individual round, the cumulative spending across multiple rounds, and further shows how a household's MPC and the overall multiplier effect can be impacted by various factors such as income tax rates and/or spending on imported goods and services (i.e., leakages).

The application demonstrates the multiplier effect in three ways: (i) via a change in government spending on domestic goods and services, (ii) via a change in lump-sum taxation or government transfer payments (i.e., subsidies), or (iii) via a simultaneous change in both. The third option allows for changes in government spending and lump-sum taxation / government transfers to not necessarily equal or offset each other (i.e., one can examine combinations of spending and subsidy packages that are not restricted to a "Balanced Budget Multiplier").

Another application feature is to illustrate the multiplier effect when an economy is populated by heterogeneous households (with different marginal propensities). While the assumption of a single MPC value existing for all households (or on average) simplifies the analysis, multiple MPC values do exist, and their interaction can significantly impact the multiplier effect. The application allows users to explore the impact of heterogeneous MPC values on the multiplier effect via simulation, alleviating any mathematical complexity. Additionally, since the app is equipped to consider two types of households, it can be used to compare policy outcomes across different household types (or across two separate economies), without necessarily having to consider the interaction between the different households.

It should be noted that the application illustrates the multiplier under some typical assumptions. First, it is assumed that prices are constant and there are no supply-side constraints. This implies that any change in quantity demanded from the households or government will be satisfied by the market at the current price. Second, it is assumed that interest rates are constant. This implies that there is no monetary policy response to any of the fiscal policies considered in the application, and no crowding out of investment due to any policy change impacting government budget deficits. Finally, the analysis allows for the purchase of imported goods, but it abstracts away from the sale of exports for simplicity. Any increase in export purchases from foreign countries could be shown to be a response to the policy-induced change in import sales by the home country, resulting in a smaller net effect on import sales. Explicitly considering export sales would not significantly improve the illustration of the multiplier but add an additional level of complexity.

[1] Note that while the example considers expansionary fiscal policy in delivering additional household income, the multiplier story delivers an equal but opposite impact to contractionary fiscal policy (i.e., a decrease in government spending that decreases household income).

The application utilizes the Shiny package (in R) and is hosted on a freely available website (Posit Connect Could). These pedagogical tools are popular in statistics and econometrics and can provide important diversity in teaching methods missing from introductory economics classes[2]. Asarta, Chambers, and Harter (2021) report that "chalk and talk" remains the primary method of instruction, and the use of activities such as simulations has declined over time. With respect to the application feature of heterogeneous households, it accords with the literature reporting a variety of MPCs across demographic characteristics and the income/wealth distribution. Boehm, Fize, and Jaravel (2025) find the MPC of women is approximately half of that of men, and households with lower incomes have higher MPCs. Fisher et al. (2020) find low-wealth households to have higher MPCs than wealthier households. Given a distribution of MPC values across households, the impact of a fiscal policy decision will depend not only on the magnitude of the fiscal policy implemented but also on the distribution of the fiscal policy across households with differing MPCs (Carroll et al. 2017). Most introductory courses may not fully address this last point, but this application can easily illustrate the variable impact of fiscal policy decisions given a distribution of MPC values across households.

2. Application Details

The application can be found here:

https://01992aa6-2eae-09eb-7d03-aaf88a24c7a1.share.connect.posit.cloud/

This application is intended to solidify understanding after students have been introduced to the topics of the MPC (with or without leakages), and both the government spending and lump-sum tax multipliers. Since the application is designed to be interactive and offer side-by-side comparisons, it is recommended that a device with a screen size larger than a phone (e.g., tablet, laptop, etc.) be used. A detailed appendix contains the following: (i) The assumptions of the economic environment and the explicit derivation of the spending multipliers in the presence of leakages, (ii) A thorough explanation of the instructions appearing on the application, and (iii) a series of exercises illustrating everything from basic multiplier effect scenarios up to the empirical estimates of the multiplier effect provided by the Congressional Budget Office in the context of the American Recovery and Reinvestment Act of 2009.

3. Conclusion

Analyzing the economic impact of policy decisions and feedback mechanisms, such as the multiplier effect, are precisely the things that make macroeconomics uniquely interesting, but sometimes confusing. The goal of this app is to visually illustrate the various ways the multiplier effect can impact the effectiveness of fiscal policy changes. We hope that the app as well as the exercises provided in the appendix can help students of macroeconomics better understand the world they live in.

