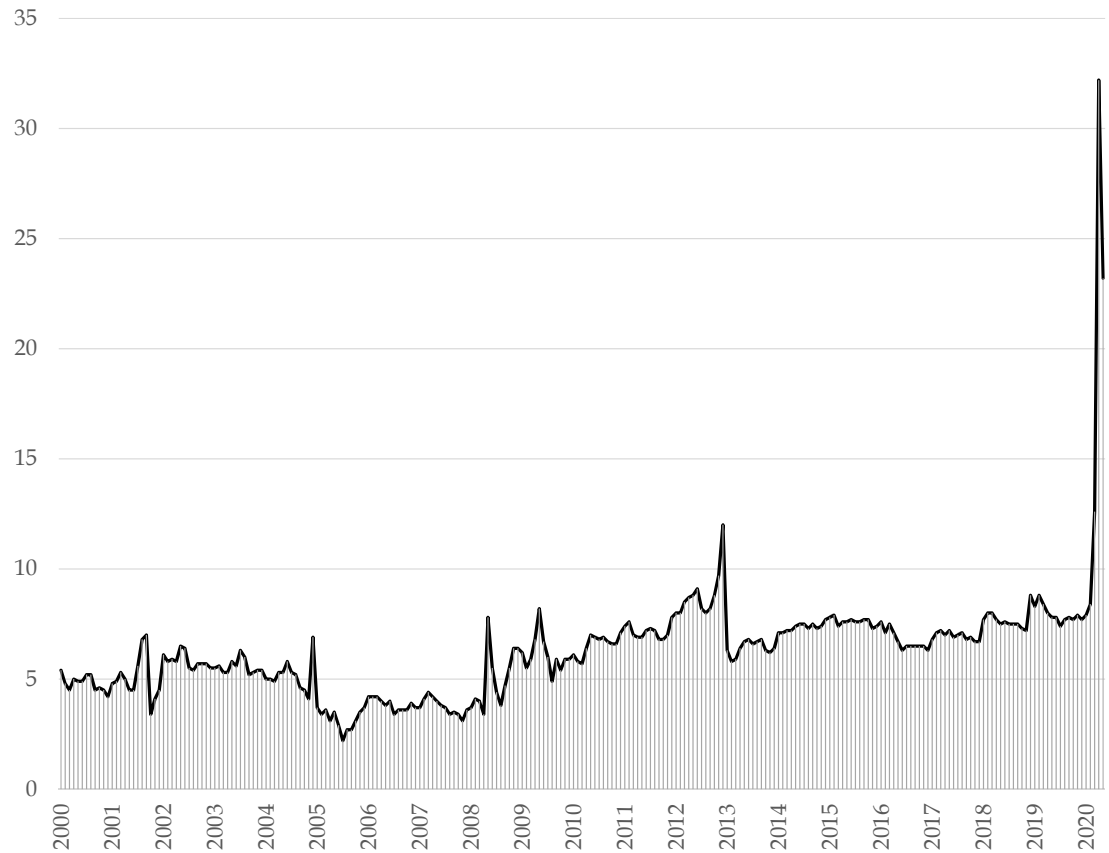
The Covid-19 Lockdown and the Keynesian Cross

Florian Sniekers

Tilburg University

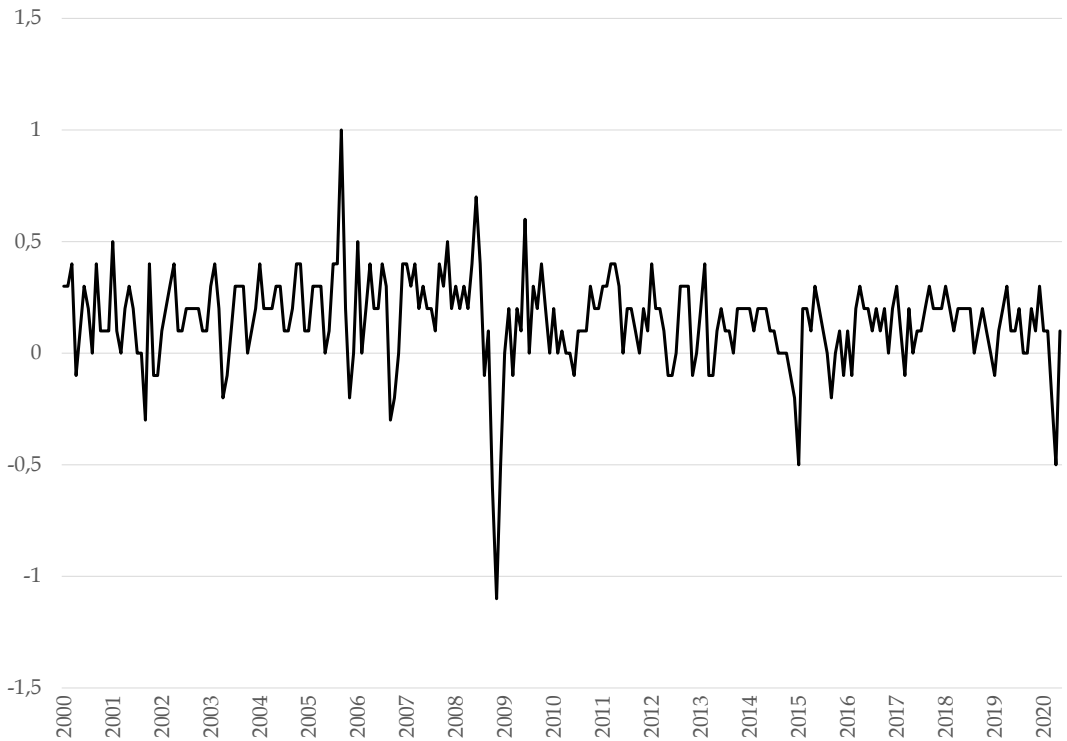
July 27, 2021

Enormous increase in personal savings rate



Personal savings as a percentage of personal disposable income. Monthly, United States, January 2000 - May 2020. *Source:* Bureau of Economic Analysis.

Deflation, but only mild



Percent price changes from preceding month for Personal Consumption Expenditures (PCE), United States, January 2000 - May 2020. *Source:* Bureau of Economic Analysis.

What does a lockdown do?

- Huge increase in personal savings, but only mild deflation.
  $\Rightarrow$ A lockdown is not just a fall in demand.
- Deflation rather than inflation.
  $\Rightarrow$ A lockdown is not just a supply shock.
- How to explain deflation resulting from a supply shock?
  $\Rightarrow$ We need a model with multiple sectors.

Two sectors and a lockdown

- Consider an economy that consists of two sectors:
  1. will be shut down in a lockdown because it is contact-intensive and non-essential.
  2. will **not** be shut down, either because it is not contact-intensive, or because it is essential (e.g. healthcare or food supply).

Two sectors and a lockdown

- Consider an economy that consists of two sectors:
  1. will be shut down in a lockdown because it is contact-intensive and non-essential.
  2. will **not** be shut down, either because it is not contact-intensive, or because it is essential (e.g. healthcare or food supply).
- Output in the economy is the sum of output in each sector: $Y = Y_1 + Y_2$

Two sectors and a lockdown

- Consider an economy that consists of two sectors:
  1. will be shut down in a lockdown because it is contact-intensive and non-essential.
  2. will **not** be shut down, either because it is not contact-intensive, or because it is essential (e.g. healthcare or food supply).
- Output in the economy is the sum of output in each sector: $Y = Y_1 + Y_2$

- Before a lockdown, sector
  1. employs a fraction ϕ of the employed labor force, and produces a fraction ϕ of all output: $Y_1 = \phi Y$
  2. employs and produces a fraction $1 - \phi$: $Y_2 = (1 - \phi)Y$

