Using Causal Diagrams to Teach Macroeconomics

Supporting Materials

March 16, 2025

Appendix A: Activity 1 – The national income model, Questions

These are multiple-choice questions for Activity 1. Students were asked to answer these questions twice, before and after the causal diagram of the national income model was introduced. Correct answers are presented in bold.

Date _____ Team #_____

Team Members:

_____ _____

_____ _____

Q1: Assuming in the short-term that labor and capital employed in the economy remain constant, the wide adoption of AI, which is a technological innovation, is likely to have the following effect on consumption in the short term.

a) Consumption will increase
b) Consumption will decrease
c) AI will have no effect on consumption
d) This effect cannot be determined
e) I have no idea

Q2: An increase in government purchases is likely to have the following effect on the interest rate.

a) Increase
b) Decrease
c) Have no effect
d) Cannot be determined
e) I have no idea

Q3: A higher interest rate is likely to have the following effect on private savings.

a) Increase
b) Decrease
c) Have no effect
d) Cannot be determined
e) I have no idea

Appendix B: Activity 2 - The government-purchases multiplier

This appendix includes the forms that were distributed to students during the structural debriefing of the multiplier effects.

FORM 1
Government-purchases multiplier

Date: _____ Instructor _____
Team # _____ Course: _____

Team Members:

_____ _____
_____ _____

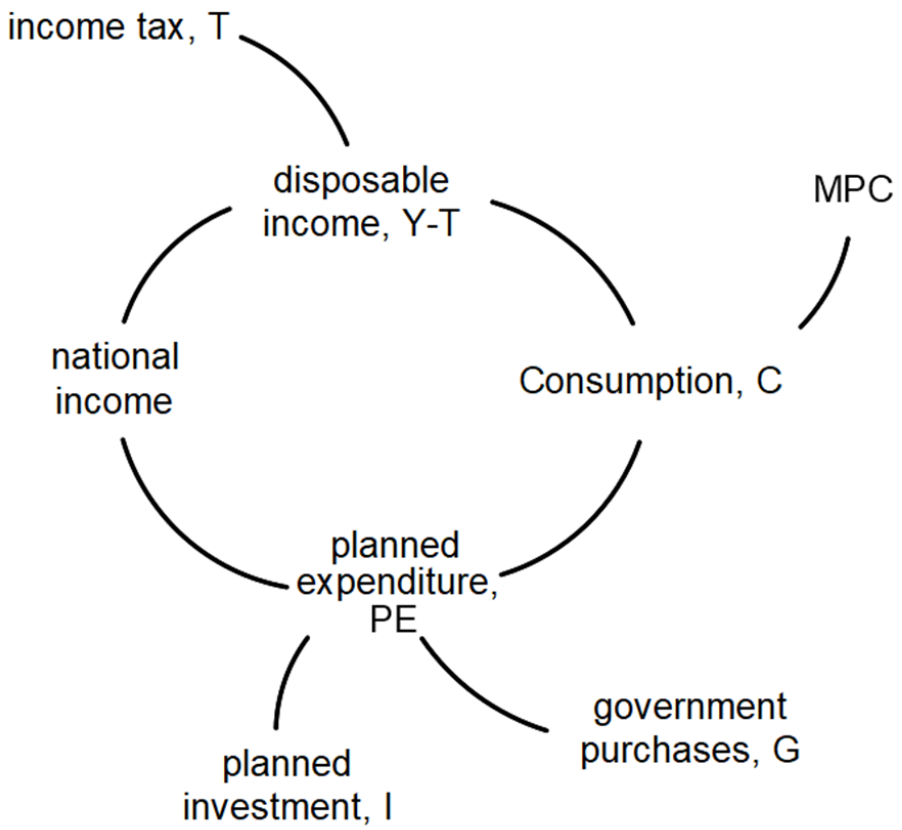
Please read the following quotes from Mankiw' Macroeconomics (9th ed) that explain the nature of the government-purchases multiplier (pp. 314-317):