[2] See Wang et al. (2021) for examples of statistics materials, and Heiss (2008) for examples of econometrics materials.

References

Asarta, C. J., Chambers, R., & Harter, C. (2021). Teaching methods in undergraduate introductory economics courses: Results from a sixth national quinquennial survey. *The American Economist*, 66(1), 18. DOI: 10.1177/0569434520974658

Boehm, J., Fize, E., & Jaravel, X. (2025). Five facts about MPCs: Evidence from a randomized experiment. *American Economic Review*, 115(1), 1–42. DOI: 10.1257/AER.20240138

Carroll, C., Slacalek, J., Tokuoka, K., & White, M. (2017). The distribution of wealth and the marginal propensity to consume. *Quantitative Economics*, 8(3), 977. DOI: 10.3982/QE694

Congressional Budget Office. (2012, May). Estimated impact of the American Recovery and Reinvestment Act on employment and economic output from January 2012 through March 2012. https://www.cbo.gov/publication/43216

Conley, T. G., & Dupor, B. (2013). The American recovery and reinvestment act: Solely a government jobs program? *Journal of Monetary Economics*, 60(5), 535-549. DOI: 10.1016/j.jmoneco.2013.04.011

Fisher, J.D., Johnson, D., Smeeding, T., & Thompson, J. (2020). Estimating the marginal propensity to consume using the distributions of income, consumption, and wealth. *Journal of Macroeconomics*, 65. Article 103218. DOI: 10.1016/j.jmacro.2020.103218

Heiss, F. (2020). *Using R for Introductory Econometrics*. Independently published.

Wang, S. L., Zhang A.Y., Messer, S., Wiesner, A., & Pearl, D.K. (2021). Student-Developed Shiny Applications for Teaching Statistics. *Journal of Statistics and Data Science Education*, 29(3), 218–27. DOI: 10.1080/26939169.2021.1995545

Appendix to The Multiplier Effect: An Application

1. Introduction

This three-part appendix details the derivation of the multipliers used in the application, the instructions on how to use the application, and three multi-part, ready-to-use exercises demonstrating the various uses of the application. The exercises include a simple hypothetical fiscal policy change as well as analyses of recent fiscal policy changes during the 2008 financial crisis and the COVID-19 pandemic. Each exercise includes specific instructions and several questions that an instructor could either present as class exercises, or have students answer as group work or homework. Instructors are welcome to alter these exercises that best suits their needs or come up with exercises entirely on their own.

The link to the application is:

https://01992aa6-2eae-09eb-7d03-aaf88a24c7a1.share.connect.posit.cloud/

For instructors interested in making applications their own, the link to the source code for the application is available HERE. Any questions can be directed to scott.dressler@villanova.edu.

2. Part I: Derivation of the Multipliers

A. Basic Derivations

Consider an economic environment comprising of a government, a large population of domestic households, and a foreign market strictly for the sale of imported goods. The government can purchase domestic goods and services (G), collect lump-sum taxes, make transfer payments or subsidies, and levy a proportional / marginal tax rate on household income (MTR). It is assumed that there is no government budget constraint (e.g., it can go into debt), there is a fixed interest rate (i.e., no monetary policy), and all prices and exchange rates are fixed.

Households have a budget constraint where their gross income is distributed among consumption of domestic goods and services, savings, taxes, and purchases of imported goods and services. It is assumed that this budget constraint always holds with equality, meaning that if a household were to receive one additional dollar of gross income, it would be distributed among these four items. This allows us to introduce a key identity in the spending multiplier framework using the marginal propensity to save (MPS), the marginal propensity to consume domestic goods and services (MPC), the marginal propensity to consume imported goods and services (MPI), and the marginal income tax rate (MTR).

(1) $$1 = \mathrm{MPS} + \mathrm{MPC} + \mathrm{MPI} + \mathrm{MTR}$$

Equation (1) assumes that all variables are between 0 and 1 and makes the restriction that an additional dollar of gross income must be distributed amongst savings, consumption of domestic and imported goods, and taxes. The app allows the user to choose the MTR, as well as the household's MPS and MPI, and then uses equation (1) to determine the amount of the additional dollar the household spends on domestic goods and services, as shown in equation (2).