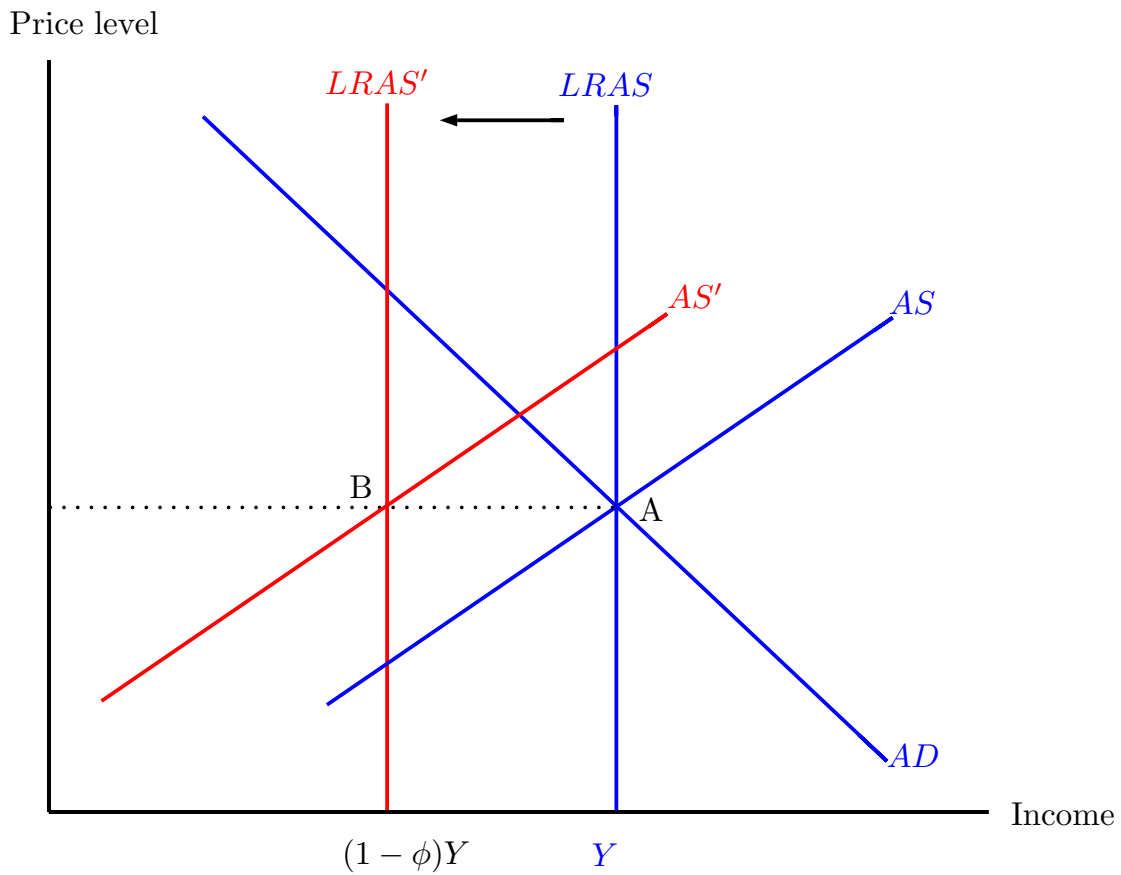
Two sectors and a lockdown

- Consider an economy that consists of two sectors:
  1. will be shut down in a lockdown because it is contact-intensive and non-essential.
  2. will **not** be shut down, either because it is not contact-intensive, or because it is essential (e.g. healthcare or food supply).
- Output in the economy is the sum of output in each sector: $Y = Y_1 + Y_2$
- Before a lockdown, sector
  1. employs a fraction ϕ of the employed labor force, and produces a fraction ϕ of all output: $Y_1 = \phi Y$
  2. employs and produces a fraction $1 - \phi$: $Y_2 = (1 - \phi)Y$
- What does a lockdown do?

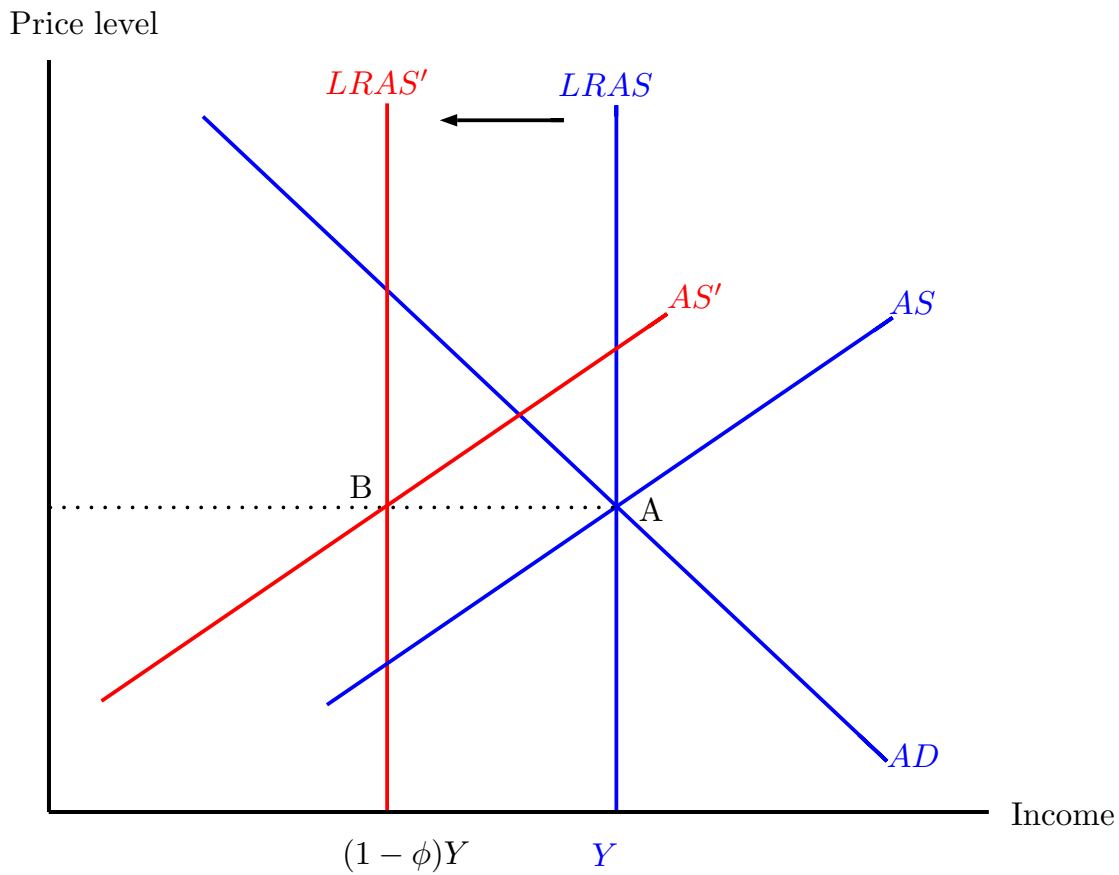
Two sectors and a lockdown

- Consider an economy that consists of two sectors:
  1. will be shut down in a lockdown because it is contact-intensive and non-essential.
  2. will **not** be shut down, either because it is not contact-intensive, or because it is essential (e.g. healthcare or food supply).
- Output in the economy is the sum of output in each sector: $Y = Y_1 + Y_2$
- Before a lockdown, sector
  1. employs a fraction ϕ of the employed labor force, and produces a fraction ϕ of all output: $Y_1 = \phi Y$
  2. employs and produces a fraction $1 - \phi$: $Y_2 = (1 - \phi)Y$
- What does a lockdown do? A **supply shock of size** ϕ.

A negative supply shock



A negative supply shock



What will happen to aggregate demand AD?

This lecture

1. Will the sector that is not shut down also suffer?
2. Can we control the damage to this sector by giving transfers?
3. Will aggregate demand fall by more than a fraction ϕ?
   - Does it matter whether we shut down only one sector of size ϕ, or both sectors for a fraction ϕ?
4. Should we expect disinflaton or higher inflation?
5. What are the government spending and tax multipliers?
   - Should we have a large-scale stimulus program from the government?
6. What is the multiplier on transfers to workers employed in either sector?
   - Is this the time for a basic income, or should we target transfers to workers in the sector that is shut down?

Aggregate income Y

- Focus on a closed economy.
- Focus on equilibrium: income equals planned expenditure, $Y = PE$.
- Planned or aggregate expenditure PE consists of
  - consumption C,
  - investment I,
  - government expenditure G, excluding transfers.
- T denotes aggregate taxes net of transfers.
- Spending is income: $Y = C + I + G$.
- Assume investment and government spending are exogenous.

