

# Economic Dynamics

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*Professor, NaUKMA*

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Lecture 2: Simplified 3-Equation Model

September 23, 2021

*Professor  
ISM University, Lithuania*

*Professor  
Virginia Western College, USA*



UNIVERSITETET I BERGEN

System Dynamics Group

# Lectures: Thursdays, 16:30-17:30



|                |  |  |
|----------------|--|--|
| Sep 16         | Introduction to Dynamic Modeling         |  |
| <b>Sep 23</b>  | <b>Simplified 'Three-Equation Model'</b> |  |
| Sep 30         | Add Money to the Model                   |  |
| Oct 7          | Monetary Policy: Exogenous Friedman Rule |  |
| Oct 14         | Monetary Policy: Endogenous Taylor Rule  |  |
| Oct 18-27      | — autumn break —                         |  |
| Oct 28         | Add Banking Sector to the Model          |  |
| Nov 4          | Add Central Bank to the Model            |  |
| Nov 11         | Add Foreign Sector to the Model          |  |
| Nov 18         | Review & Test of the Model               |  |
| Nov 19- Dec 16 | Study for Final Exam                     |  |

lab dates to be announced, by **Alina Novik** and **Marianna Oliskevych**

# Assignments due before next lab



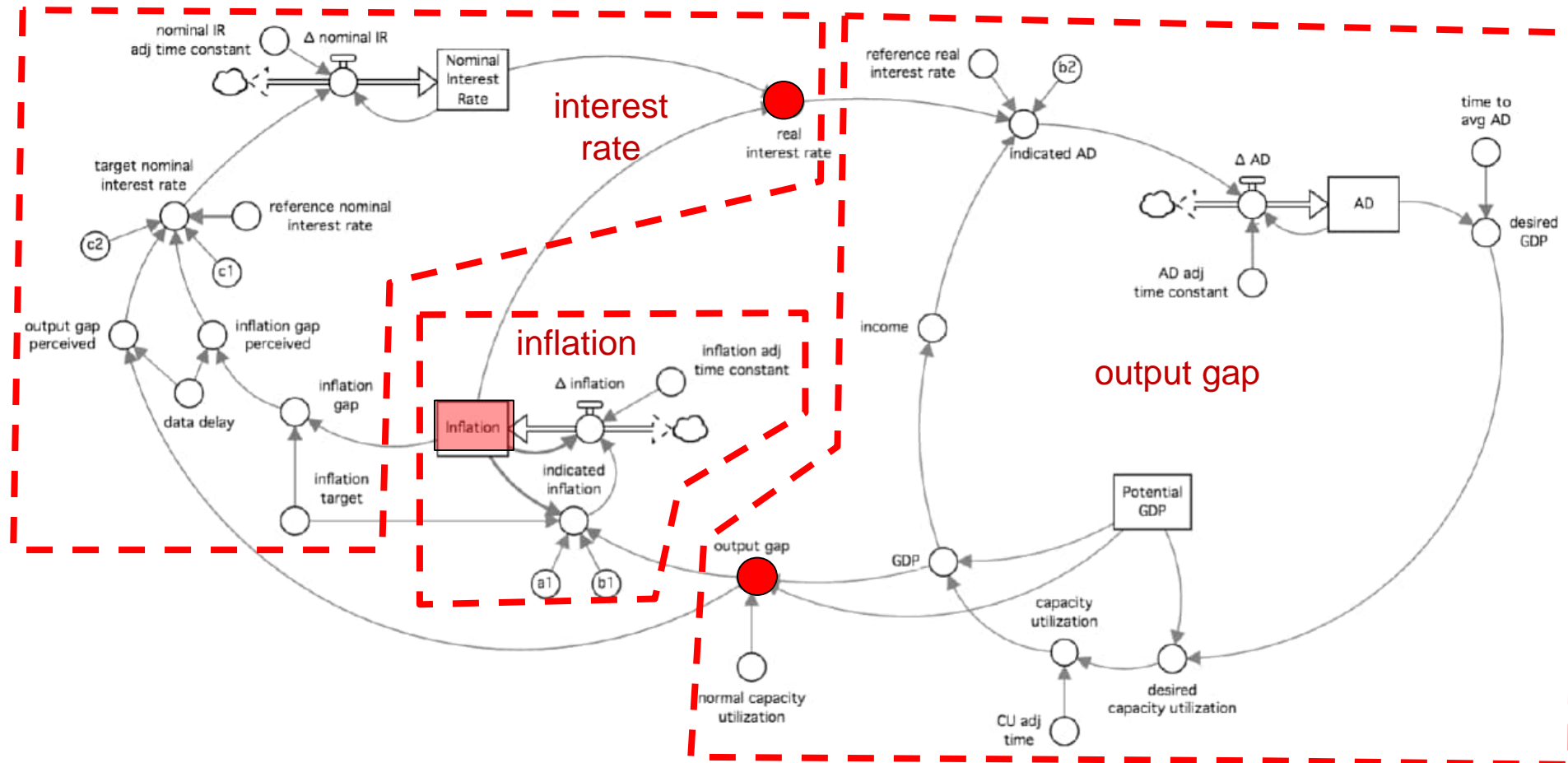
1. Play the Game <https://exchange.iseesystems.com/public/david-wheat/edsetmp1>
  2. (a) Play with our Model. (b) Add text to the three stories.
  3. Be prepared to discuss your assignments.
  4. Practice with *Stella*.
- 

Send all written assignments to Alina (NaUKMA), Marianna (LNU), and me  
[novikaj@ukma.edu.ua](mailto:novikaj@ukma.edu.ua)   [olisk@ukr.net](mailto:olisk@ukr.net)   [david.wheat@uib.no](mailto:david.wheat@uib.no)

\*Use this format for file names:  
LastNameFirstName YYMMDD     e.g., HarrisEmmylou 210916