(2) $$\mathrm{MPC} = 1 - \mathrm{MPS} - \mathrm{MPI} - \mathrm{MTR}$$

We can now derive the spending multipliers. If the government were to change spending on domestic goods and services by an amount $\Delta \mathrm{G}$, then the sequence of subsequent household expenditures arising from the change in domestic income would evolve over several rounds and eventually deliver the government spending multiplier (with and without the use of equation 2).

$$\Delta \mathrm{G} + \Delta \mathrm{G}\mathrm{MPC} + \Delta \mathrm{G}\mathrm{MPC}^2 + \Delta \mathrm{G}\mathrm{MPC}^3 + \Delta \mathrm{G}\mathrm{MPC}^4 + \cdots =$$

$$\Delta \mathrm{G}\left(1 + \mathrm{MPC} + \mathrm{MPC}^2 + \mathrm{MPC}^3 + \mathrm{MPC}^4 + \cdots\right) \approx$$

$$\Delta \mathrm{G}\left(\frac{1}{1-\mathrm{MPC}}\right) = \Delta \mathrm{G}\left(\frac{1}{\mathrm{MPS}+\mathrm{MPI}+\mathrm{MTR}}\right) \tag{3}$$

Equation 3 illustrates that the total change in expenditures equals the change in government spending $(\Delta \mathrm{G})$ times the government spending multiplier.

Instead of the government making a change to purchases, they could make a change to either lump-sum taxes or transfer payments (i.e., subsidies). It should be noted that while a change in lump-sum taxes and a change in transfer payments are two different fiscal policy changes, they have a similar (but opposite) impact on household income. For example, a 1 billion USD increase in transfer payments and a 1 billion USD decrease in lump-sum taxes would deliver the same 1 billion USD increase to household income. We therefore interpret the variable $\Delta \mathrm{T}$ in the derivations below to be the change in household income as a result of a change to fiscal policy. For example, $\Delta \mathrm{T} > 0$ could equally be considered a $\Delta \mathrm{T}$ increase in transfer payments or a $\Delta \mathrm{T}$ decrease in lump-sum taxes since they both increase household income by $\Delta \mathrm{T}$.

Given a change in transfer payments (or equivalently opposite change in lump-sum taxes) by an amount $\Delta \mathrm{T}$, then the sequence of domestic income and subsequent expenditures would evolve over several rounds and eventually deliver the tax (or transfer) multiplier.

$$\Delta \mathrm{T}\mathrm{MPC} + \Delta \mathrm{T}\mathrm{MPC}^2 + \Delta \mathrm{T}\mathrm{MPC}^3 + \Delta \mathrm{T}\mathrm{MPC}^4 + \cdots =$$

$$\Delta \mathrm{T}\left(\mathrm{MPC} + \mathrm{MPC}^2 + \mathrm{MPC}^3 + \mathrm{MPC}^4 + \cdots\right) \approx$$

$$\Delta \mathrm{T}\left(\frac{\mathrm{MPC}}{1-\mathrm{MPC}}\right) = \Delta \mathrm{T}\left(\frac{1}{\mathrm{MPS}+\mathrm{MPI}+\mathrm{MTR}} - 1\right) \tag{4}$$

These multipliers are used in the app to deliver the sequential and cumulative spending in response to a change to fiscal policy. For example, an increase in government spending of 2 billion USD $(\Delta \mathrm{G} = 2)$ would deliver the following sequence and total spending impact for a given value of MPC.

$$2\left(1 + \mathrm{MPC} + \mathrm{MPC}^2 + \mathrm{MPC}^3 + \mathrm{MPC}^4 + \cdots\right) \approx \frac{2}{1-\mathrm{MPC}} = \frac{2}{\mathrm{MPS}+\mathrm{MPI}+\mathrm{MTR}} \tag{5}$$

Furthermore, an increase in government transfer payments (or decrease in lump-sum taxes) of 2 billion USD $(\Delta \mathrm{T} = 2)$ would deliver the following sequence and total spending impact for a given value of MPC.

$$2\left(\mathrm{MPC} + \mathrm{MPC}^2 + \mathrm{MPC}^3 + \mathrm{MPC}^4 + \cdots\right) \approx \frac{2\,\mathrm{MPC}}{1-\mathrm{MPC}} = \frac{2}{\mathrm{MPS}+\mathrm{MPI}+\mathrm{MTR}} - 2 \tag{6}$$

While the above examples illustrate how the households' MPC value determines the overall impact of an increase in government expenditures or transfer payments, note that one could easily illustrate the impact of a decrease in either by considering $\Delta \mathrm{G} < 0$ or $\Delta \mathrm{T} < 0$. This is because the MPC not only indicates how much of an additional dollar gained would deliver increased consumption, but it also indicates how much of an additional dollar lost would deliver decreased consumption.

