Business Cycles

Part 4: The New Keynesian Model
Lecture 7: Deriving the New Keynesian Model

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Outline

Part 1: Introduction

Part 2: Microeconomic Foundations

Part 3: The Real Business Cycle Model

Part 4: The New Keynesian Model

- Lecture 7: Deriving the New Keynesian Model

- Lecture 8: The Effects of Shocks in the New Keynesian Model

Part 5: Financial Crises

Learning Objective of Todays Lecture

1. Understanding the New Keynesian model

2. How does it differ from the RBC model? Prices are exogenously fix. This slight change makes the equilibrium demand rather than supply determined.

3. See that the graphical analysis is similar to the one in undergraduate macroeconomics, but the model is fully microfounded with clearly defined shocks.

Literature

Required reading:

- Textbook chapter 24-25.

Optional reading:

- Klenow, Peter J. & Malin, Benjamin A., 2010. "Microeconomic Evidence on Price-Setting," Handbook of Monetary Economics,in: Benjamin M. Friedman & Michael Woodford (ed.), Handbook of Monetary Economics, edition 1, volume 3, chapter 6, pages 231-284 Elsevier.

From the RBC to the New Keynesian model

- RBC model well suited as an efficient benchmark and to describe the medium run. But it is not suited for short-run analysis (several month up to several years).

  - Money neutrality does not hold in the short run. Monetary policy has temporary real effects.

  - Business cycles are mainly driven by demand shocks in the short run.

  - At least some cyclical fluctuations are not efficient and there is a role for stabilization policy.

- We develop the New Keynesian model in the following lectures to analyze short-run dynamics.

  - Backbone of this model is the RBC model with intertemporal optimization and market clearing. In the medium run / long run the models are the same.

  - Price or wage rigidities lead to deviations from the efficient allocation. There is a sensible role for activist policy.

  - Demand shocks matter for short-run economic dynamics.

  - Classical dichotomy fails in the short run. Nominal variables affect real variables temporarily. Monetary policy has temporary short-run real effects.
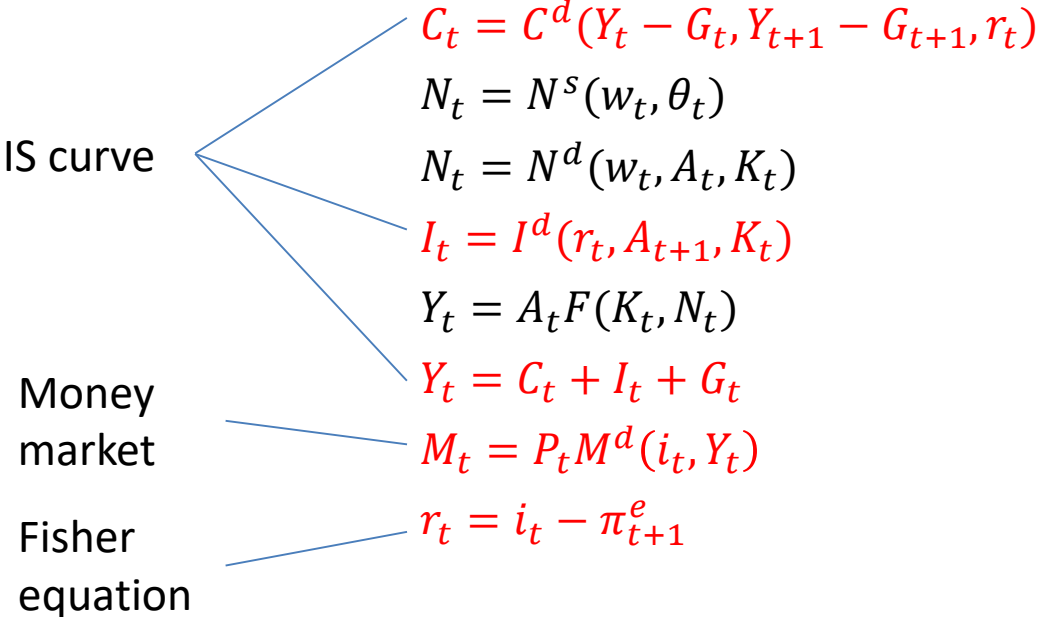
Demand and Supply

- The demand side of the neoclassical and New Keynesian models are the same

- Differences arise on the supply side. The supply curve is upward sloping (or in the extreme case horizontal) in the New Keynesian model

- Two basic variants (or mixture of the two): wage stickiness and/or price stickiness

- Mathematically, what we are going to assume is that either the nominal wage or price level are predetermined (i.e. exogenous).

- This will require some change in the labor market – either the firm (price stickiness) or household (wage stickiness) is off its demand or supply schedule

- Because it works out to be a bit simpler, we will focus on the sticky price model in class, though the book covers both.

Exogenous Price Setting in the New Keynesian Model

- So far, the firm maximized profits via choosing the optimal amount of labor and capital.

- The firm was acting under perfect competition, so that it took prices as given and did not have any price setting power.