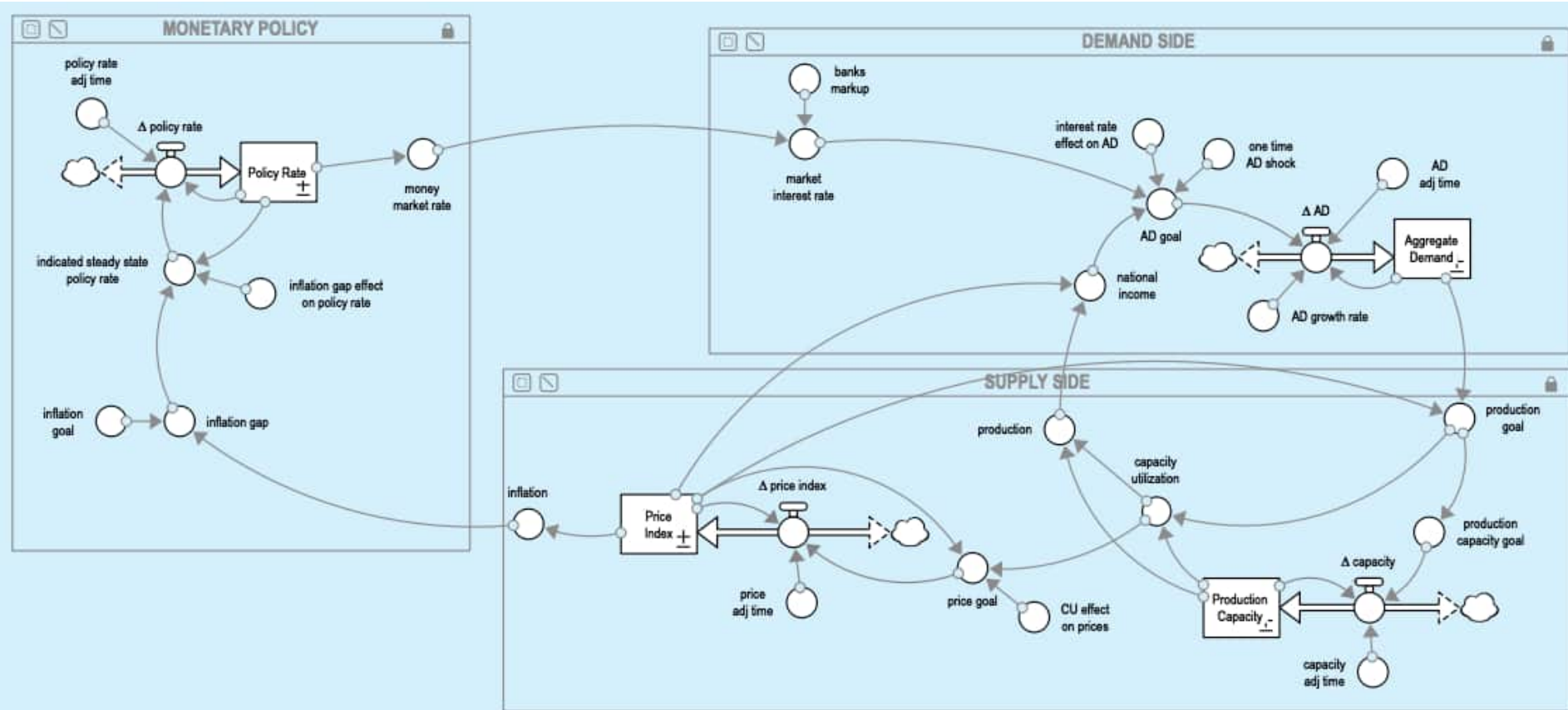
zip all files before emailing

# So-called '3 Equation' Model\*



\* Wheat & Orlishevych (2018) The Canonical New Keynesian Monetary Policy Model: A System Dynamics Translation (2018 International System Dynamics Conference)

# Simpler Model Divided into Sectors





aggregate  
demand



+

GDP



-

output  
gap

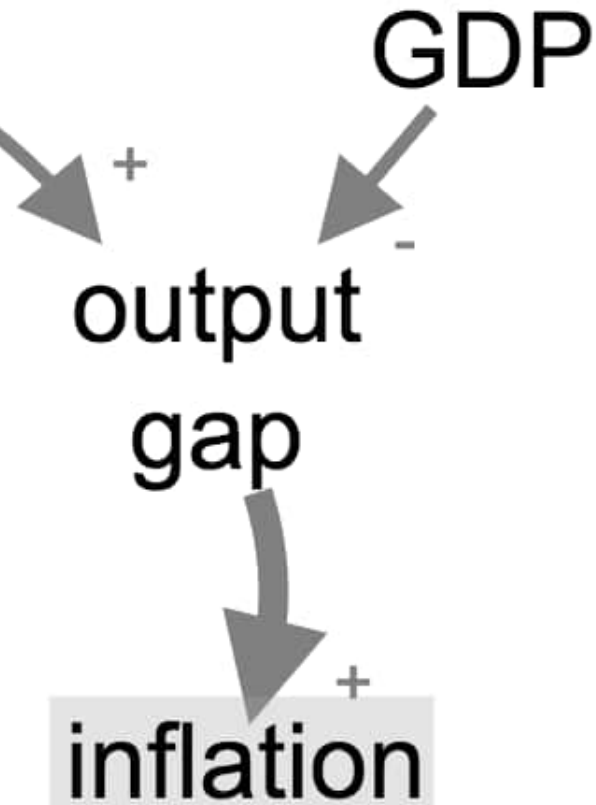
## definition

When  $AD > GDP$ , the output gap is positive; i.e., aggregate demand exceeds aggregate supply. If GDP increases, that will reduce the gap, but that will take time.