A concave consumption function

- Consumption function of disposable income $Y - T > 0$,

$$C = \begin{cases} Y - T, & \text{if } Y - T \leq \bar{C}; \\ \bar{C} + c\left(Y - T - \bar{C}\right), & \text{if } Y - T > \bar{C}. \end{cases}$$

  - Consumption level at which liquidity constraints stop to bind: $\bar{C} > 0$
  - Marginal propensity to consume $c \in (0, 1)$

A concave consumption function

- Consumption function of disposable income $Y - T > 0$,

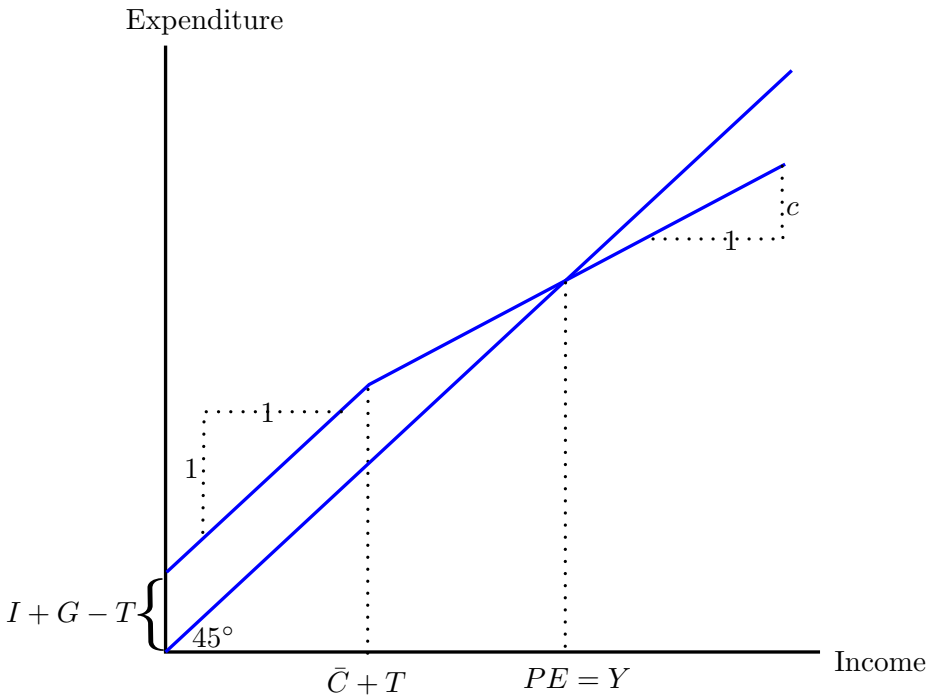
$$C = \begin{cases} Y - T, & \text{if } Y - T \leq \bar{C}; \\ \bar{C} + c\left(Y - T - \bar{C}\right), & \text{if } Y - T > \bar{C}. \end{cases}$$

  - Consumption level at which liquidity constraints stop to bind: $\bar{C} > 0$
  - Marginal propensity to consume $c \in (0, 1)$
- Alternative formulation:

$$C = \min\left(\bar{C}, Y - T\right) + c \max\left(Y - T - \bar{C}, 0\right)$$

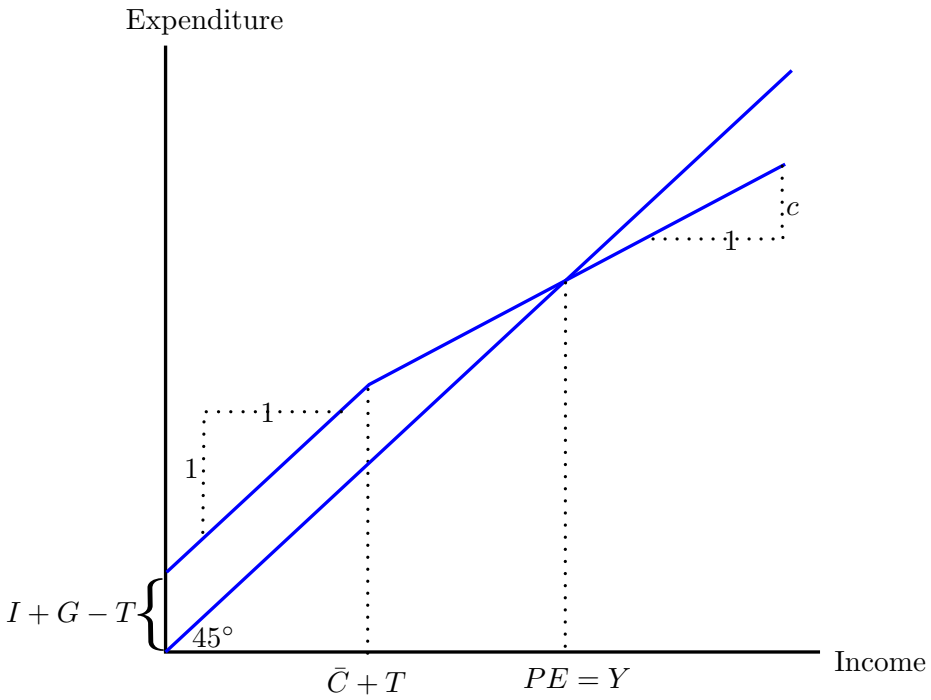
- A concave consumption function: decreasing marginal propensity.
- No autonomous consumption/animal spirits.

The Keynesian cross with liquidity constraints



$$PE = \min\left(\bar{C}, Y - T\right) + c\max\left(Y - T - \bar{C}, 0\right) + I + G \overset{\text{eq.}}{=} Y$$

The Keynesian cross with liquidity constraints



$$PE = \min\left(\bar{C}, Y - T\right) + c\max\left(Y - T - \bar{C}, 0\right) + I + G \overset{\text{eq.}}{=} Y$$

- Assume that $I + G - T \geq \bar{C}$, so that $Y - T \geq \bar{C}$:

$$PE = \bar{C} + c\left(Y - T - \bar{C}\right) + I + G \overset{\text{eq.}}{=} Y$$

Remember two sectors

- The economy that consists of two sectors:
  1. will be shut down
  2. will **not** be shut down

Remember two sectors

- The economy that consists of two sectors:
  1. will be shut down
  2. will **not** be shut down
- Spending *on* sector $i \in \{1, 2\}$ denoted by C_i, I_i, and G_i:

$$Y_1 = C_1 + I_1 + G_1 \quad \text{and} \quad Y_2 = C_2 + I_2 + G_2$$

- Net taxes paid, or transfers received, by workers in sector i: T_i.

Remember two sectors

- The economy that consists of two sectors:
  1. will be shut down
  2. will **not** be shut down
- Spending *on* sector $i \in \{1, 2\}$ denoted by C_i, I_i, and G_i:

$$Y_1 = C_1 + I_1 + G_1 \quad \text{and} \quad Y_2 = C_2 + I_2 + G_2$$

- Net taxes paid, or transfers received, by workers in sector i: T_i.

- Consumption *by* workers employed in sector i, $\tilde{C}_i$
  - Fraction ϕ of workers employed in sector 1.
  - Fraction $1 - \phi$ of workers employed in sector 2.

Consumption *by* workers in each sector

Suppose that workers working in different sectors:

- have the same preferences: c
- have the same consumption level at which liquidity constraints are no longer binding, so that the aggregate level $\bar{C}$ can to be allocated to sectors:
  - Consumption by workers in sector 1 goes beyond the level at which liquidity constraints bind at $\phi\bar{C}$
  - Consumption by workers in sector 2 goes beyond the level at which liquidity constraints bind at $(1-\phi)\bar{C}$

Consumption *by* workers in each sector

Suppose that workers working in different sectors:

- have the same preferences: c
- have the same consumption level at which liquidity constraints are no longer binding, so that the aggregate level $\bar{C}$ can to be allocated to sectors:
  - Consumption by workers in sector 1 goes beyond the level at which liquidity constraints bind at $\phi\bar{C}$
  - Consumption by workers in sector 2 goes beyond the level at which liquidity constraints bind at $(1-\phi)\bar{C}$

Consumption *by* workers employed in sector i, $\tilde{C}_i$, is then

$$\tilde{C}_1 = \min\left(\phi\bar{C}, Y_1 - T_1\right) + c\max(Y_1 - T_1 - \phi\bar{C}, 0),$$
$$\tilde{C}_2 = \min\left((1-\phi)\bar{C}, Y_2 - T_2\right) + c\max(Y_2 - T_2 - (1-\phi)\bar{C}, 0)$$

Consumption *on* each sector

For simplicity, assume that

- all consumption up to the liquidity constraint is spent in sector 2, the essential sector.
- marginal propensities to consume in each sector are fixed: $\mathbf{c_1} + \mathbf{c_2} = \mathbf{c} < \mathbf{1}$

Consumption *on* each sector

For simplicity, assume that

- all consumption up to the liquidity constraint is spent in sector 2, the essential sector.
- marginal propensities to consume in each sector are fixed: $\mathbf{c_1} + \mathbf{c_2} = \mathbf{c} < \mathbf{1}$

Consumption in sector 1 is then

$$C_1 = c_1 \max\left(Y_1 - T_1 - \phi\bar{C}, 0\right) + c_1 \max\left(Y_2 - T_2 - (1-\phi)\bar{C}, 0\right),$$