One final item to note is that we are denoting MPC as the marginal propensity to consume *domestic* goods and services to streamline the exposition and allow the instructor to avoid the discussion of *leakages* (MPI and MPR) if desired. For example, an economy without imported goods would set $\mathrm{MPI} = 0$ by default and therefore MPC would report the consumption of all available (domestic) goods. Furthermore, an economy without imports and income taxes would set $\mathrm{MTR} = \mathrm{MPI} = 0$, which results in a traditional marginal budget constraint of $1 = \mathrm{MPC} + \mathrm{MPS}$. Finally, there is no marginal propensity to export in the model; meaning that any increase in income from foreign sellers due to the sale of imports does not enter back into this economy. This is a minor assumption that would not add anything material to the analysis and come at the complexity cost of an additional variable to consider.

B. Summary of Derivations and Extensions

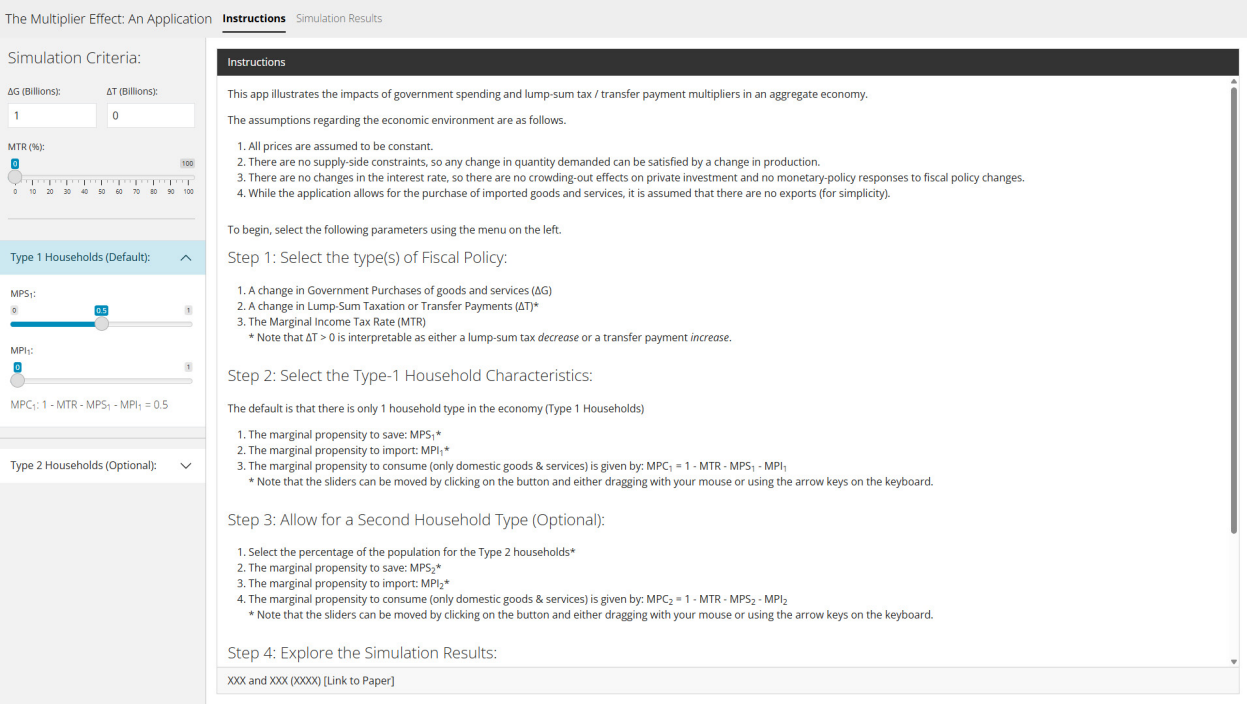
In an economy with only one type of household, the app will calculate the household's $\mathrm{MPC} = 1 - \mathrm{MPS} - \mathrm{MPI} - \mathrm{MTR}$ and illustrate the cumulative impact (CI) of a change in government spending on goods and services $(\Delta \mathrm{G})$ and a change in government transfers $(\Delta \mathrm{T})$.