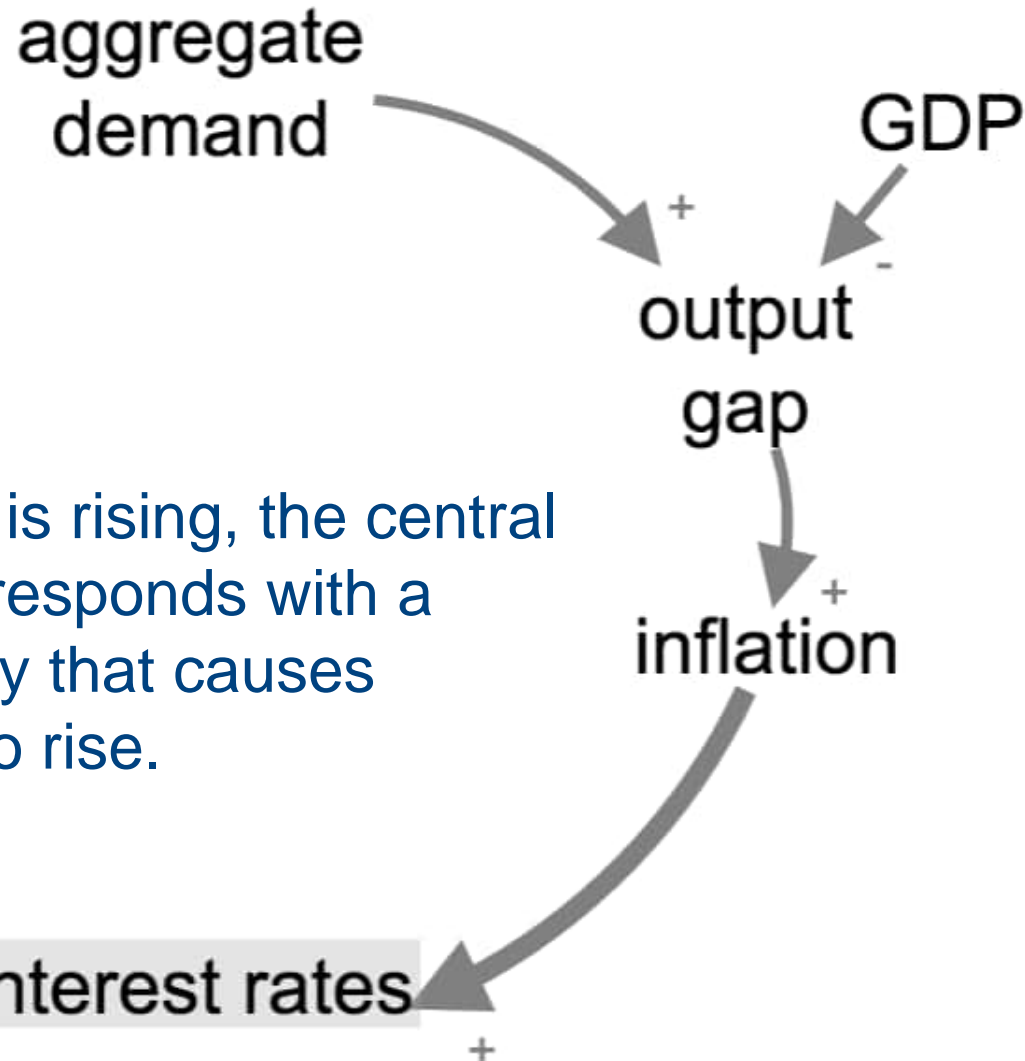
aggregate  
demand

**hypothesis:**

An increase in the output gap means that demand is growing faster than supply, which puts upward pressure on prices. Inflation is the annual percentage increase in the price index.



# Feedback Perspective on 3-Equation Model



## hypothesis:

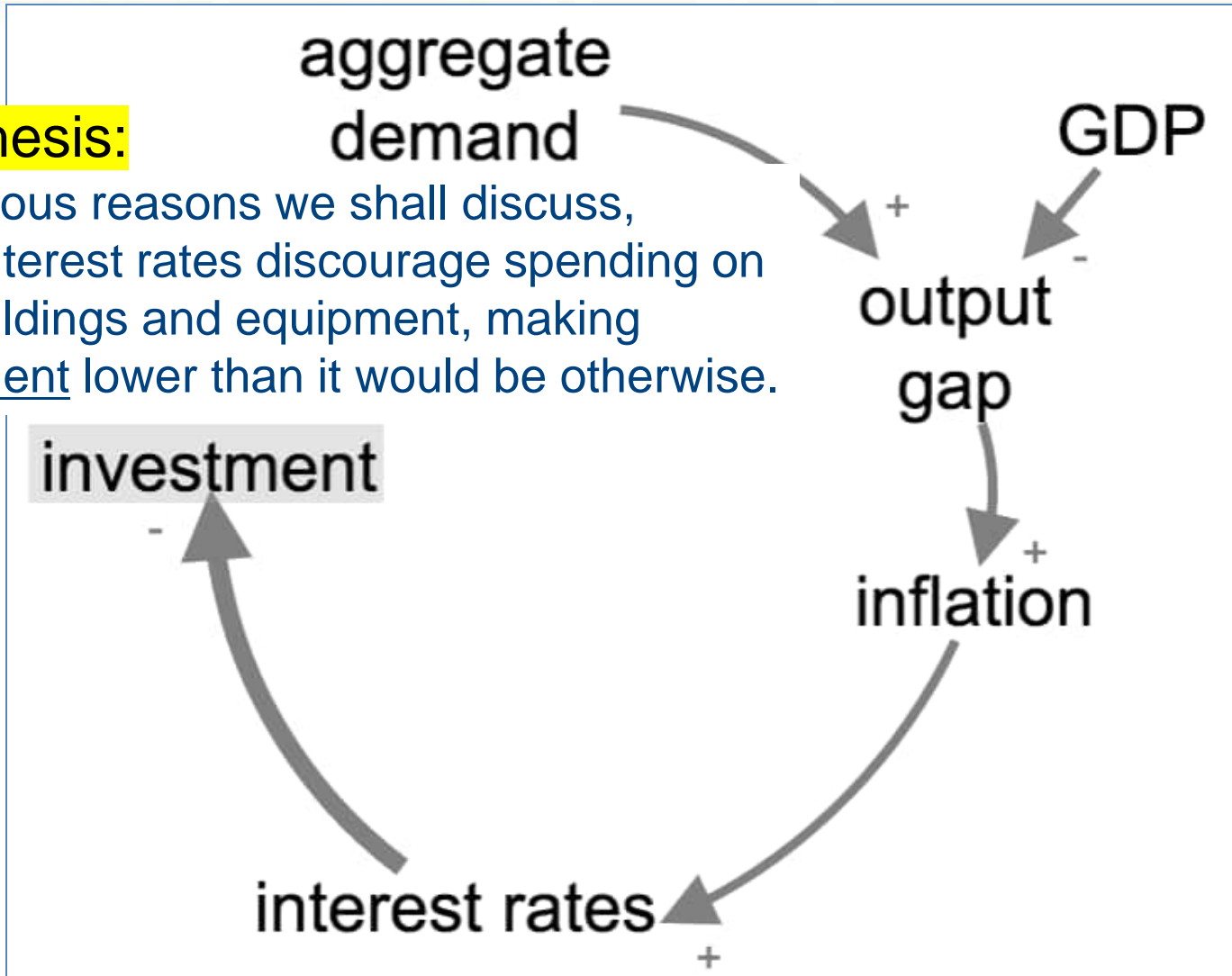
When inflation is rising, the central bank typically responds with a monetary policy that causes interest rates to rise.