Consumption in sector 2 is

$$\begin{aligned} C_2 = &\min\left(\phi\bar{C}, Y_1 - T_1\right) + c_2 \max\left(Y_1 - T_1 - \phi\bar{C}, 0\right) \\ &+ \min\left((1-\phi)\bar{C}, Y_2 - T_2\right) + c_2 \max\left(Y_2 - T_2 - (1-\phi)\bar{C}, 0\right). \end{aligned}$$

Before the lockdown

- We assumed $I + G - T \geq \bar{C}$, so that $Y - T \geq \bar{C}$:
- Now assume that **before the lockdown**, the same applies to each sector separately: no worker is liquidity-constrained
  - $I_1 + G_1 - T_1 \geq \phi \bar{C}$, so that $Y_1 - T_1 \geq \phi \bar{C}$
  - $I_2 + G_2 - T_2 \geq (1 - \phi) \bar{C}$, so that $Y_2 - T_2 \geq (1 - \phi) \bar{C}$

Before the lockdown

- We assumed $I + G - T \geq \bar{C}$, so that $Y - T \geq \bar{C}$:
- Now assume that **before the lockdown**, the same applies to each sector separately: no worker is liquidity-constrained
  - $I_1 + G_1 - T_1 \geq \phi \bar{C}$, so that $Y_1 - T_1 \geq \phi \bar{C}$
  - $I_2 + G_2 - T_2 \geq (1 - \phi) \bar{C}$, so that $Y_2 - T_2 \geq (1 - \phi) \bar{C}$

- Consumption on each sector is then simply

$$C_1 = c_1 \left(Y_1 - T_1 + Y_2 - T_2 - \bar{C} \right),$$
$$C_2 = \bar{C} + c_2 \left(Y_1 - T_1 + Y_2 - T_2 - \bar{C} \right).$$

The lockdown

A lockdown implies that

- spending in sector 1 is shut down: $C_1' = G_1' = I_1' = 0$
- sector 1 does no longer contribute to output: $Y_1' = 0$, and $Y' = Y_2'$.

The lockdown

A lockdown implies that

- spending in sector 1 is shut down: $C_1' = G_1' = I_1' = 0$
- sector 1 does no longer contribute to output: $Y_1' = 0$, and $Y' = Y_2'$.

Now suppose that

- Consumption function remains unchanged: $\bar{C}$ and c_2 constant
- To prevent negative disposable income, sector 1 is given a tax holiday, but no transfers (yet): $T_1' = 0$
  - Workers in sector 1 are **liquidity-constrained**: $Y_1' - T_1' = 0 < \phi \bar{C}$

The lockdown

A lockdown implies that

- spending in sector 1 is shut down: $C_1' = G_1' = I_1' = 0$
- sector 1 does no longer contribute to output: $Y_1' = 0$, and $Y' = Y_2'$.

Now suppose that

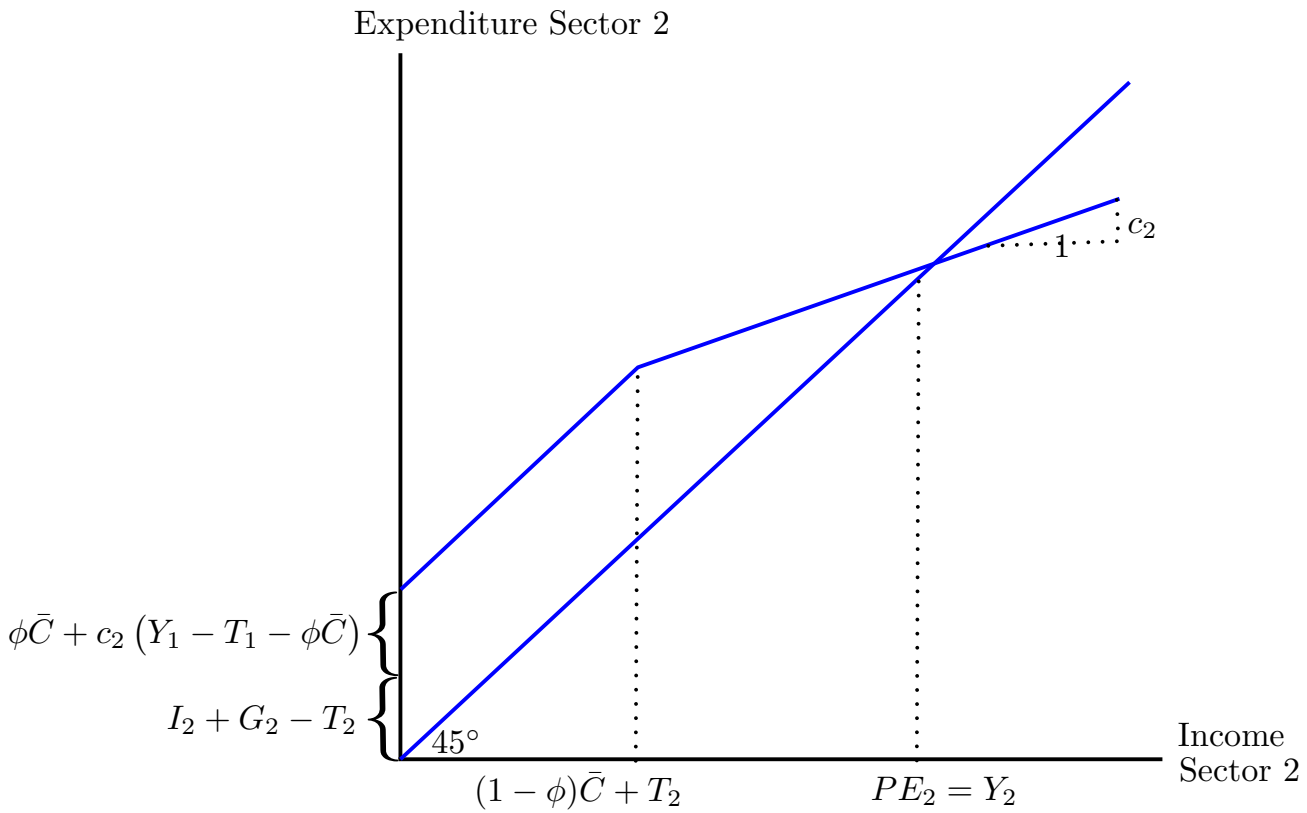
- Consumption function remains unchanged: $\bar{C}$ and c_2 constant
- To prevent negative disposable income, sector 1 is given a tax holiday, but no transfers (yet): $T_1' = 0$
  - Workers in sector 1 are **liquidity-constrained**: $Y_1' - T_1' = 0 < \phi\bar{C}$
- Exogenous variables in sector 2 remain unchanged: $I_2' = I_2$, $G_2' = G_2$, and $T_2' = T_2$
- Thus, $I_2' + G_2' - T_2' \geq (1-\phi)\bar{C}$, so that $Y_2' - T_2' \geq (1-\phi)\bar{C}$
  - Workers in sector 2 are **not** liquidity-constrained