> *Assuming that the economy is closed, so that net exports are zero, we write planned expenditure PE as the sum of consumption C, planned investment I, and government purchases G:*
>
> $$PE = C + I + G$$

> ***An Increase in Government Purchases in the Keynesian Cross**: An increase in government purchases of raises planned expenditure by that amount ….*
> *(Source: caption for Figure 11-5, p. 317).*

> *…according to the consumption function $C = C(Y - T)$, higher income causes higher consumption. When an increase in government purchases raises income, it also raises consumption, which further raises income, which further raises consumption, and so on. Therefore, in this model, an increase in government purchases causes a greater increase in income.*
>
> *How big is the multiplier? To answer this question, we trace through each step of the change in income. The process begins when expenditure rises by ΔG, which implies that income rises by ΔG as well. This increase in income in turn raises consumption by $MPC \times \Delta G$, where MPC is the marginal propensity to consume. This increase in consumption raises expenditure and income once again. This second increase in income of $MPC \times G$ again raises consumption, this time by $MPC \times (MPC \times \Delta G)$, which again raises expenditure and income, and so on. This feedback from consumption to income to consumption continues indefinitely.*

Instructions: Using the provided text, complete the 'causal skeleton' graph that explains the mechanism of the government-purchases multiplier. Show causal directions and causal polarities of the edges. Positive causal relationships between variables are drawn as positive arrows. Negative links show inverse causal relationships. Please also identify the polarity of the feedback loop. Is it a positive (reinforcing) or negative (balancing) feedback loop?



Appendix C: Activity 3 – The tax multiplier

FORM 2
Tax multiplier

Date: _____ Instructor _____
Team # _____ Course: _____

Team Members:

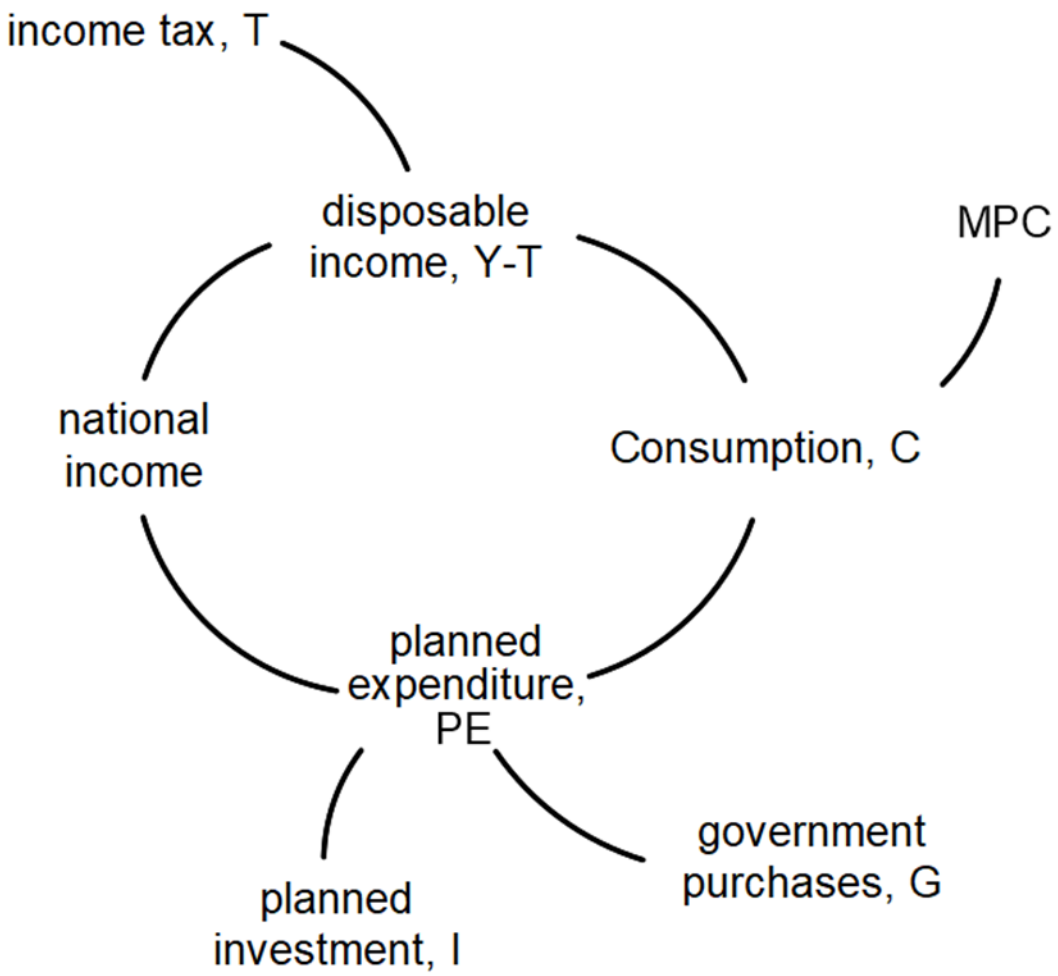
_____ _____
_____ _____

Please read the following quote from Mankiw's Macroeconomics (9th ed) that explains the nature of the tax multiplier (pp. 318-319):

> *A decrease in taxes of ΔT immediately raises disposable income $Y - T$ by ΔT and, therefore, increases consumption by $MPC \times \Delta T$. For any given level of income Y, planned expenditure is now higher… Just as an increase in government purchases has a multiplied effect on income, so does a decrease in taxes. As before, the initial change in expenditure, now $MPC \times \Delta T$, is multiplied by $1/(1 - MPC)$.*

Instructions:

1. Using the above text, complete the graph below that explains the mechanism of the tax multiplier. Show causal directions and causal polarities of the edges. Positive causal relationships between variables are drawn as positive arrows. Negative links show inverse causal relationships. Please also identify the polarity of the feedback loop. Is it a positive (reinforcing) or negative (balancing) feedback loop?
2. Use the causal diagram to explain the tax multiplier effect of a decrease in taxes, ΔT.


income tax, T
disposable income, Y-T
MPC
national income
Consumption, C
planned expenditure, PE
government purchases, G
planned investment, I

Appendix D: Form 3 – Questionnaire

FORM 3
G & T multipliers

Date: _____ Instructor _____
Name: _____ Course: _____

Now that you've reviewed the government purchases multiplier and the tax multiplier, please answer the following questions.

1. Are there any **similarities** between the economic structures that are responsible for the government purchases multiplier and the tax multiplier?

2. Are there any **differences** between the economic structures that are responsible for the government purchases multiplier and the tax multiplier?

3. Were the causal diagrams helpful in understanding the multiplier effects? Please elaborate.

4. Did you find any part of the activity with causal diagrams confusing?

5. Do you think you can apply the causal diagrams approach to explain situations that you face at work, at home, read about in the news, etc.? Can you provide an example?

Appendix E: Instructor Manual

Instructor Manual

Version: 2.0
October 22, 2024

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This is an activity called "structural debriefing" [1] that visualizes the logical structure of the models presented in Mankiw's Macroeconomics. In this analysis, we're not arguing whether or not the models presented in Mankiw's Macroeconomics are accurate.

Note: all the pages refer to Mankiw's Macroeconomics, 9th edition.

In this section we conduct structural debriefing of the Mankiw explanations for government-purchase multiplier and tax multiplier.