# Feedback Perspective on 3-Equation Model



## hypothesis:

For various reasons we shall discuss, rising interest rates discourage spending on new buildings and equipment, making investment lower than it would be otherwise.

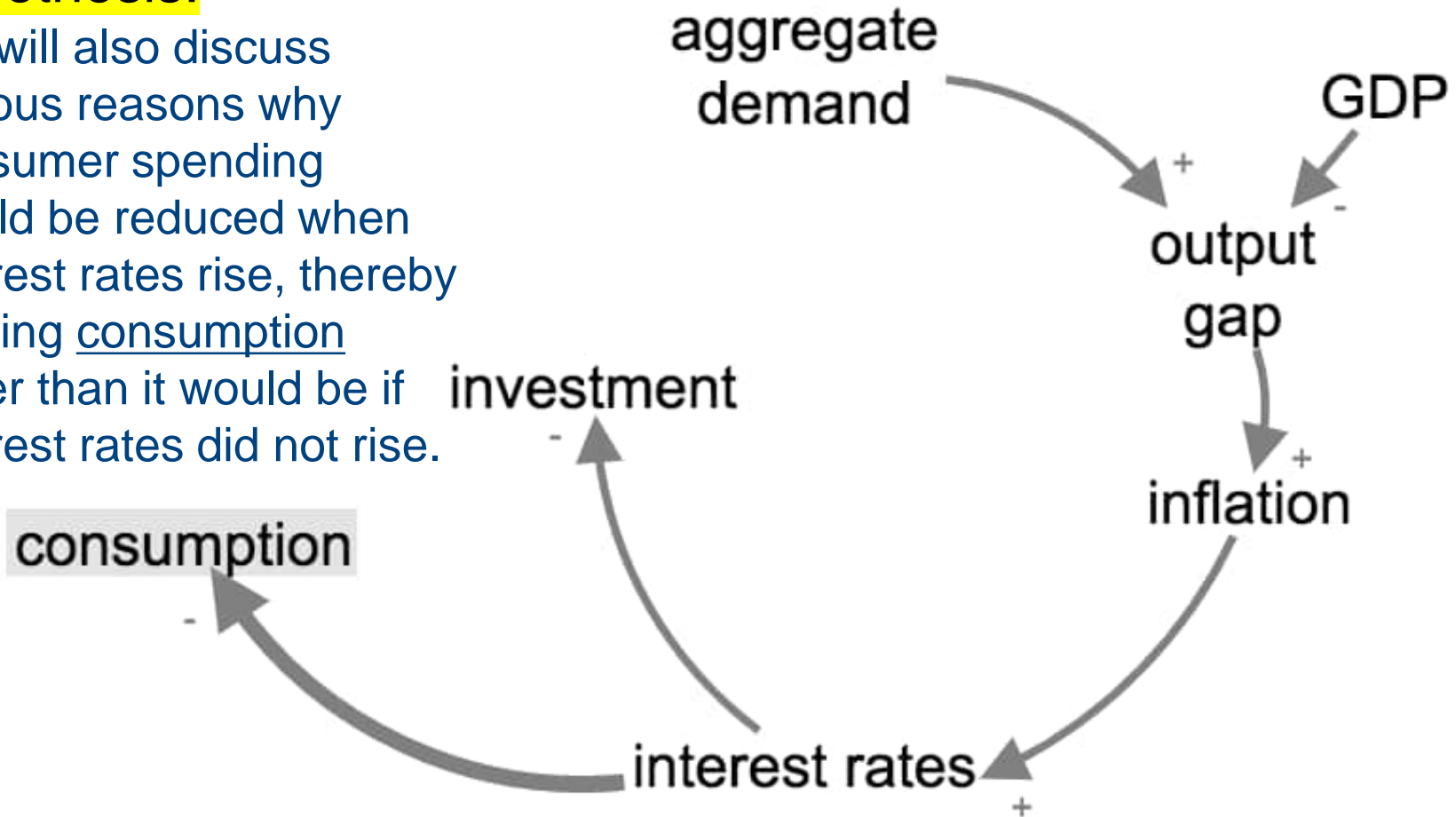


# Feedback Perspective on 3-Equation Model



## hypothesis:

We will also discuss various reasons why consumer spending would be reduced when interest rates rise, thereby making consumption lower than it would be if interest rates did not rise.