Question 1. Demand shortages

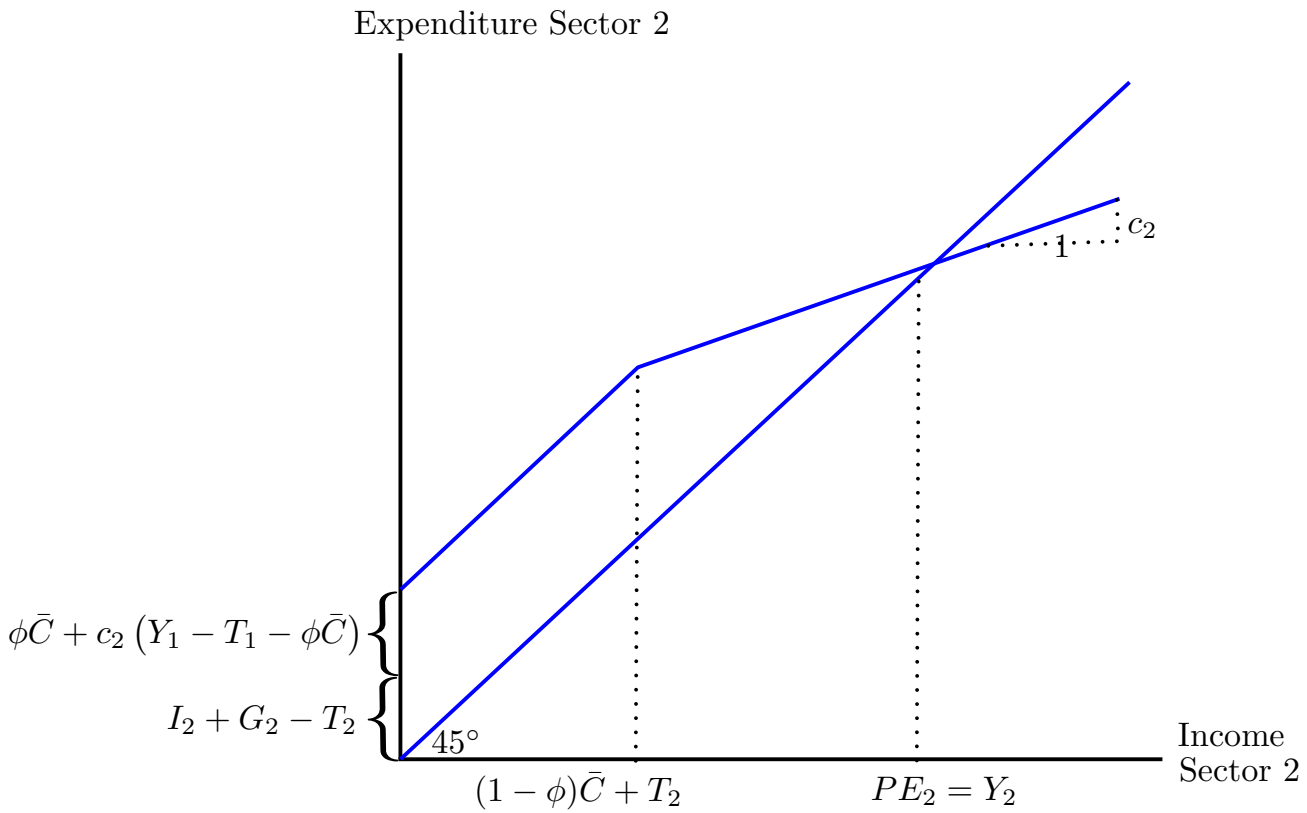
What will happen to income earned in sector 2, Y_2':

Will the sector that is not shut down also suffer from the lockdown?

The Keynesian Cross in Sector 2

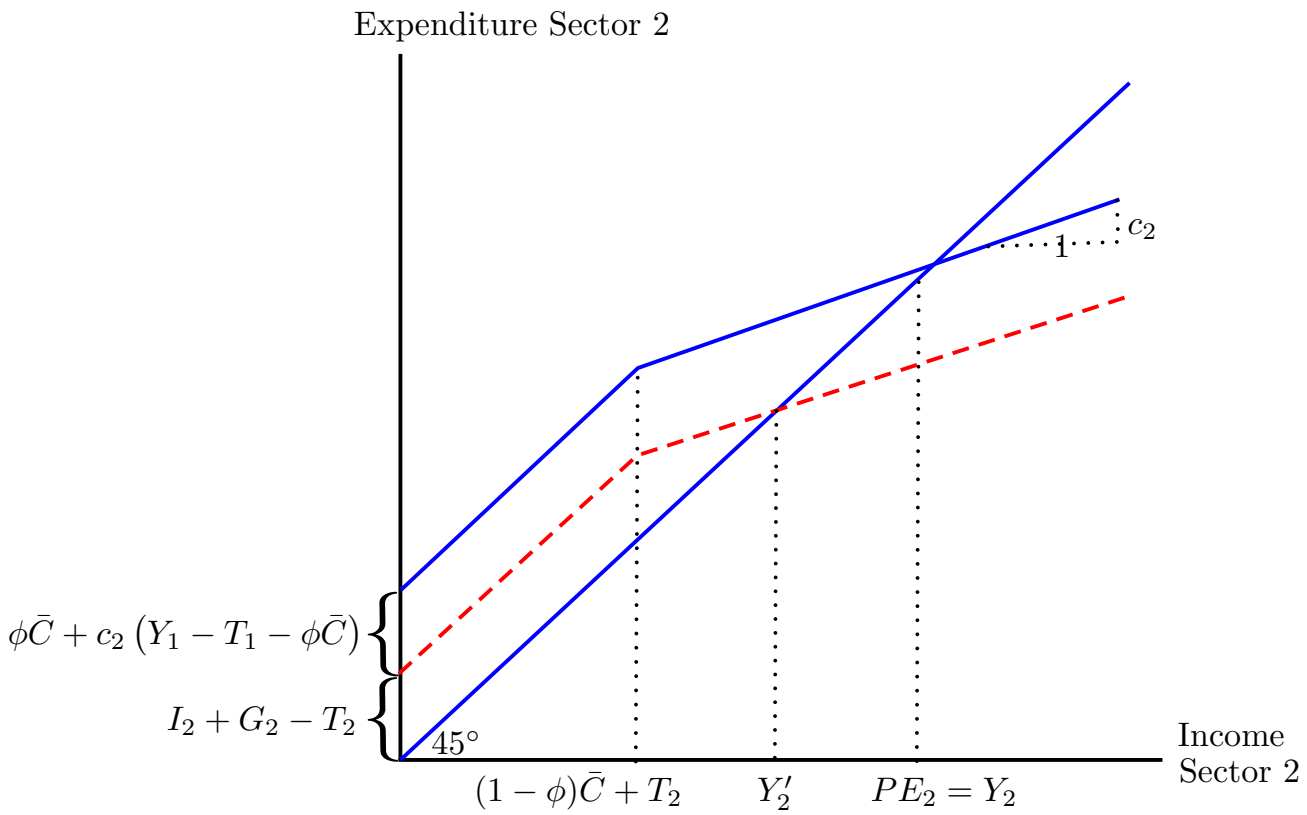


The Keynesian Cross in Sector 2



What does a lockdown do?

Income in Sector 2 during a lockdown



- Income falls because workers in sector 1 do not spend.
- Shock is amplified by a multiplier based on c_2

Income in sector 2

- Before the lockdown, income in sector 2 was

$$\begin{aligned} Y_2 &= \bar{C} + c_2\left(Y_1 + Y_2 - T_1 - T_2 - \bar{C}\right) + I_2 + G_2, \\ &= \bar{C} + \frac{c_2}{1-c_2}\left(Y_1 - T_1 - T_2\right) + \frac{1}{1-c_2}\left(I_2 + G_2\right). \end{aligned} \tag{1}$$

- In a lockdown, $Y_1' - T_1' = 0$, thus $\tilde{C}_1 = 0$, so that

$$\begin{aligned} Y_2' &= (1-\phi)\bar{C} + c_2\left(Y_2' - T_2 - (1-\phi)\bar{C}, 0\right) + I_2 + G_2, \\ &= (1-\phi)\bar{C} - \frac{c_2}{1-c_2}T_2 + \frac{1}{1-c_2}\left(I_2 + G_2\right). \end{aligned} \tag{2}$$

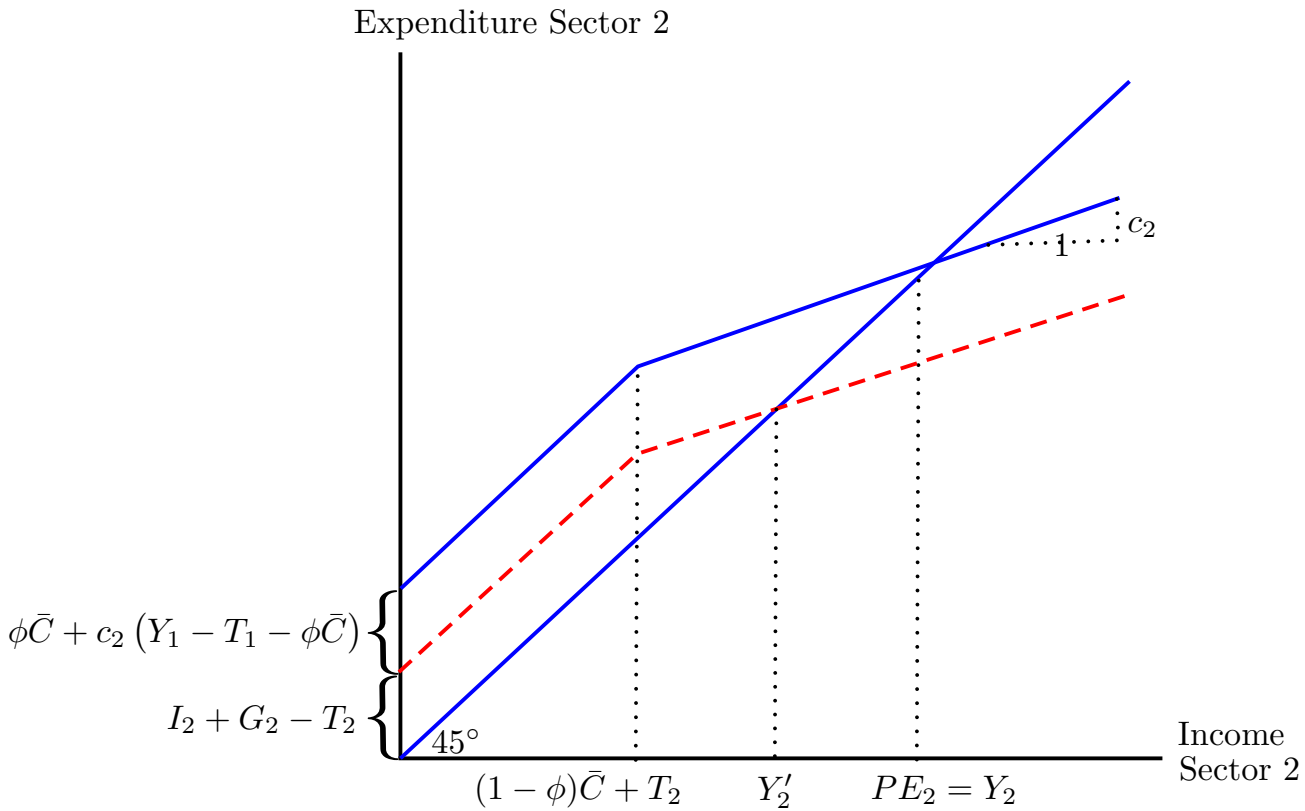
  and thus $Y_2' < Y_2$.
- Difference comes from both $\phi\bar{C}$ and $Y_1 - T_1$