- In the New Keynesian model, the firm acts under monopolistic competition. This means it has (limited) price setting power.

- The firm maximizes profits via setting prices and not via choosing the optimal amount of labor and capital.

- The firm takes into account that it is costly to readjust prices, so that the firm sticks to a price for some time.

- We will not model the price setting process with sticky prices formally (it is quite complicated). We will take a short-cut and assume that the firm sets prices exogenously and leaves them there in the short run. At this pre-set price level, the firm is willing to supply the quantity that is demanded by households.

- Only in the medium run prices adjust. We will assume that in the medium run prices adjust to the level prescribed by the RBC-model. This is a short-cut, because we ignore that in the New Keynesian model there is monopolistic competition leading to a mark-up over marginal cost, while in the RBC model there is perfect competition, so that there is no mark-up.

Review: RBC Model

- Equilibrium conditions

IS curve

Money market

Fisher equation

$$C_t = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_t)$$

$$N_t = N^s(w_t, \theta_t)$$

$$N_t = N^d(w_t, A_t, K_t)$$

$$I_t = I^d(r_t, A_{t+1}, K_t)$$

$$Y_t = A_t F(K_t, N_t)$$

$$Y_t = C_t + I_t + G_t$$

$$M_t = P_t M^d(i_t, Y_t)$$

$$r_t = i_t - \pi^e_{t+1}$$

Demand side is the same in the RBC and the New Keynesian model.

- P_t is endogenous

- Nominal wage, W_t, is $W_t = w_t P_t$, and is also therefore endogenous

- In the New Keynesian model the price level will be exogenous $P_t = \bar{P}_t$ (check the book chapter for a version with constant nominal wages $W_t = \bar{W}_t$).

The IS and LM Curves

- The IS curve is identical to before: set of (r_t, Y_t) pairs where income equal to desired demand holds:

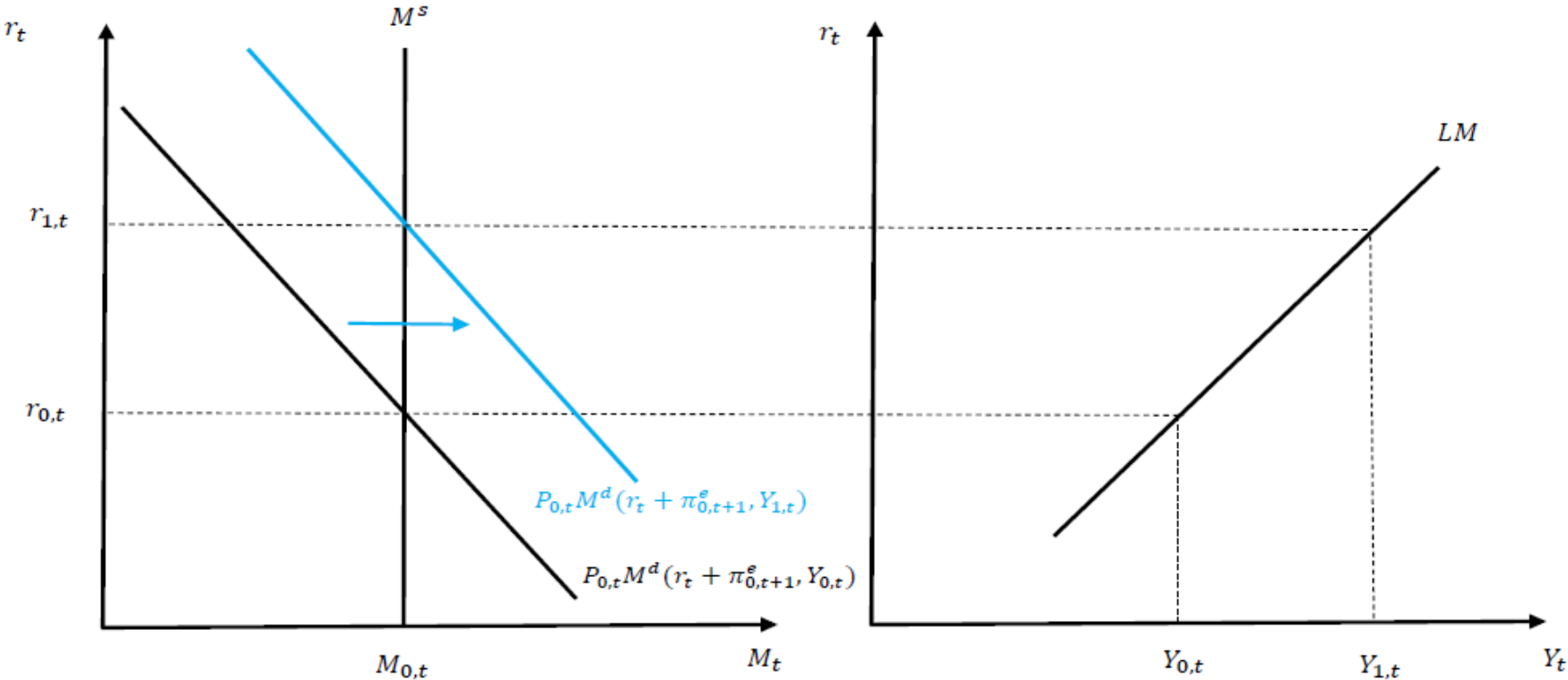$$Y_t = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_t) + I^d(r_t, A_{t+1}, K_t) + G_t$$

- In the New Keynesian model money <u>non</u>-neutrality holds. M_t has an effect on r_t and Y_t. Hence, we incorporate equilibrium conditions from the nominal side of the economy in the (r_t, Y_t)-graph: the LM curve.