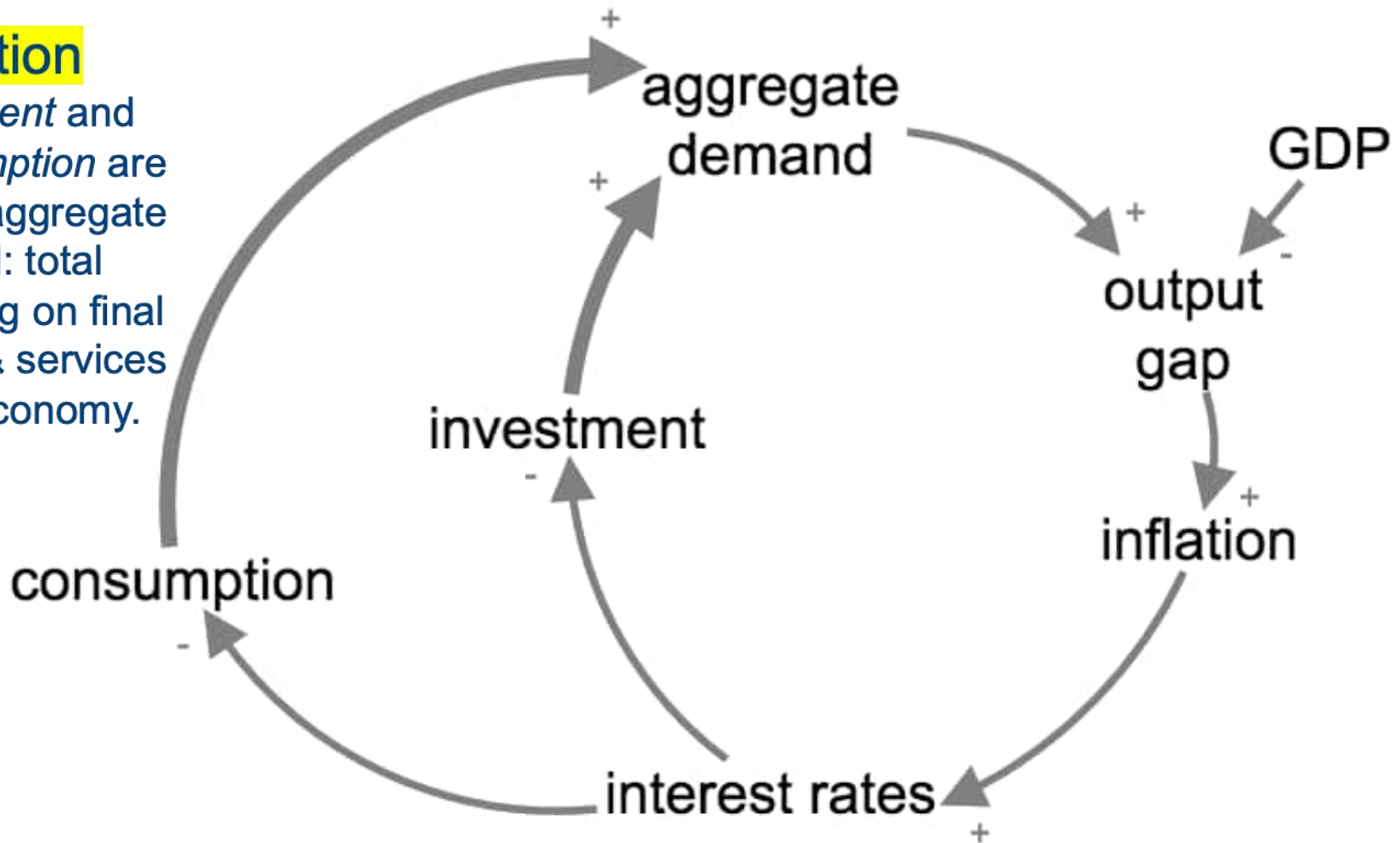


# Feedback Perspective on 3-Equation Model

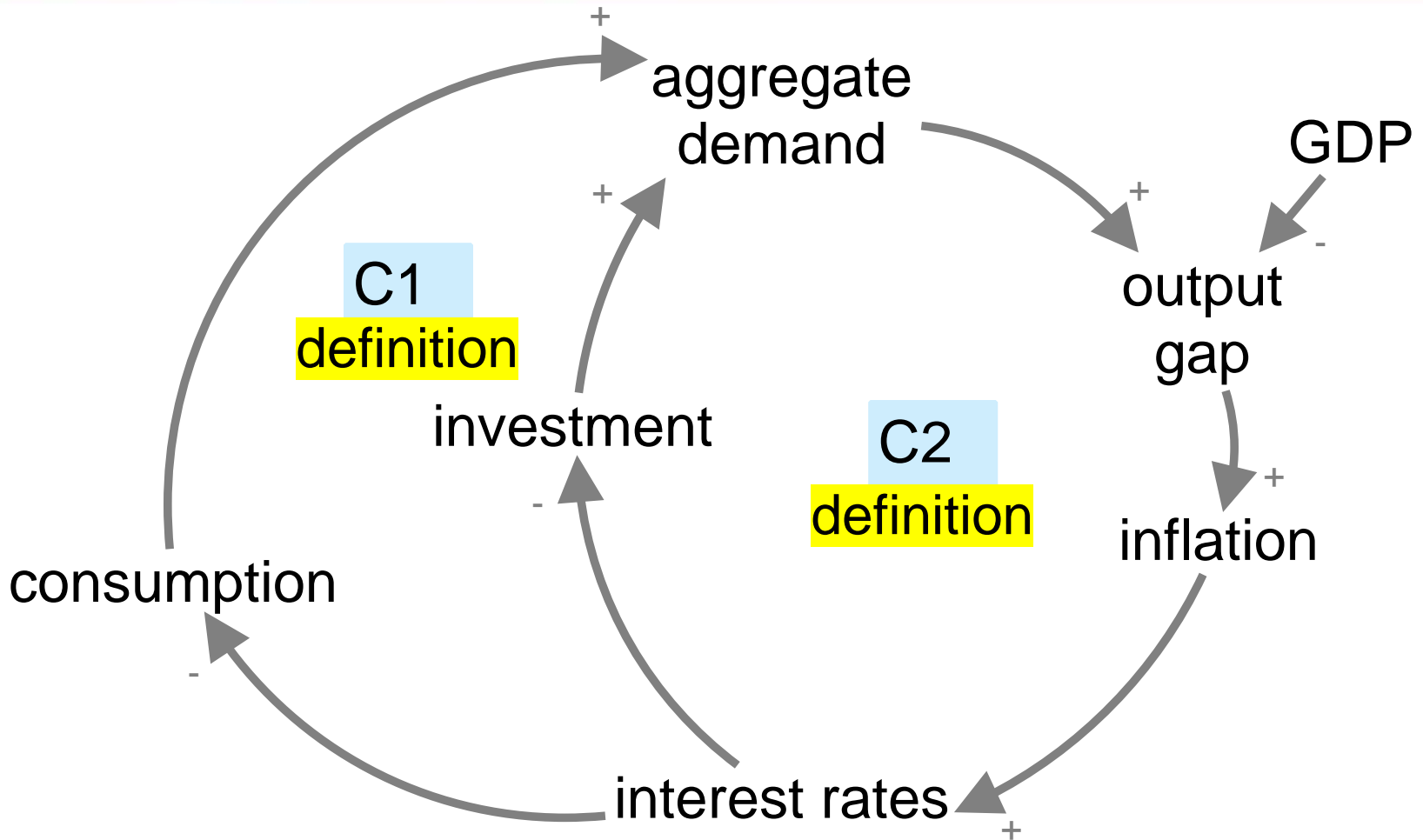


## Definition

*Investment and Consumption are part of aggregate demand: total spending on final goods & services in the economy.*