Government Purchases-Multiplier

Mankiw explains the multiplier effects. First, Mankiw defines planned expenditure (p. 314):

> *Assuming that the economy is closed, so that net exports are zero, we write planned expenditure PE as the sum of consumption C, planned investment I, and government purchases G:*
>
> $$PE = C + I + G$$

Then Mankiw makes the following observation:

> ***An Increase in Government Purchases in the Keynesian Cross**: An increase in government purchases of ΔG raises planned expenditure by that amount …. (Source: caption for Figure 11-5, p. 317).*

Here is a quote from Mankiw (p. 317) that explains the government-purchases multiplier model:

> *…according to the consumption function $C = C(Y - T)$, higher income causes higher consumption. When an increase in government purchases raises income, it also raises consumption, which further raises income, which further raises*

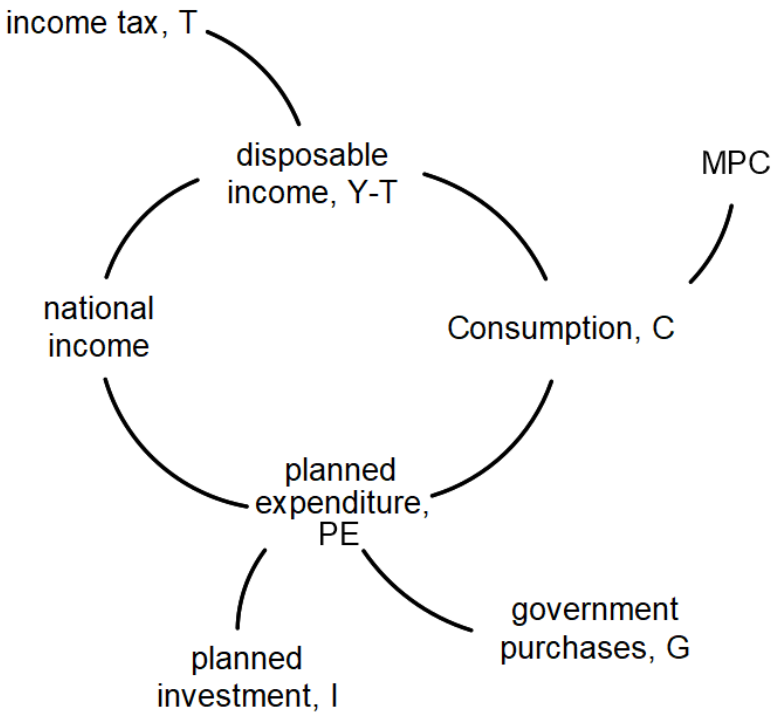
[1] Pavlov, O. V., K. Saeed and L. W. Robinson (2015). "Improving Instructional Simulation with Structural Debriefing." Simulation & Gaming 46(3-4): 383-403.

consumption, and so on. Therefore, in this model, an increase in government purchases causes a greater increase in income.

How big is the multiplier? To answer this question, we trace through each step of the change in income. The process begins when expenditure rises by ΔG, which implies that income rises by ΔG as well. This increase in income in turn raises consumption by $MPC \times \Delta G$, where MPC is the marginal propensity to consume. This increase in consumption raises expenditure and income once again. This second increase in income of $MPC \times \Delta G$ again raises consumption, this time by $MPC \times (MPC \times \Delta G)$, which again raises expenditure and income, and so on. This feedback from consumption to income to consumption continues indefinitely.

Task

Form student teams. Ask each team to complete the graph in Figure 1, which is called a "causal skeleton"[2], using the description above from Mankiw. Show causal directions between variables by adding arrow heads to the edges. Indicate whether the causal relationships are positive (show a plus, +) or negative (show a minus, -). Please also identify the feedback loop and its polarity. Is it a positive (reinforcing) or negative (balancing) feedback loop?



[2] The causal skeleton is an undirected graph that shows causal relationships between variables.

Figure 1: Causal skeleton that shows the logic of the government-purchases multiplier.

Solution

The solution to the above question is shown in Figure 2. There is only one inverse relationship between taxes and disposable income. All other causal relationships are positive. Since there are only positive arrows in the loop, the feedback loop is reinforcing, which is shown by placing a plus sign in the center of the loop. A curved arrow shows the direction of the feedback loop.