Question 2. Transfers

Can we restore income in sector 2 to pre-lockdown levels Y_2 by giving income transfers to workers in sector 1?

Question 2. Transfers

Can we restore income in sector 2 to pre-lockdown levels Y_2 by giving income transfers to workers in sector 1?



Yes, with transfers equal to $-T_1' = Y_1 - T_1$, which will result in spending of $\phi\bar{C} + c_2\left(Y_1 - T_1 - \phi\bar{C}\right)$!

Question 3. A proportional 'lockdown'

Will aggregate demand fall by more than a fraction ϕ? Does it matter whether we shut down only one sector of size ϕ, or both sectors for a fraction ϕ?

Question 3. A proportional 'lockdown'

Will aggregate demand fall by more than a fraction ϕ? Does it matter whether we shut down only one sector of size ϕ, or both sectors for a fraction ϕ?

- Suppose activity in both sectors is reduced by a fraction ϕ.
  - A fraction ϕ of taxes is given a tax holiday.
- In this case aggregate income is $(1-\phi)Y$.
- How does this compare to $Y' = Y_2'$?

Question 3. A proportional 'lockdown'

Will aggregate demand fall by more than a fraction ϕ? Does it matter whether we shut down only one sector of size ϕ, or both sectors for a fraction ϕ?

- Suppose activity in both sectors is reduced by a fraction ϕ.
  - A fraction ϕ of taxes is given a tax holiday.
- In this case aggregate income is $(1-\phi)Y$.
- How does this compare to $Y' = Y_2'$?

- Assume that before the lockdown,
  - workers in both sectors pay equal per capita taxes: $T_2 = (1-\phi)T$
  - investment and government expenditure are proportional across sectors: $I_2 + G_2 = (1-\phi)(I+G)$

Sectors do matter

Before the lockdown:

$$Y = \bar{C} - \frac{c}{1-c}T + \frac{1}{1-c}(I+G),$$

so that $(1-\phi)Y$ is

$$(1-\phi)Y = (1-\phi)\bar{C} - \frac{c}{1-c}(1-\phi)T + \frac{1}{1-c}(1-\phi)(I+G).$$

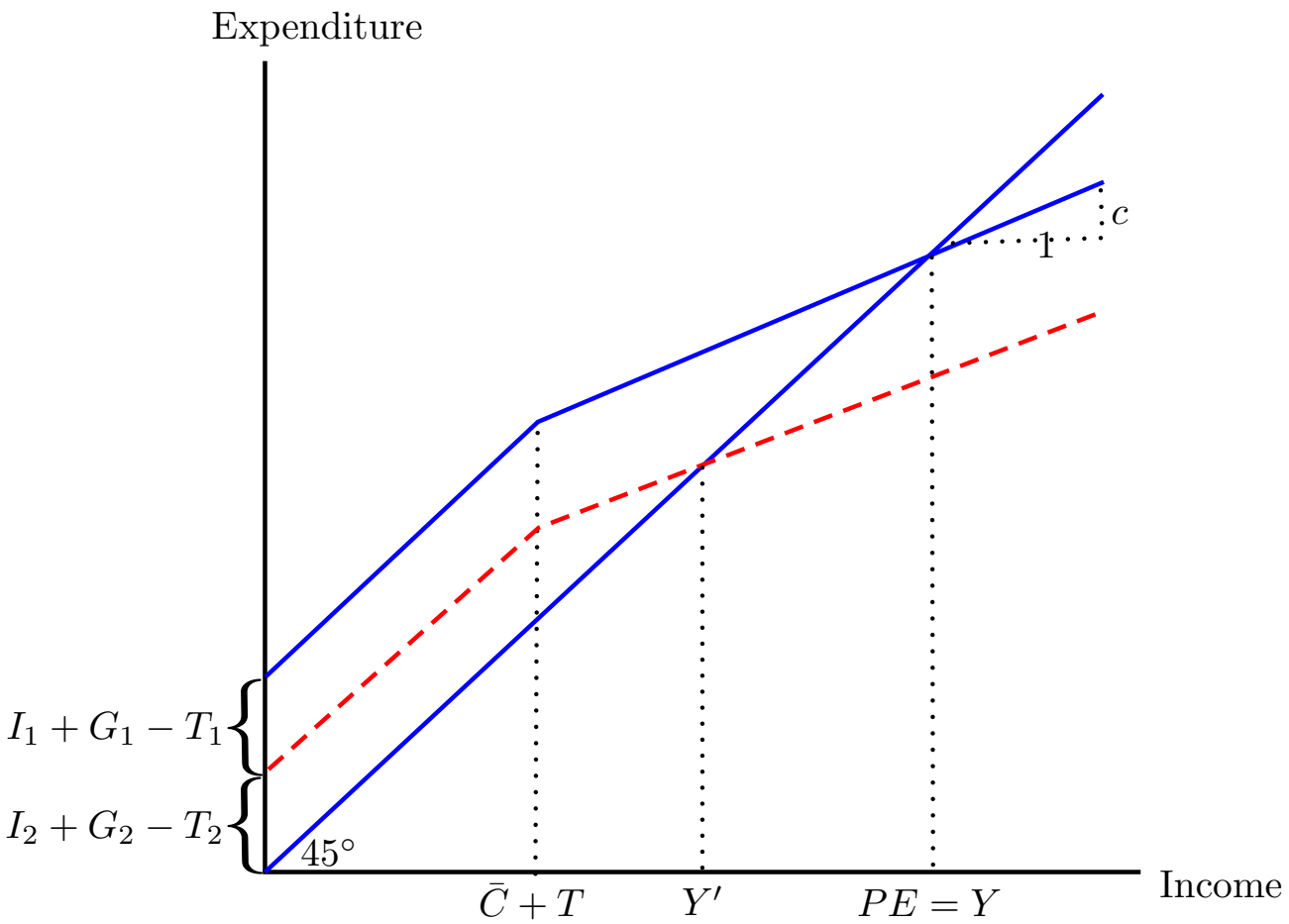
Consequently, $\boxed{(1-\phi)Y > Y'}$ since

$$Y_2' = (1-\phi)\bar{C} - \frac{c_2}{1-c_2}T_2 + \frac{1}{1-c_2}(I_2+G_2) \tag{2}$$