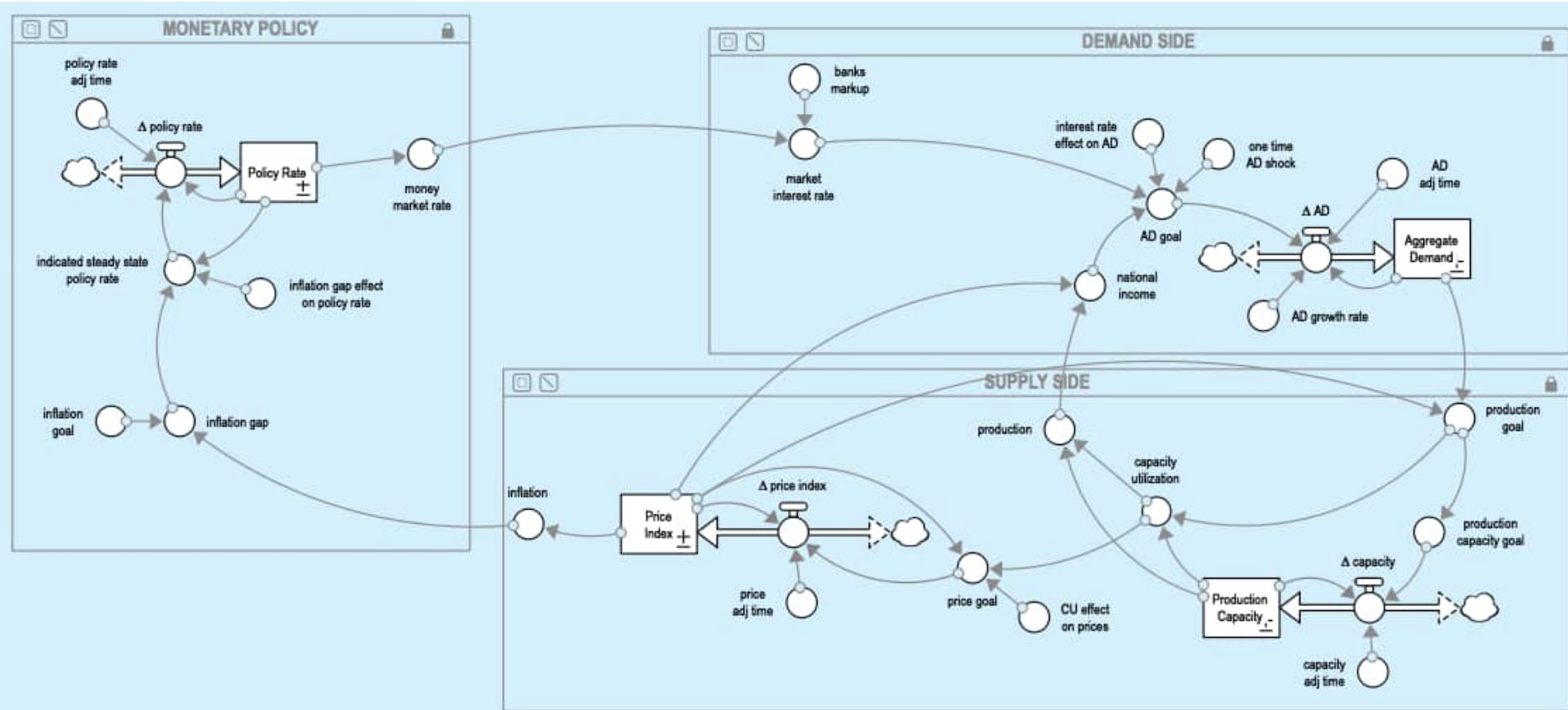


# Feedback Perspective on 3-Equation Model





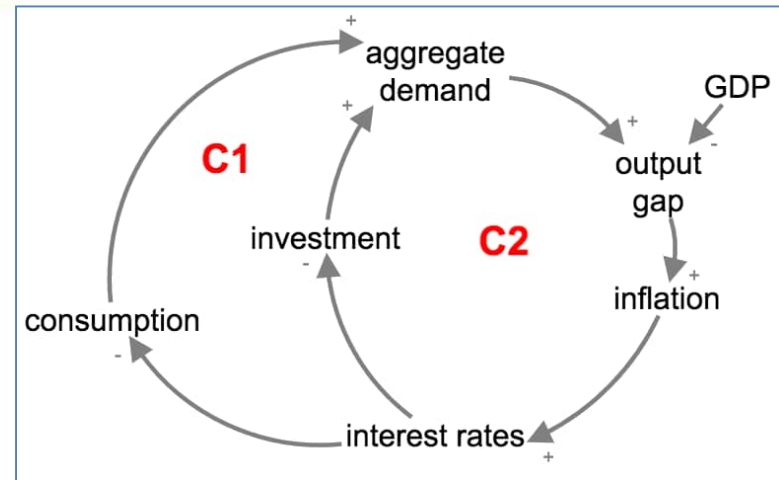
# Let's Write a Story About Each Sector



## Combining the Hypotheses:

Two negative ('counteracting') feedback loops are visible. Here's how the loops work:

- When AD starts rising faster than GDP, the output gap increases and puts upward pressure on prices.