- LM curve (liquidity = money) plots combinations of (r_t, Y_t) where the two nominal equilibrium relations hold:

$$M_t = P_t M^d(i_t, Y_t)$$

$$r_t = i_t - \pi^e_{t+1}$$

- LM curve is upward-sloping in (r_t, Y_t) space. Basic idea: holding M_t and P_t fixed, if r_t goes up, Y_t must go up for money demand to equal money supply (in the RBC model P_t adjusted)

Graphical Derivation of the LM Curve

r_t

M^s

r_t

LM

$r_{1,t}$

$r_{0,t}$

$P_{0,t} M^d (r_t + \pi^e_{0,t+1}, Y_{1,t})$

$P_{0,t} M^d (r_t + \pi^e_{0,t+1}, Y_{0,t})$

$M_{0,t}$

M_t

$Y_{0,t}$

$Y_{1,t}$

Y_t

Shifts in the LM curve

- The LM curve is defined for given values of M_t, P_t and π_{t+1}^e

- LM curve will shift if M_t, P_t ore π_{t+1}^e change.

- The position of the LM curve depends on the level of real money balances, M_t/P_t. If real money balances increases (either because of an increase in Mt or a decrease in Pt), the LM curve shifts down (equivalently to the right). If real money balances decreases (either because of a decrease in Mt or an increase in Pt), the LM curve shifts up (equivalently in to the left).

- We will analyze how the LM curve shifts if M_t increases or P_t decreases. Check at home what happens if π_{t+1}^e increases.

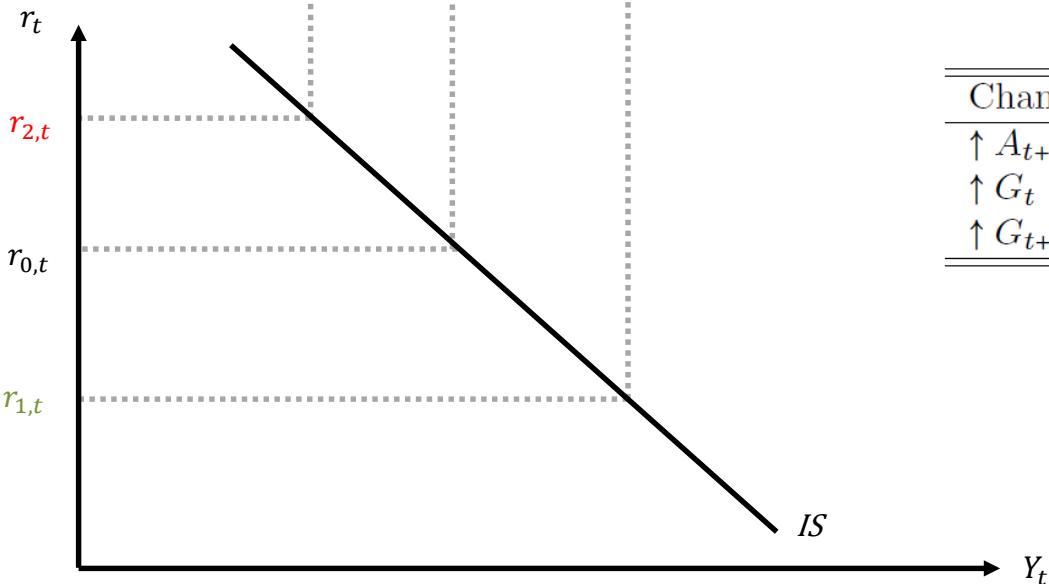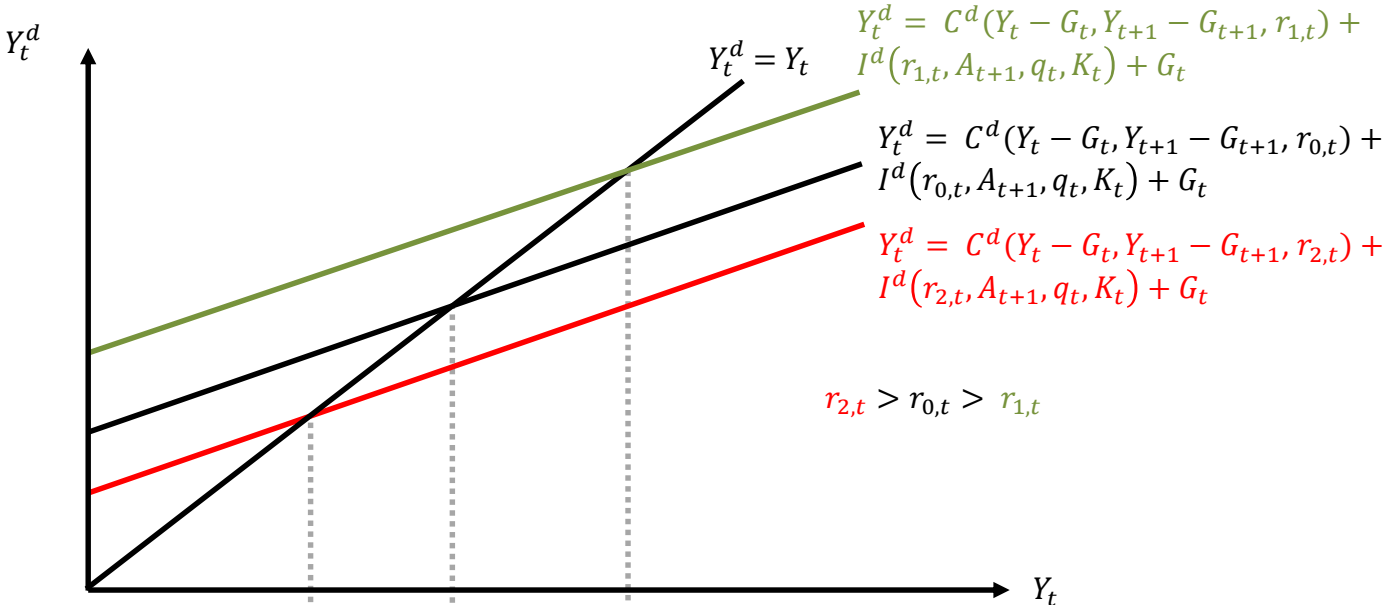| Change in Variable	Direction of Shift of LM
$\uparrow M_t$	Down (Right)
$\uparrow P_t$	Up (Left)
$\uparrow \pi_{t+1}^e$	Down (Right)