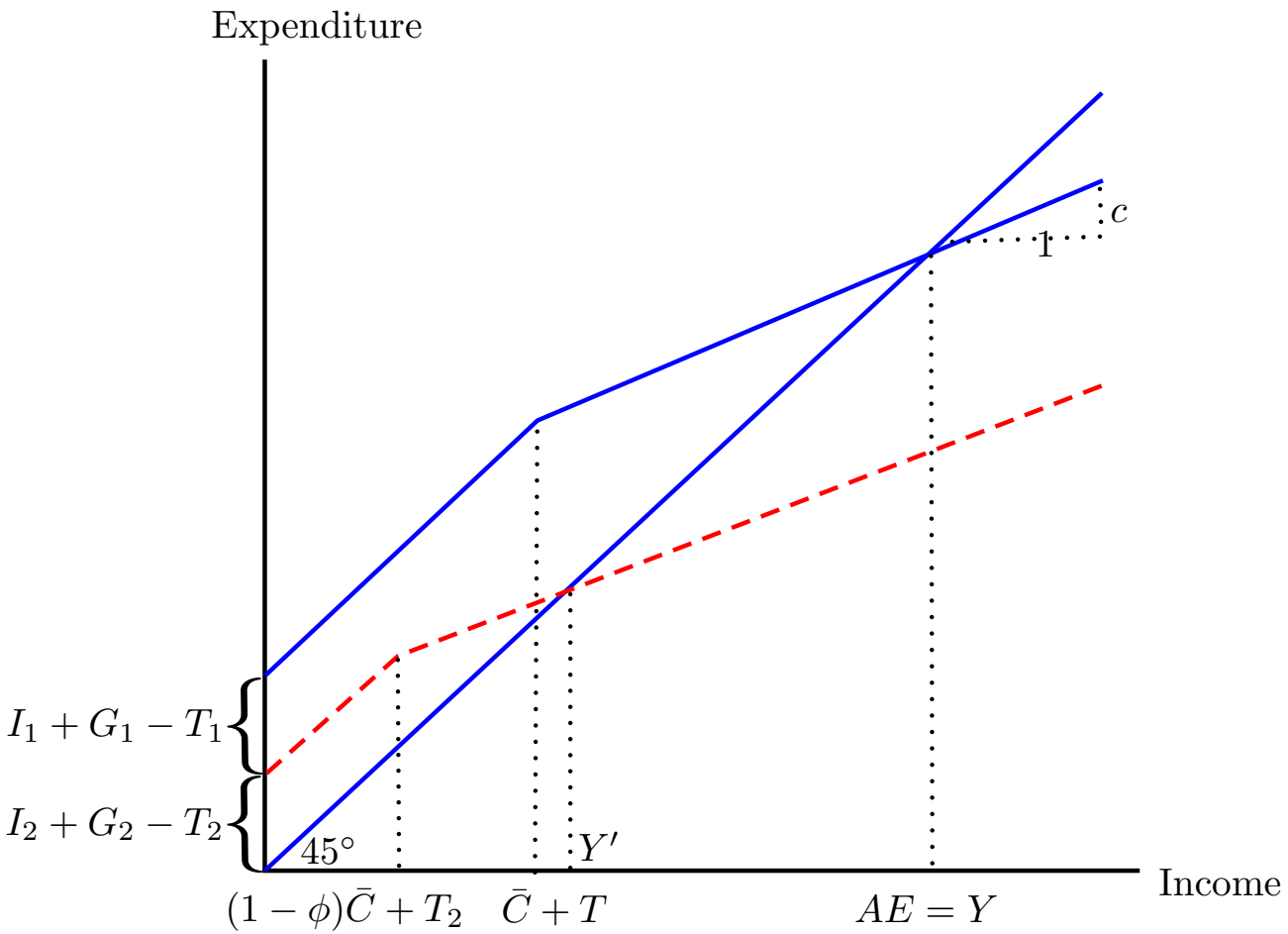
- $(1-\phi)T = T_2$.
- $(1-\phi)(I+G) = I_2 + G_2$.
- $I_2 + G_2 > T_2$, since we assumed $I_2 + G_2 - T_2 \geq (1-\phi)\bar{C}$.

Shutting down one sector, the marginal propensity to consume is lower!