- A rise in inflation triggers monetary policy that raises interest rates.
- When consumption and investment decrease due to rising interest rates, AD decreases and that reduces the output gap and reduces price pressures in the economy.
- When monetary policy responds to conditions in the economy and, in turn, affects those conditions, we call it an '**endogenous**' policy.

# Simulation Game

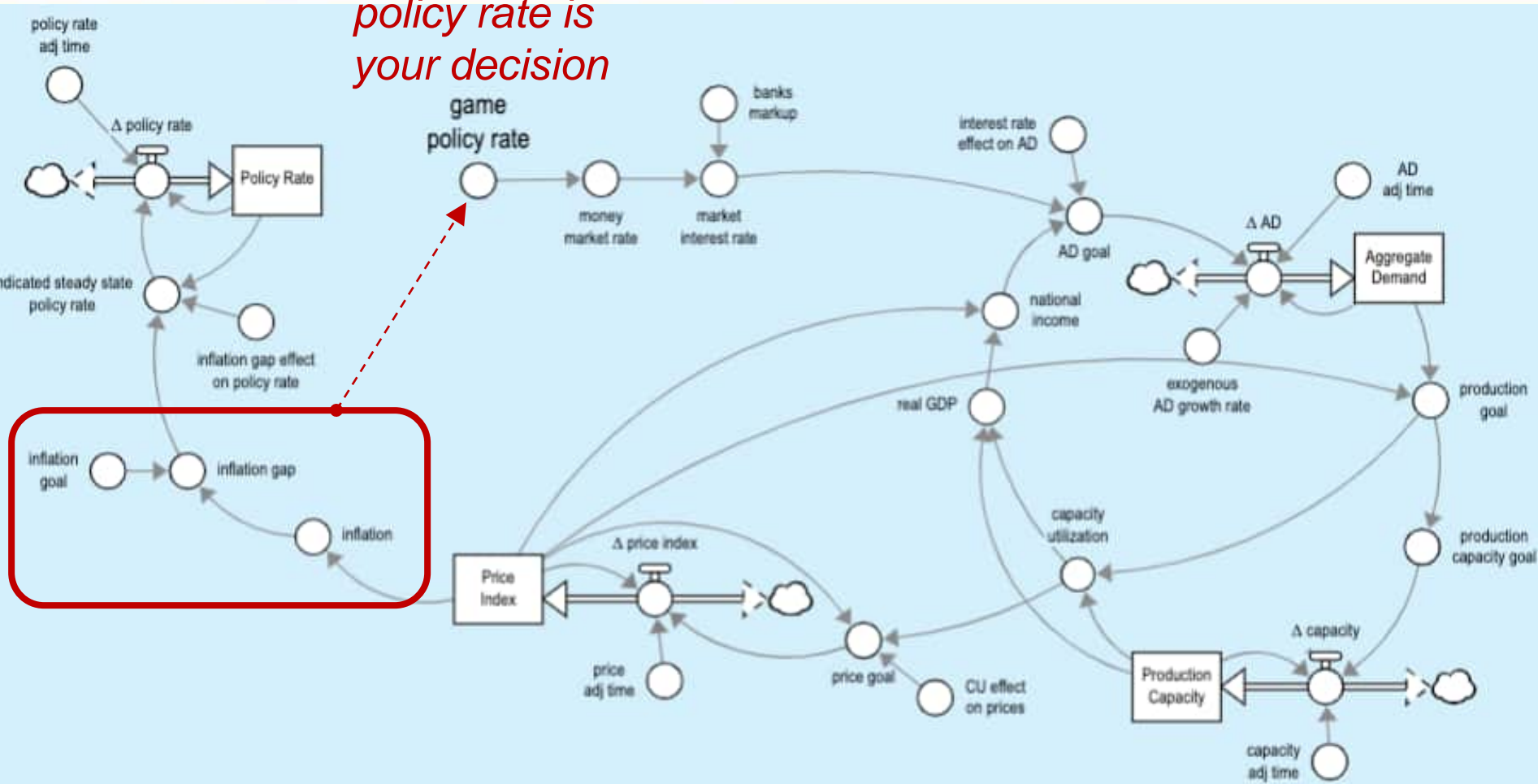


- *You will play the role of central bank leader.*
- *Your policy goal is low & stable inflation.*
- *You will*
  - *review the economic conditions after each quarter and*
  - *decide what the policy rate should be during the next quarter.*
- *In Task 1, you will have about 5 minutes to play the game.*  
*(in the homework assignment, you can work in groups of 2-3 and take as much time as you need to 'do your best.')*

# Model Structure behind Simulation Game



*policy rate is your decision*



*In Task 1, you will have about 5 minutes to play the game.*

After the simulation begins in 2025, inflation is low (but rising).  
In the first task, there are no shocks after the simulation begins. Other tasks are more challenging.

Click 'PLAY' to run the simulation. Each quarter, you will review the economic conditions and decide whether to change the Policy Rate. You have three options: raise it, lower it, or no change. After you decide, click 'PLAY' again. Repeat until the simulation ends (2035).

*tasks 2 & 3*

Do each task several times, and take a screenshot of your results each time.  
Then, for each task, pick you 'best' results and email that screenshot to Marianna, Alina, and David.

- In the email,
- (1) Write your name (or names, if you are part of a team).
  - (2) Explain the strategy you used in your 'best' game.