Increase in M_t
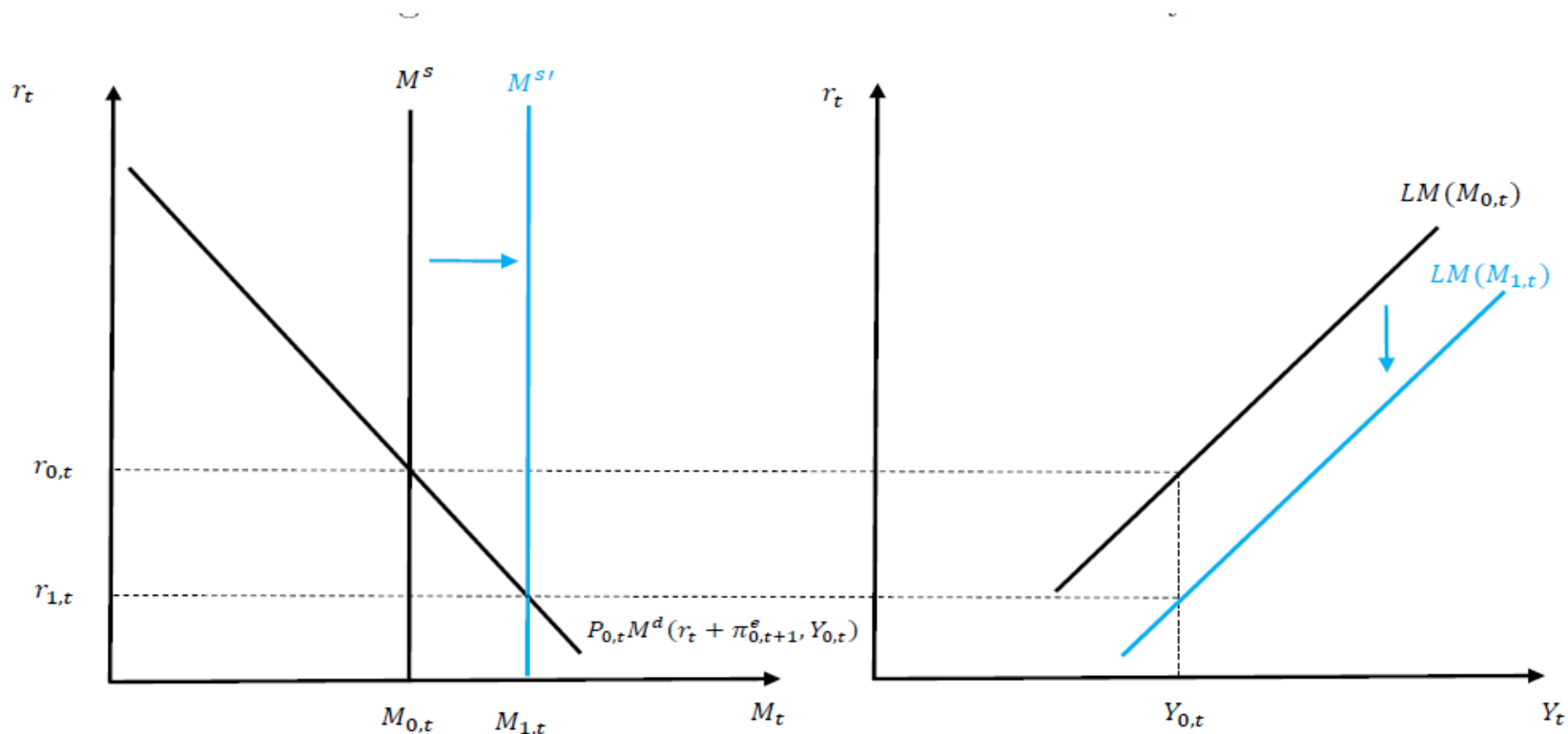
- Increase in M_t leads in the RBC model to an increase in P_t
- In the NK model P_t is constant. Hence, either for a given r_t there must be an increase in Y_t or for a given Y_t there must a reduction in r_t to shift money demand to keep P_t constant.
- The LM curve shifts to the right / down.