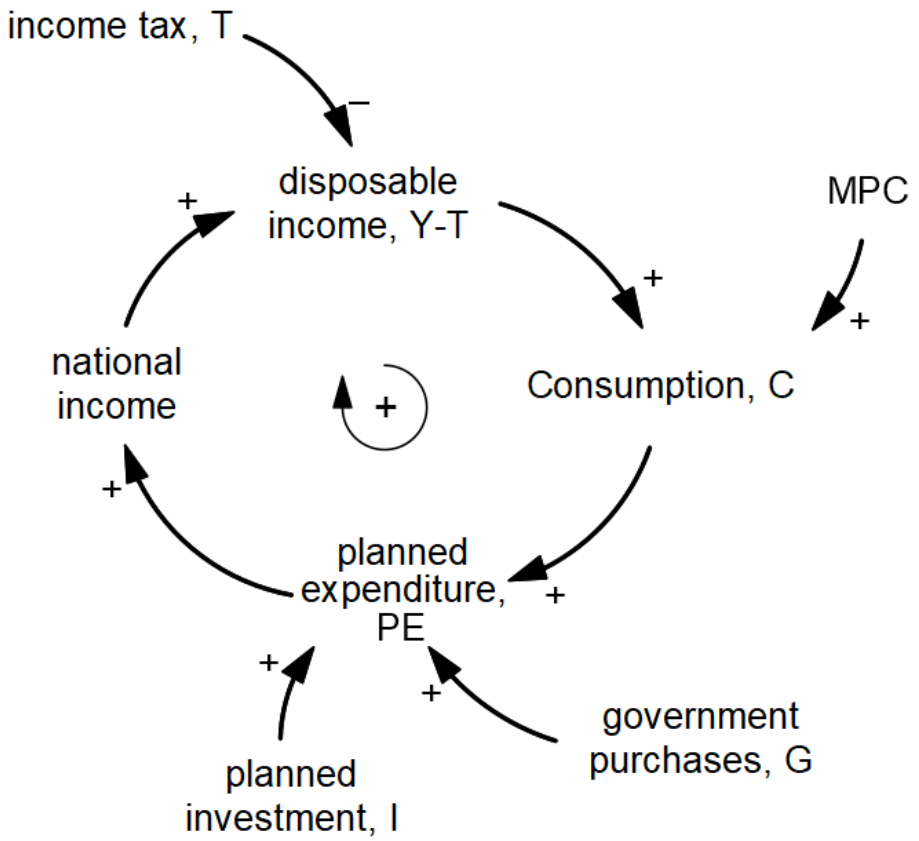


Figure 2: Causal diagram that shows the logic of the government-purchases multiplier. This figure corresponds to the causal skeleton in Figure 1.

Figure 3 explains how the initial increase in government purchase ΔG can be traced around the loop as it adds to the consumption smaller amounts with each iteration. Start the analysis by imaging that government purchases increase by ΔG. The size of each red arrow indicates the relative increase of the variable value during an iteration around the feedback loop. Note that during the first iteration,

C increases by MPC x ΔG, which is less that ΔG; therefore, the first consumption arrow is shorter than the arrow for ΔG next to the variable government purchases.