(7)
$$\mathrm{CI} = \frac{1}{1 - \mathrm{MPC}} \Delta \mathrm{G} + \frac{\mathrm{MPC}}{1 - \mathrm{MPC}} \Delta \mathrm{T}$$

If the economy were extended to consider heterogeneous households, then the user would need to select a second set of marginal propensities $(\mathrm{MPS}_2, \mathrm{MPI}_2,$ and $\mathrm{MPC}_2)$ as well as the proportion of the household population that possesses these values. The application will illustrate a policy change separately for each household type, facilitating a comparison of the policy impact across different household types (or separate economies). The application will then also simulate the cumulative impact of a policy change on the economy when different household types interact by randomly giving the change in income among these Type-1 and Type-2 households. The simulation repeats the random path 1000 times, illustrates the average outcome, as well as a 90% central range of all individual paths to show how variable the multiplier process can be in an environment with heterogeneity.

3. Part 2: Application Instructions

The initial view of the application is below.



The instruction page details a basic analysis of the application in 4 steps:

Step 1: Select the type(s) of Fiscal Policy: This step requires the user to utilize the first three inputs at the top of the sidebar entitled *Simulation Criteria*. The change in government spending $(\Delta \mathrm{G})$ and the change in lump-sum taxes / transfers $(\Delta \mathrm{T})$ can be any whole number (positive or negative). The marginal tax rate (MTR) can be selected along the slider from 0 to 100. Setting any of these values to zero simply removes that feature from the analysis.

Step 2: Select the Type-1 Household Characteristics: The default setting of the app focuses on an economy populated by just one type of household. Under the panel labelled *Type 1 households (Default)*, a user can input the household's MPS and MPI and therefore determine the MPC using Equation 2.

Step 3: Allow for a Second Household Type (Optional): If desired, a user can also consider household heterogeneity and consider a second household type. Opening the panel labelled *Type 2 households (Optional)*, a user can input the proportion of the household population comprising of this second household type, the Type-2 household's MPS and MPI, and therefore determine the MPC using Equation 2. The default setting is that there is zero proportion of the population that are Type-2 households, so they are not considered until a user increases the proportion.

Step 4: Explore the Simulation Results: The simulation results can be viewed by clicking on the tab at the top of the screen. The *Simulation Results* page opens illustrating the cumulative spending and spending per round given the policy parameters and household characteristics the user selected in Steps 1 through 3. The value boxes at the bottom of the screen provide the numerical values of the government spending and lump-sum tax multipliers. The second

tab of the simulation results show the cumulative spending and spending per round in table form, in case that is preferable to the figure on the previous tab. Finally, the third tab shows the interaction of heterogeneous households. When the households have different marginal propensities (and there is a non-zero proportion of Type-2 households), a user can analyze the full extent of the simulation. Note that since the results are based on 1000 random simulations, one will rarely get the exact answer twice.

4. Part 3: Exercises

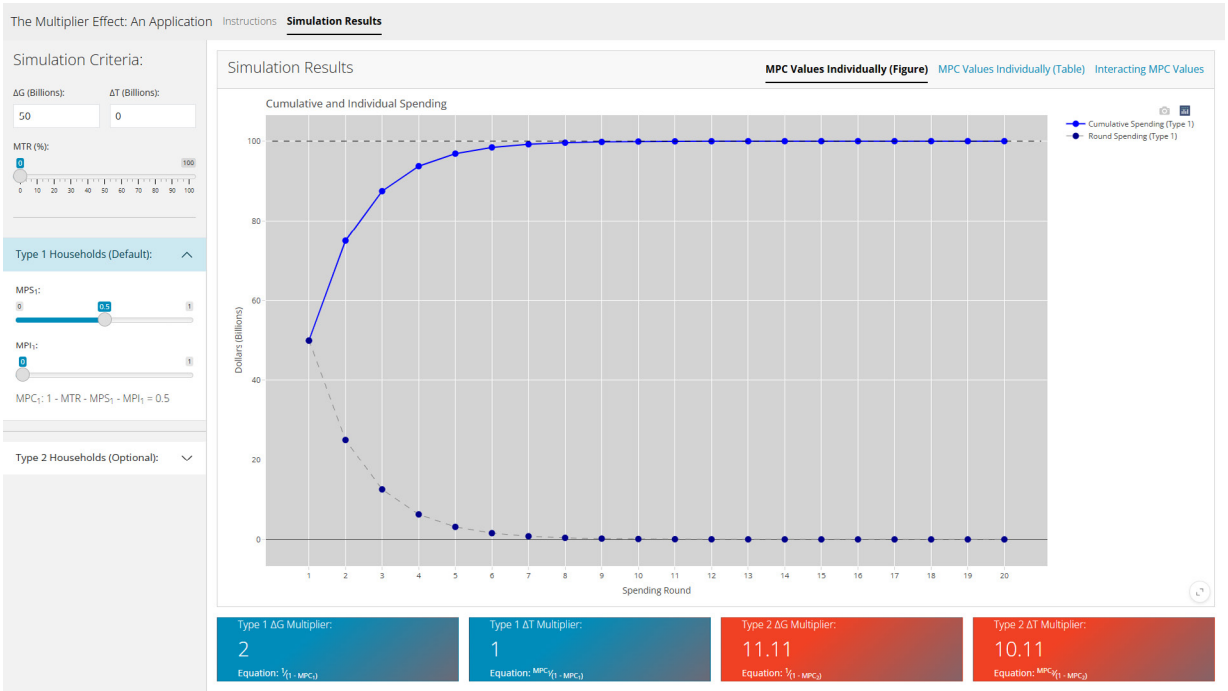
This section provides some ready-to-use exercises for the application. These exercises could easily be modified to meet an instructor's specific needs, and/or instructors could create their own exercises for students to explore with the app.