Increase in P_t
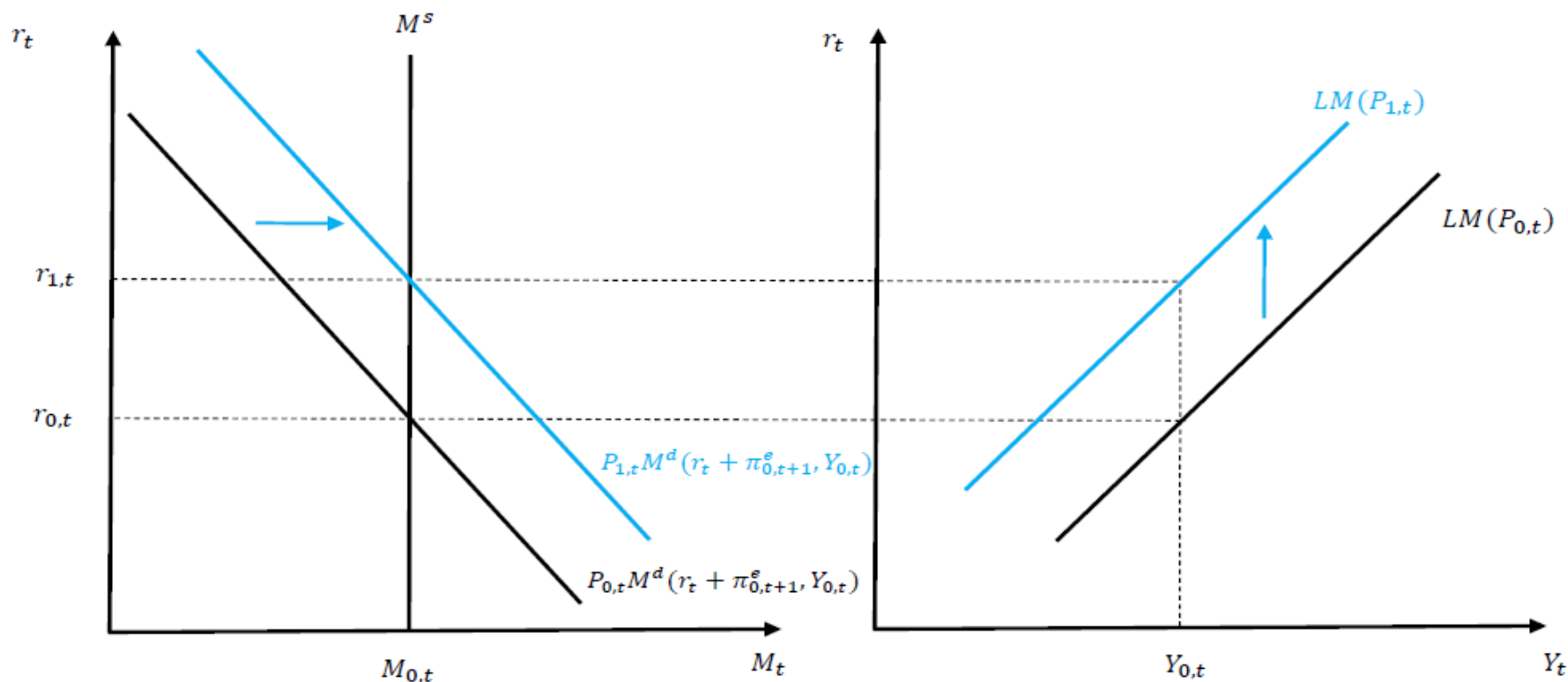
- An exogenous increase in P_t leads to a shift of money demand to the right.
- If people demand more money, but money supply is constant, the interest rate r_t must increase to "undo" the increase in money demand.
- The opportunity cost of holding money increases so that people demand exactly as much money as before the increase in P_t.
- Hence, for a given income level the real interest rate increases, so that the LM-curve shifts upwards (to the left).