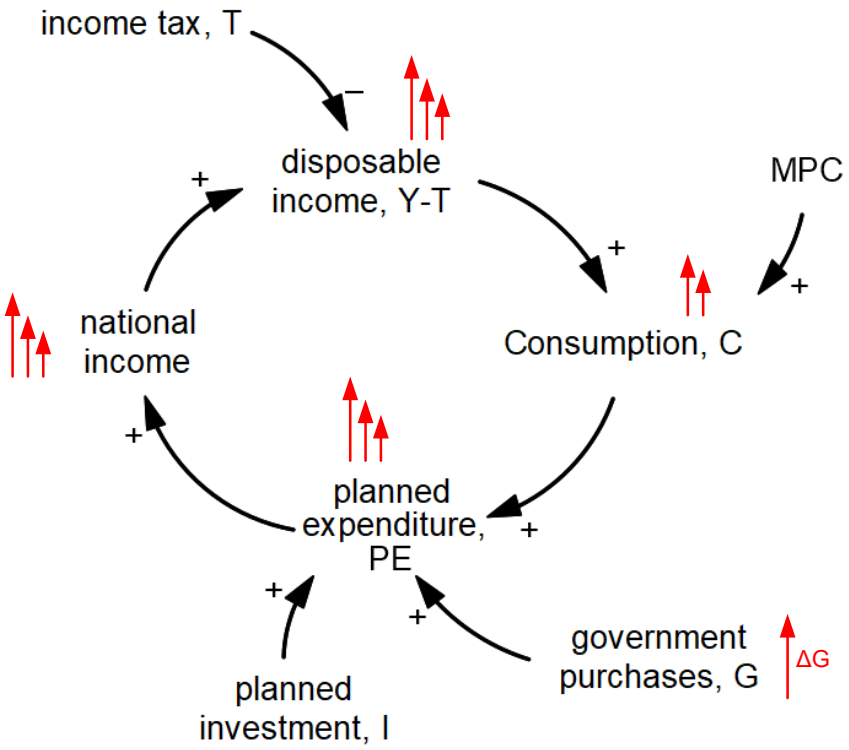


Figure 3: Government purchases-multiplier effect.

Confirm Mankiw's (p. 317) explanation of the total effect on **national income**, ΔY, that is

Initial Change in Government Purchases	= ΔG
First Change in Consumption	= MPC x ΔG
Second Change in Consumption	= MPC^2 x ΔG
Third Change in Consumption	= MPC^3 x ΔG
.	.
.	.
.	.

ΔY = (1 + MPC + MPC^2 + MPC^3 +...) ΔG

Then, the **government-purchases multiplier** is:

ΔY / ΔG = (1 + MPC + MPC^2 + MPC^3 +...) ΔG / ΔG
= 1 + MPC + MPC^2 + MPC^3 +... *an infinite geometric series*

= 1 / (1 – MPC)

Tax Multiplier

The above graphs can also be used to explain the logic of the tax multiplier. Here is a quote from Mankiw's Macroeconomics (9th ed) that explains the nature of the tax multiplier (pp. 318-319):

> *A decrease in taxes of ΔT immediately raises disposable income $Y - T$ by ΔT and, therefore, increases consumption by $MPC \times \Delta T$. For any given level of income Y, planned expenditure is now higher… Just as an increase in government purchases has a multiplied effect on income, so does a decrease in taxes. As before, the initial change in expenditure, now $MPC \times \Delta T$, is multiplied by $1/(1 - MPC)$.*

Task

Ask the teams that have been formed earlier to fill out the causal skeleton in Figure 4. It is identical to the causal skeleton in Figure 2 since the tax multiplier works the same way as a government purchase injection.