Three exercises are considered:

1. A simple, hypothetical example to learn different features of the application.
2. Analysis of three components of the *American Recovery and Reinvestment Act of 2009*: government purchases of goods/services (e.g., new infrastructure), transfer payments to households (e.g., supplemental unemployment benefits), and tax cuts to households. This analysis uses estimates of the multiplier provided by the Congressional Budget Office.
3. Analysis of fiscal policy transfer payments in response to the COVID-19 shock.

A. Exercise 1: A Traditional Multiplier Effect

Consider only one household type, and set $\text{MPS} = 0.5$, $\text{MPI} = 0$, and $\text{MTR} = 0$. This produces the traditional multiplier in a closed economy under the standard assumption that $\text{MPC} + \text{MPS} = 1$. Consider a \$50 billion increase in government purchases with no change in lump-sum taxes or transfer payments. The app should look as follows:



1. What is the total, cumulative change in spending as a result of this increased government spending? (Note this is in a closed economy where all spending is on domestically produced goods/services.) (Answer: \$100 billion = 50 × 1/0.5.)

2. How many rounds of spending does it take for the economy to reach the full impact of the multiplier effect? (Answer: Both the table and figure indicate that it takes 15 rounds of spending to reach \$100 billion in total spending.)

3. After the \$50 billion increase in government spending in Round 1, show how the additional spending in Round 2 = \$25 billion. Why does the spending in each round continually decrease? (Answer: In Round 2, the household recipient of the \$50 billion in the previous round spends \$25 billion = 0.5 ×50. The household recipient of \$25 billion in Round 3 spends \$12.5 billion, and the sequence continues.)

4. To consider the impact of moving from a closed economy to an open economy, suppose households spend 25% of their income on imported goods (i.e., set $\mathrm{MPI} = 0.25$). How does the purchase of imports impact the cumulative change in spending as a result of this increased government spending? (Answer: The MPC (on domestic spending) declines from 0.5 to 0.25, resulting in the multiplier falling from 2 to 1.33. The cumulative change in spending therefore falls from \$100 billion to \$66.67 billion.)

5. To consider the impact of paying taxes on income received throughout the multiplier process, suppose households face a marginal income tax rate of 15% (i.e., set $\mathrm{MTR} = 0.15$). How do both the purchase of imports and income taxes impact the cumulative change in spending as a result of this increased government spending? (Answer: A marginal income tax rate of 15%, holding $\mathrm{MPS} = 0.5$ and $\mathrm{MPI} = 0.25$, results in an MPC of 0.1. This implies that only 10 cents out of every dollar received as additional income will pass onto the subsequent spending round. The multiplier falls to 1.11, and the cumulative change in spending falls to \$55.56 billion.)

6. To consider heterogeneous households, suppose that a second household type faces the same income tax rate, has the same marginal propensity to import, but only saves 30% of each additional dollar of income (i.e., $\mathrm{MPI}_2 = 0.25 \text{ and } \mathrm{MPS}_2 = 0.3$). Suppose this household type makes up 50% of the household population. Compare these two household types (as if these were two separate economies). How does the difference in marginal propensity to save impact the cumulative change in spending as a result of this increased government spending? (Answer: Type-2 households have a higher MPC than the Type-1 households (0.3 versus 0.1) and therefore have a higher multiplier (1.43 versus 1.11). If these households were in two separate economies, a \$50 billion increase in government spending would deliver a cumulative impact of \$71.43 billion for the Type-2 economy and \$55.56 billion for the Type-1 economy.)