Click here for information about the Tasks

Select your Task:

1    2    3

Set the Policy Rate:

2

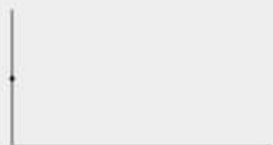
PLAY

re-set

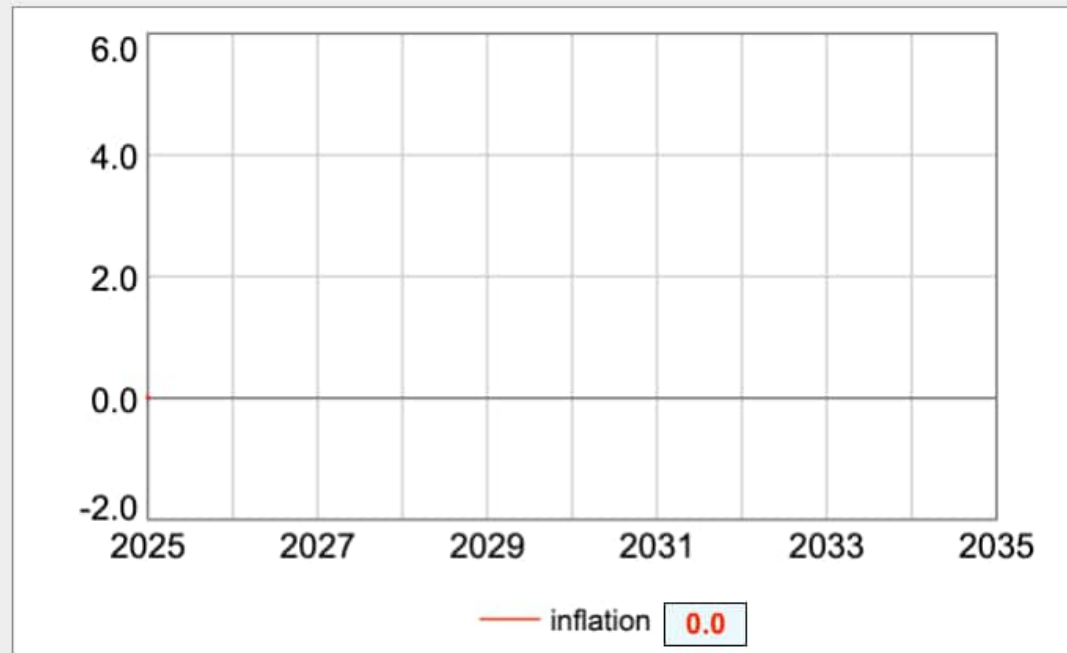
### Key Indicators



GDP growth %



capacity utilization



You are the leader of a central bank in the future, and you have only one monetary policy goal: low & stable inflation (near 2%)

*In Task 1, you will have about 5 minutes to play the game.*

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 In the first task, there are no shocks after the simulation begins. Other tasks are more challenging.

Click 'PLAY' to run the simulation. Each quarter, you will review the economic conditions and decide whether to change the Policy Rate. You have three options: raise it, lower it, or no change. After you decide, click 'PLAY' again. Repeat until the simulation ends (2035).

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Select your Task:  1  2  3

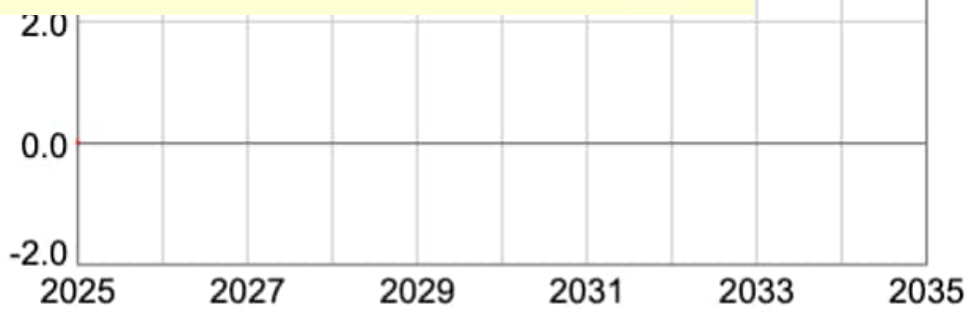
Set the Policy Rate:

Each task is more challenging than the previous one.

- A. No shocks after the simulation begins.
- B. There will be one or more shocks to demand or supply during the simulation.
- C. GDP growth rate will change during the simulation, and there will be a shock at some point.

GDP growth %

capacity utilization



inflation

# Online Simulation Game



<https://exchange.iseesystems.com/public/david-wheat/edsetmp1>





# I. David Wheat

Professor of System Dynamics, University of Bergen, Norway  
Adjunct Professor of Economics, Virginia Western Community College, U.S.A.  
Professor, Monetary Policy, ISM University of Management & Economics, Lithuania  
Professor, Economic Dynamics, National University of Kyiv-Mohyla Academy, Ukraine

Professor Wheat studies economic systems. His research specialty is simulation modeling of European economies, including Ukraine, Lithuania, Latvia, and the Euro Area.

He teaches monetary policy and economic dynamics to graduate students in Lithuania and Ukraine. He also teaches macroeconomics to undergraduates in the United States. In Norway, after teaching the system dynamics modeling process for many years, he continues to offer courses in macroeconomic dynamics and policy design & implementation. His projects include collaboration with Ukrainian economists to build dynamic modeling capacity at national universities in Kyiv and Lviv, creation of a system dynamics version of the central bank's monetary policy model and building an economic development policy model for Ukrainian government ministries. He also worked with economists at Lithuania's central bank to develop a multi-industry system dynamics model of price dynamics in Europe.

For more than twenty years, his system dynamics-based *MacroLab* model has been used by macroeconomics students in the United States. That model is available online, and students can use it without special software. He is currently writing a textbook to supplement student use of *MacroLab*. His latest economics journal article is *Teaching Endogenous Money with Systems Thinking and Simulation Tools*, and the most recent conference paper was *MacroLab20: A Framework for Comparative Macroeconomics* (with M. Oliskevych and A. Novik). He is co-editor of *Feedback Dynamics*, published by Springer in July 2021, including a chapter co-authored with Oliskevych and Novik: 'Get Started with Macro Modeling.'

Wheat is past-president of the economics chapter of the International System Dynamics Society. He served as Associate Editor of the *System Dynamics Review* and on the Advisory Board of the *International Journal of Pluralism and Economics Education*. He has given more than thirty international guest lectures. For three decades, he was president of Wheat Resources Inc, a consulting firm serving business and government clients. His current firm, Praktika LLC, specializes in coaching others to build useful models (<https://www.usefulmodels.net>). He received his PhD at the University of Bergen, his master's degree in public policy at Harvard University, and his bachelor's degree in government and mathematics at Texas Tech University. During the 1970s, he served at the White House as staff assistant to the President of the United States.