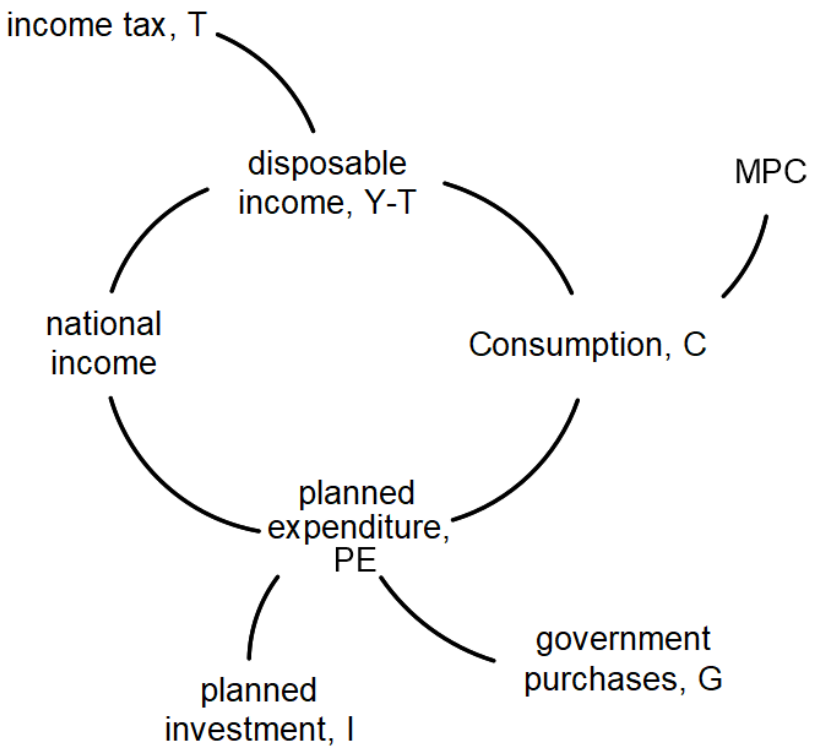


Figure 4: Causal skeleton that shows the logic of the government-purchase multiplier.

Solution

The tax multiplier mechanism is shown in Figure 5. It is identical to the government-purchase multiplier mechanism in Figure 2.

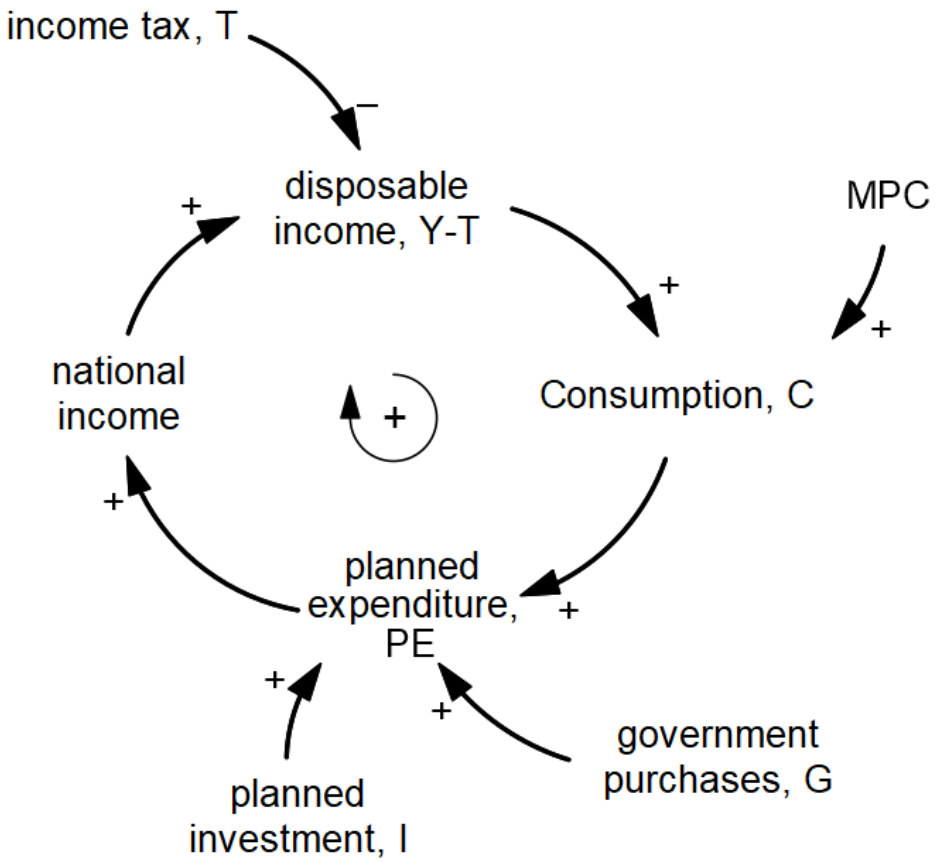


Figure 5: Causal diagram that shows the logic of the tax multiplier.

Figure 6 explains the tax multiplier effect of a tax decrease. A decrease in taxes, ΔT, increases the disposable income by ΔT, which increases consumption and planned expenditure by $MPC \times \Delta T$. The second increase in consumption and planned expenditure is $MPC \times (MPC \times \Delta T)$.