7. To consider the interaction between household types, click on the tab entitled "Interacting MPC Values." What is the average (or expected) cumulative change in spending as a result of this increased government spending when different households can interact throughout the multiplier process? What is the maximum and minimum outcome that can be expected with 90% confidence? (Answer: The expected cumulative impact is \$62.54 billion. The minimum outcome that can be expected with 90% confidence is \$55.56 billion, which is close to the cumulative impact if only Type-1 households received the income. The maximum outcome that can be expected with 90% confidence is \$71.31 billion, which is close to the cumulative impact if only Type-2 households received the income. Note that since the upper bound of the simulation deals with high-MPC households, more spending rounds are required to reach the cumulative impact,

and each round has the potential to deliver the income to a low-MPC household. This is why the upper value might tend to be farther away from the maximum (high-MPC only) spending result than the lower value equaling the minimum (low-MPC only) spending result.)

B. Exercise 2: The 2009 American Recovery and Reinvestment (ARRA) Act

The ARRA Act was designed to save and create jobs, cushion the economic downturn of the 2008 Great Financial Crisis, and make crucial public investments. It authorized roughly $499 billion in federal government spending and $288 billion in federal tax cuts. While these numbers could readily fit into an analysis as $\Delta \mathrm{G}$ and $\Delta \mathrm{T}$, respectively, one should be careful. For example, these amounts were not one-time changes but were spread over time. Furthermore, the spending component was largely a stimulus to state and local governments, and some studies (e.g., Conley & Dupor, 2013) suggest that federal money for infrastructure projects were fungible and only replaced the funds local governments were planning to spend from their own budgets. These caveats aside, one can reference the ARRA when considering realistically large changes in fiscal policy in the hundred-billion range.

One important outcome of the ARRA is that it renewed interest in estimating the spending multipliers for the US economy. While many values for spending, tax, and transfer multipliers have been proposed in the literature, one set of estimates relevant for the application come from the Congressional Budget Office (CBO) (2012). The CBO used evidence from models and historical relationships to estimate multipliers for each of several categories of spending and tax provisions in the ARRA. They provided a range of values for each multiplier, and the individual values indicate the cumulative impact of policies on GDP over several quarters, assuming the Federal Reserve held short-term interest rates about as low as possible. This is the same assumption used in our multiplier application. While the complete set of multiplier estimates can be found in Table 2 of the CBO report, some key estimates are provided in the questions below.

1. In 2012, the CBO estimated the multiplier on the "purchases of goods and services by the federal government" to be between 1.5 and 3.5. Suppose the marginal tax rate is 20%, which is roughly in the middle of the 2012 range (from 10% to 35%), and assume a closed economy (i.e., $\mathrm{MPI} = 0$). Start the analysis with $\Delta \mathrm{G} = \Delta \mathrm{T} = 0$.

    a. Assuming only one household type, what value of MPC approximately delivers a multiplier that is as close as possible to the lower estimated value of 1.5? Set this as the MPC for Type-1 households. (Answer: approximately 0.33, which implies $\mathrm{MPS}_1 = 0.47$)

    b. Assuming only one household type, what value of MPC approximately delivers a multiplier that is as close as possible to the higher estimated value of 3.5? Set this as the MPC for Type-2 households (Answer: approximately 0.71, which implies $\mathrm{MPS}_2 = 0.09$)

    c. Suppose Type-2 households make up 25% of the population. What would be the estimated cumulative impact of a $100 billion increase in purchases of goods and services by the federal government (assuming these different households interact)? What range of cumulative impacts are possible with 90% confidence? (Answers: Estimated cumulative impact is approximately $173.93 billion. The 90% confidence range is approximately between $149.26 billion and $246.29 billion. Note that these numbers might slightly differ across repeated applications due to sampling.)