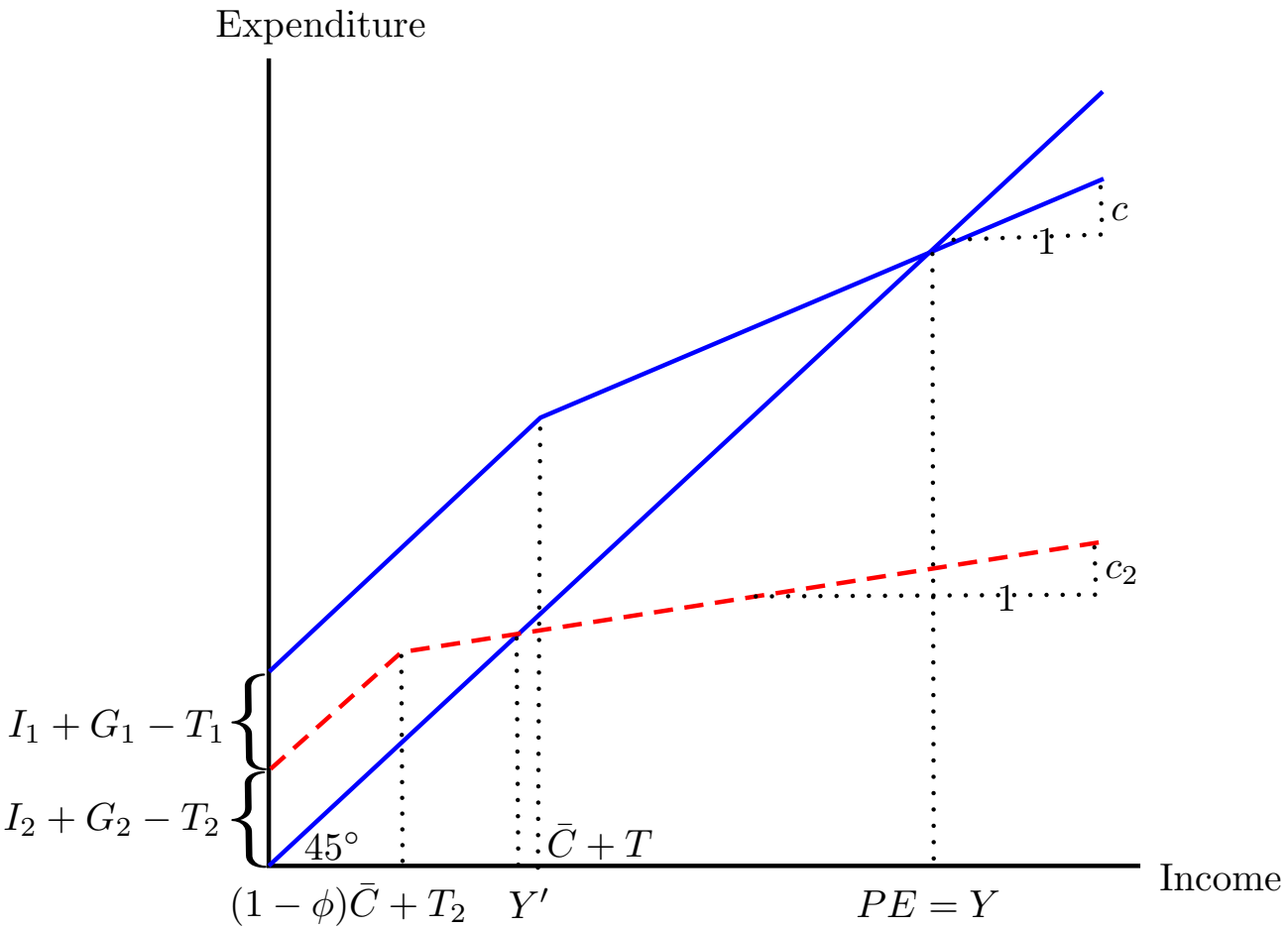
Step 1. Exogenous expenditure falls



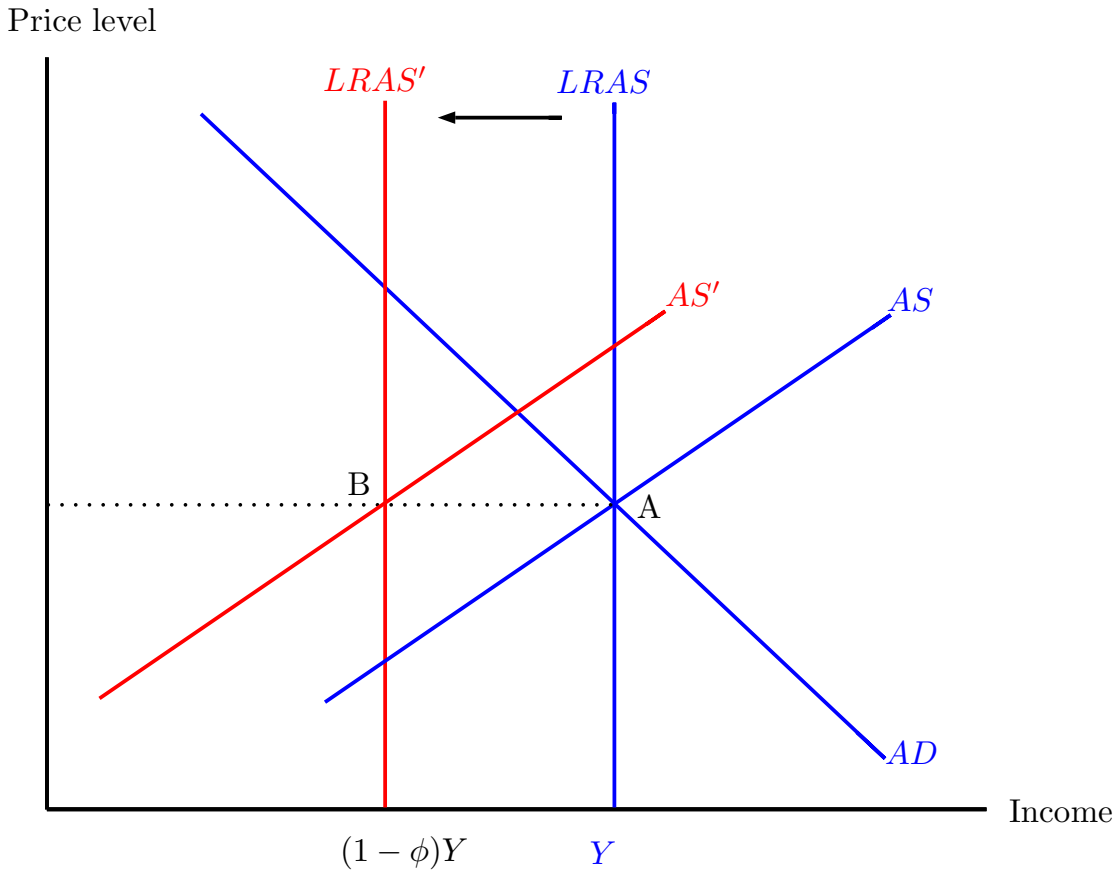
Step 2. liquidity constraints bind for sector 1 workers



Step 3. Marginal propensity to consume falls

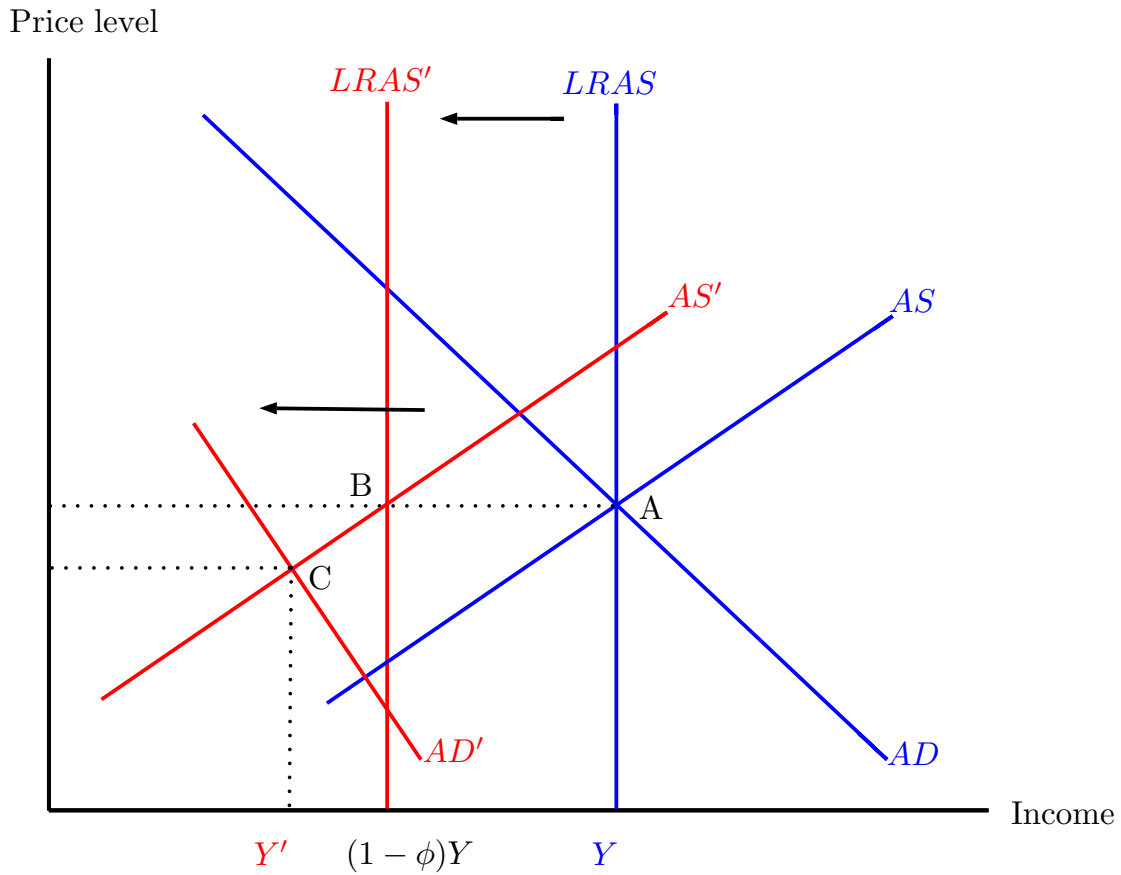


Question 4. Inflation



Should we expect disinflation or higher inflation during a lockdown?

Question 4. Inflation



For the same interest rate and thus $I(r)$, one can expect lower inflation.

Question 5. Fiscal policy

What is the size of the government spending multiplier?

Question 5. Fiscal policy

What is the size of the government spending multiplier?

- Assume all government spending on sector 2.
- Taking first differences of (2) yields

$$\Delta Y' = \frac{-c_2}{1-c_2}\Delta T_2 + \frac{1}{1-c_2}(\Delta I_2 + \Delta G_2). \tag{3}$$

- The government spending multiplier is $1/(1-c_2)$, smaller than the usual $1/(1-c)$.
- In every 'round', a smaller fraction of the additional income is spent than whenever additional income can also be spent on sector 1.

Question 5. Fiscal policy

What is the size of the government spending multiplier?

- Assume all government spending on sector 2.
- Taking first differences of (2) yields

$$\Delta Y' = \frac{-c_2}{1-c_2}\Delta T_2 + \frac{1}{1-c_2}(\Delta I_2 + \Delta G_2). \tag{3}$$

- The government spending multiplier is $1/(1-c_2)$, smaller than the usual $1/(1-c)$.
- In every 'round', a smaller fraction of the additional income is spent than whenever additional income can also be spent on sector 1.

Similarly, tax multiplier is less negative:
increasing taxes is not as contractionary as usual.

- $-c_2/(1-c_2)$ instead of $-c/(1-c)$

Question 6. A basic income

Should we introduce basic income, or target transfers to sector 1 workers?

Question 6. A basic income

Should we introduce basic income, or target transfers to sector 1 workers?

Tax multiplier less negative: relatively bad time to give unconditional transfers.

- Multiplier of transfers to workers in sector 2 is only $c_2/(1-c_2)$
  - Workers in sector 2 will save much of their transfers.

Question 6. A basic income

Should we introduce basic income, or target transfers to sector 1 workers?

Tax multiplier less negative: relatively bad time to give unconditional transfers.

- Multiplier of transfers to workers in sector 2 is only $c_2/(1-c_2)$
  - Workers in sector 2 will save much of their transfers.
- Workers in sector 1 have marginal propensity of 100% (until their liquidity constraints are no longer binding).
  - Spending ends up in sector 2, so subsequent spending rounds from workers in sector 2.
  - Workers in sector 2 have only a propensity of $c_2 < c < 1$.

Question 6. A basic income

Should we introduce basic income, or target transfers to sector 1 workers?

Tax multiplier less negative: relatively bad time to give unconditional transfers.

- Multiplier of transfers to workers in sector 2 is only $c_2/(1-c_2)$
  - Workers in sector 2 will save much of their transfers.
- Workers in sector 1 have marginal propensity of 100% (until their liquidity constraints are no longer binding).
  - Spending ends up in sector 2, so subsequent spending rounds from workers in sector 2.
  - Workers in sector 2 have only a propensity of $c_2 < c < 1$.
- Transfers to sector 1 have the same multiplier as government spending: $1/(1-c_2)$, larger than $c_2/(1-c_2)$.

Largest bang for the buck if you can target transfers to the people with highest marginal propensity to consume.