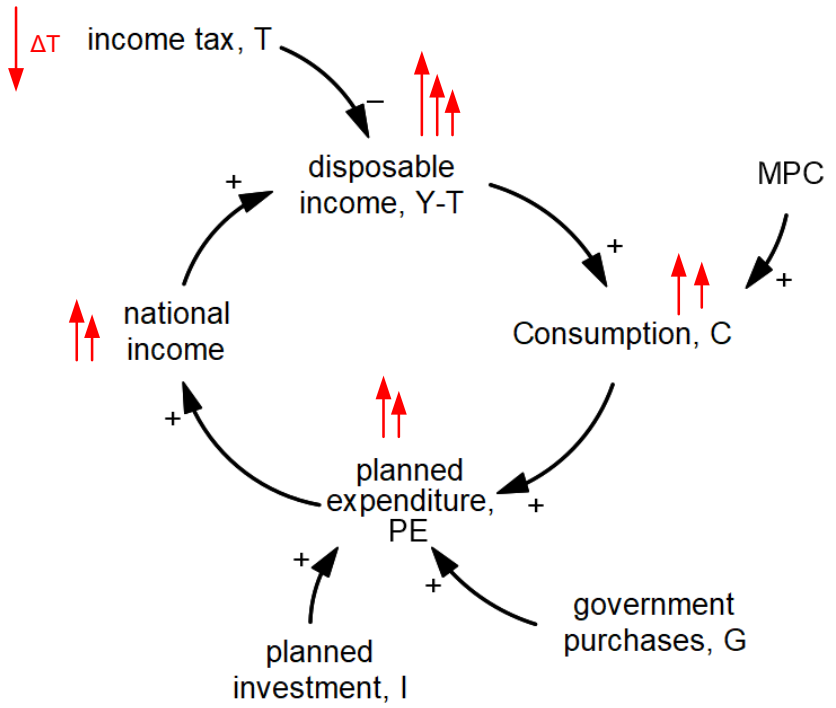


Figure 6: The tax-multiplier effect following a decrease in taxes, ΔT.

The total effect on **national income**, ΔY, is

Change in Taxes	$=-\Delta T$
Change in Disposable Income	$=\Delta T$
First Change in Consumption	$=MPC \times \Delta T$
Second Change in Consumption	$=MPC^2 \times \Delta T$
Third Change in Consumption	$=MPC^3 \times \Delta T$
.	.
.	.
.	.

$$\Delta Y = (MPC + MPC^2 + MPC^3 + \ldots)\,\Delta T$$

The **tax multiplier** is:

$$\Delta Y / \Delta T = (MPC + MPC^2 + MPC^3 + \ldots)\,\Delta T / \Delta T$$

$$= MPC + MPC^2 + MPC^3 + \ldots \quad \textit{an infinite geometric series}$$

$$= MPC\ (\ 1 + MPC + MPC^2 + MPC^3 + \ldots\ )$$

$$= MPC\ (\ 1\ /\ (1 - MPC\ )\ )$$

$$= MPC\ /\ (1 - MPC\ )$$

Possible modifications

Option 1

The two tasks above can be performed independently as two activities.

Option 2

Because the two tasks are very similar, a possible way to cover the material about the multipliers is to split the class into teams, and then ask some teams to analyze the government-purchases multiplier and the other teams can analyze the tax multiplier. Then the instructor can ask the teams to compare notes and discuss how the mechanisms of those multipliers are similar and how they are different. Below we show the similarities and differences:

Similarities in the analysis:

- The same economic structure is responsible for both multipliers: directions of causal relationships and polarities between variables are the same in both cases (Figure 2 and Figure 5 are identical).
- In both cases, there is a positive feedback loop (the same reinforcing loop in Figure 2 and Figure 5).

Differences in the analysis:

- In Figure 3, government purchases increase by ΔG and then planned expenditure increase by the same amount ΔG.
- In Figure 6, taxes decrease by ΔT, but then disposable income increases by same amount ΔT.