2. In 2012, the CBO estimated the multiplier on the "transfer payments to individuals" to be between 0.4 and 2.1. Suppose the marginal tax rate is 20%, which is roughly in the mid-

dle of the 2012 range (from 10% to 35%), and assume a closed economy (i.e., $\mathrm{MPI} = 0$). Start the analysis with $\Delta \mathrm{G} = \Delta \mathrm{T} = 0$.

a. Assuming only one household type, what value of MPC approximately delivers a multiplier that is as close as possible to the lower estimated value of 0.4? Set this as the MPC for Type-1 households. (Answer: approximately 0.28, which implies $\mathrm{MPS}_1 = 0.52$.)

b. Assuming only one household type, what value of MPC approximately delivers a multiplier that is as close as possible to the higher estimated value of 2.1? Set this as the MPC for Type-2 households (Answer: approximately 0.68, which implies $\mathrm{MPS}_2 = 0.12$)

c. Suppose Type-2 households make up 25% of the population. What would be the estimated cumulative impact of a $100 billion increase in transfer payments to individuals (assuming these different households interact)? What range of cumulative impacts are possible with 90% confidence? (Answers: Estimated cumulative impact is approximately $59 billion. The 90% confidence range is approximately between $38.89 billion and $132.22 billion. Note that these numbers might slightly differ across repeated applications due to sampling.)

3. In 2012, the CBO estimated the multiplier on a "two-year tax cut for lower and middle-income people" to be between 0.3 and 1.5, and the multiplier on a "two-year tax cut for higher-income people" to be between 0.1 and 0.6. Suppose the marginal tax rate is 20%, which is roughly in the middle of the 2012 marginal tax range (from 10% to 35%), and similar to the effective tax rate of 22.8%. Assume a closed economy (i.e., $\mathrm{MPI} = 0$). Start the analysis with $\Delta \mathrm{G} = \Delta \mathrm{T} = 0$.

   a. What value of MPC approximately delivers a multiplier that is as close as possible to the upper value of the estimated multiplier for lower and middle-income people (1.5)? Set this as the MPC for Type-1 households. (Answer: Approximately 0.6, which implies $\mathrm{MPS}_1 = 0.2$)

   b. What value of MPC approximately delivers a multiplier that is as close as possible to the upper value of the estimated multiplier for higher-income people (0.6)? Set this as the MPC for Type-2 households. (Answer: Approximately 0.37, which implies $\mathrm{MPS}_2 = 0.43$.)

   c. Given your answers to part a and b, does it seem reasonable that a household's MPC would depend upon their income level? Explain. (The general answer will be along the lines of a lower income would imply a higher likelihood of being budget constrained. An individual with a tighter budget constraint would spend more of an additional dollar of income, implying a higher MPC.)

   d. Consider the impact of a $10 billion lump-sum tax cut ($\Delta \mathrm{T} = 10$). However, instead of using the "% of Type-2 population" slider to indicate the proportion of the population that is a Type-2 household, we can also use it to determine how much of the tax cut goes to Type-2 households. Start with the slider at 50% (i.e., half of the tax cut goes to higher-income people) and see what happens to the average cumulative impact when you adjust this proportion. What proportion of the tax cut should go to high-income people (i.e., Type-2 households) if you want to maximize the cumulative impact of a tax cut? (Answer: None.)

C. Exercise 3: The 2020 Coronavirus Aid, Relief, and Economic Security (CARES) Act

The CARES Act was a $2.2 trillion economic stimulus bill signed into law on March 27, 2020, in response to the economic fallout of the COVID-19 pandemic. A primary feature of the bill was $300 billion in one-time transfers, where most single adults received $1,200, while families with dependents received more.

1. In a closed economy with no taxes and a single household type with $\mathrm{MPS}_1 = 0.65$, what is the cumulative change in spending as a result of these transfer payments? Why should we assume a relatively high MPS value when these payments were distributed? (Hint: compare the COVID lockdown to your normal daily life, were you able to do more or less activities where you spend money during the lockdown?) (Answer: Approximately $162 billion.)

2. These transfer payments were treated as a refundable tax credit, meaning that households did not have to pay taxes. However, suppose households faced a 15% tax rate on these transfer payments. How much would that reduce the multiplier effect? (Answer: The multiplier impact reduces to $75 billion as a result of the tax. The net decline is $87 billion.)

3. Instead of making transfer payments, suppose the government instead purchased goods and services totaling $300 billion. How does the cumulative impact of this policy change compare to your answer from Question 1? Why do they differ? Explain. (Answers: Since the government spending multiplier of 1.54 is larger than the tax / transfer multiplier of 0.54, it can easily be shown that the impact would be larger - $462 billion compared to $162 billion.)