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# Reminder on the IS curve (same in RBC and NK model)

Y_t^d

$Y_t^d = Y_t$

$Y_t^d = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_{1,t}) + I^d(r_{1,t}, A_{t+1}, q_t, K_t) + G_t$

$Y_t^d = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_{0,t}) + I^d(r_{0,t}, A_{t+1}, q_t, K_t) + G_t$

$Y_t^d = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_{2,t}) + I^d(r_{2,t}, A_{t+1}, q_t, K_t) + G_t$

$r_{2,t} > r_{0,t} > r_{1,t}$

Y_t

r_t

$r_{2,t}$

$r_{0,t}$

$r_{1,t}$

Change in Variable	Direction of Shift of IS
$\uparrow A_{t+1}$	Right
$\uparrow G_t$	Right
$\uparrow G_{t+1}$	Left

IS

Y_t

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The AD curve

- Combinations of P_t and Y_t for which both the demand and nominal equilibrium relations hold, i.e. the IS curve (demand) and LM curve (nominal) intersect.

- Basic idea: P_t determines position of LM curve, which determines a Y_t where the LM curve intersects the IS curve. A higher P_t means the LM curve shifts in, which results in a lower Y_t
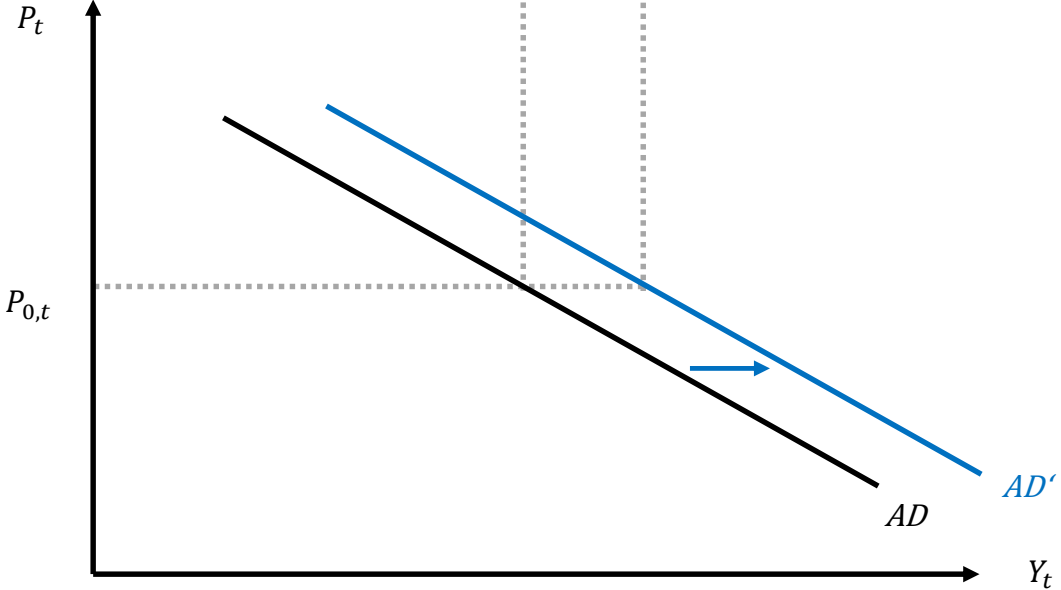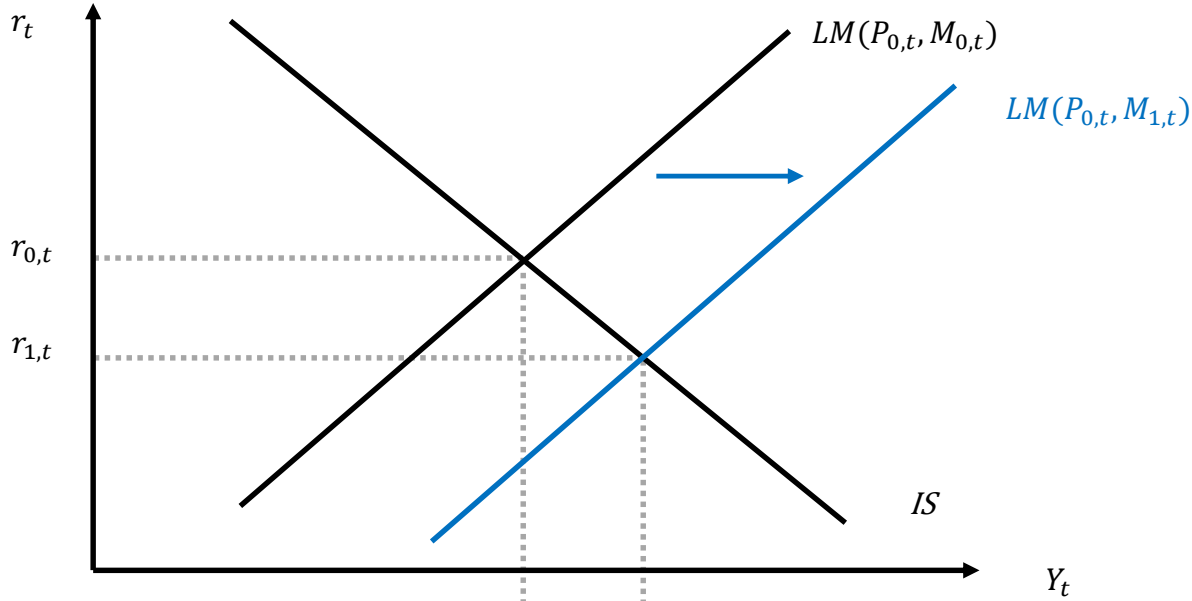
- Hence, the AD curve is downward-sloping.
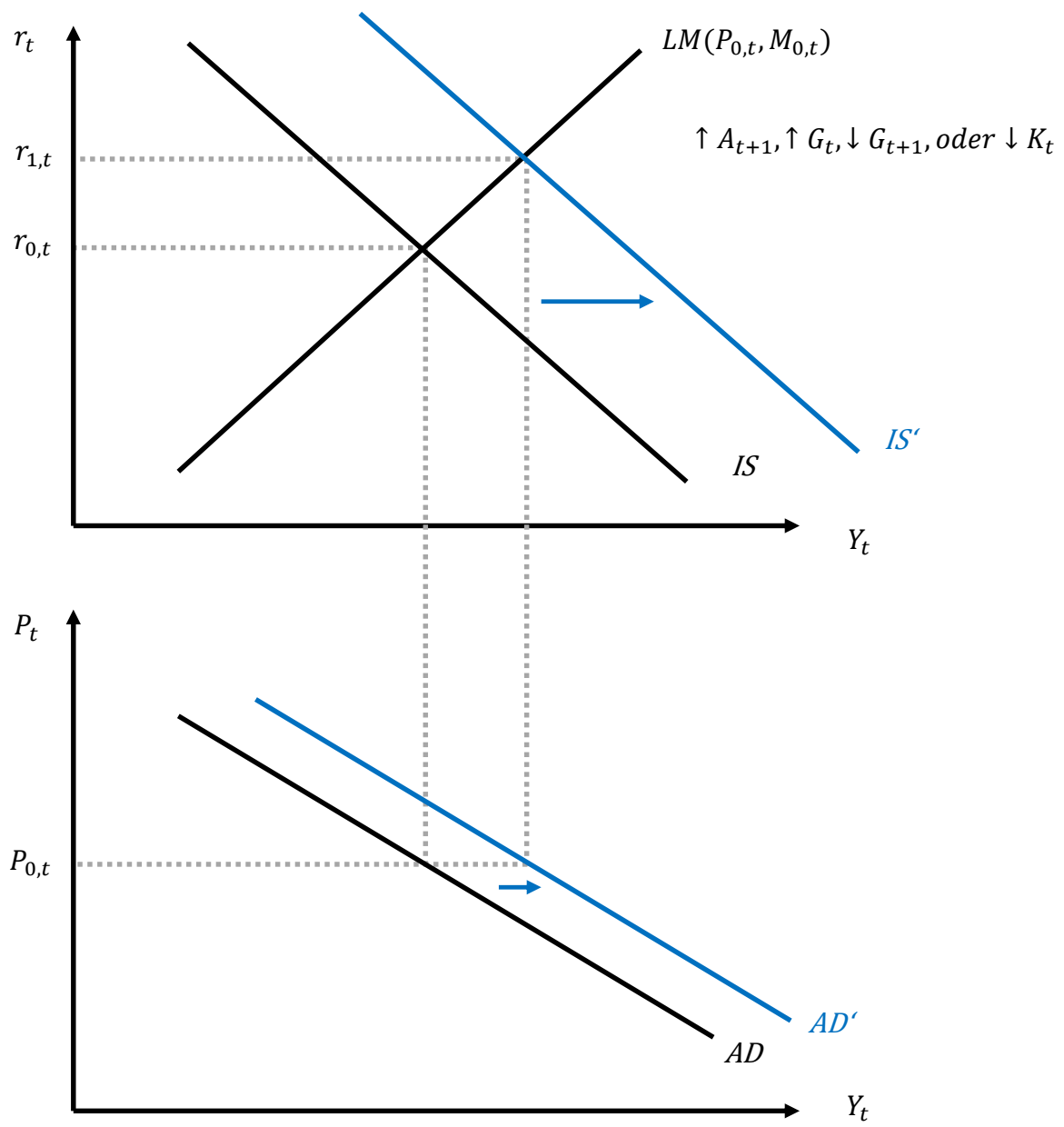
Deriving the AD Curve
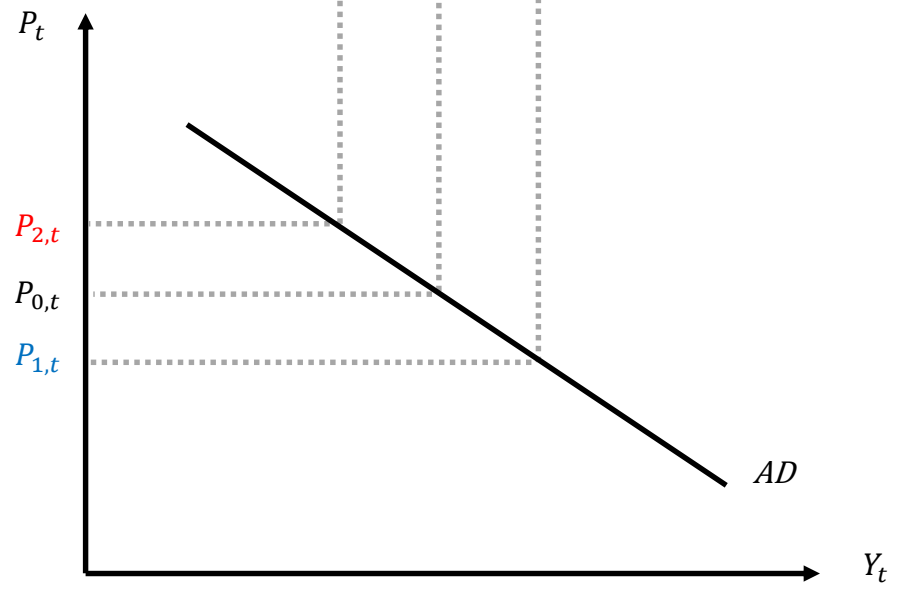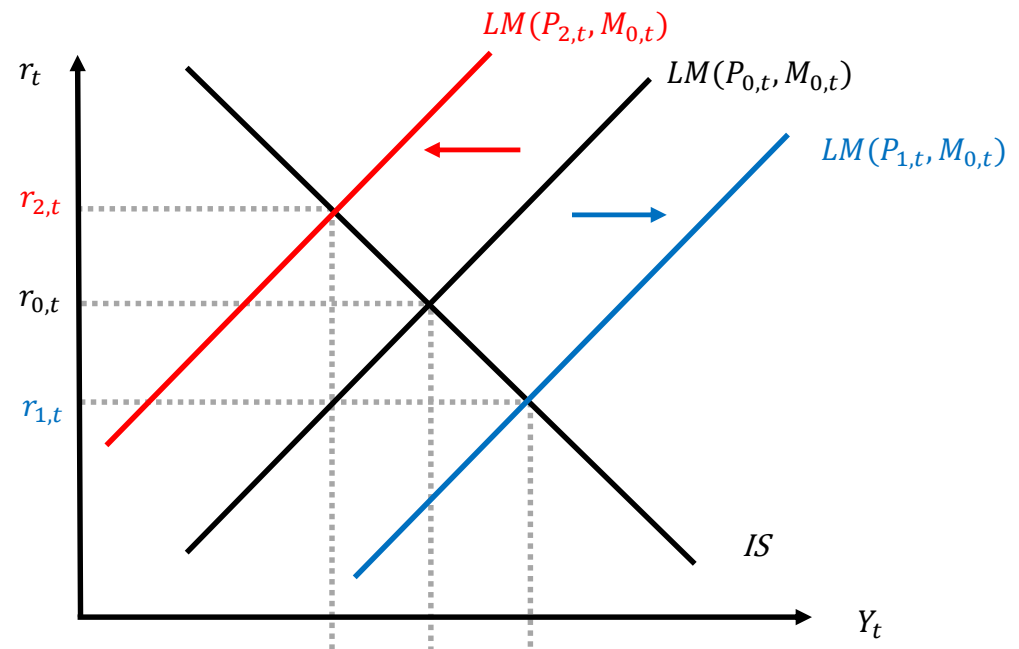
Shifts of the AD Curve

- The AD curve will shift if either the IS or LM curves shift (for reason other than P_t)

- This means that the AD curve will shift right if:

  - A_{t+1}, or G_t increase (IS shifts); M_t or π^e_{t+1} increase (LM shifts)

  - G_{t+1} decreases (IS shift)

- Note: we could use the AD curve to summarize the demand side of the neoclassical model as well. Was just convenient to not since this emphasized classical dichotomy in the neoclassical model.

Shift of the AD curve: Increase in M_t

Shift of the AD curve: IS shock

$LM(P_{0,t}, M_{0,t})$

$\uparrow A_{t+1}, \uparrow G_t, \downarrow G_{t+1}, oder \downarrow K_t$

$r_{1,t}$

$r_{0,t}$

IS'

IS

Y_t

P_t

$P_{0,t}$

AD'

AD

Y_t

The Supply Side

- Generically, the AS curve is the set of (P_t, Y_t) pairs (i) consistent with the production function, (ii) some notion of labor market equilibrium, and (iii) any exogenous restriction on nominal price or wage adjustment

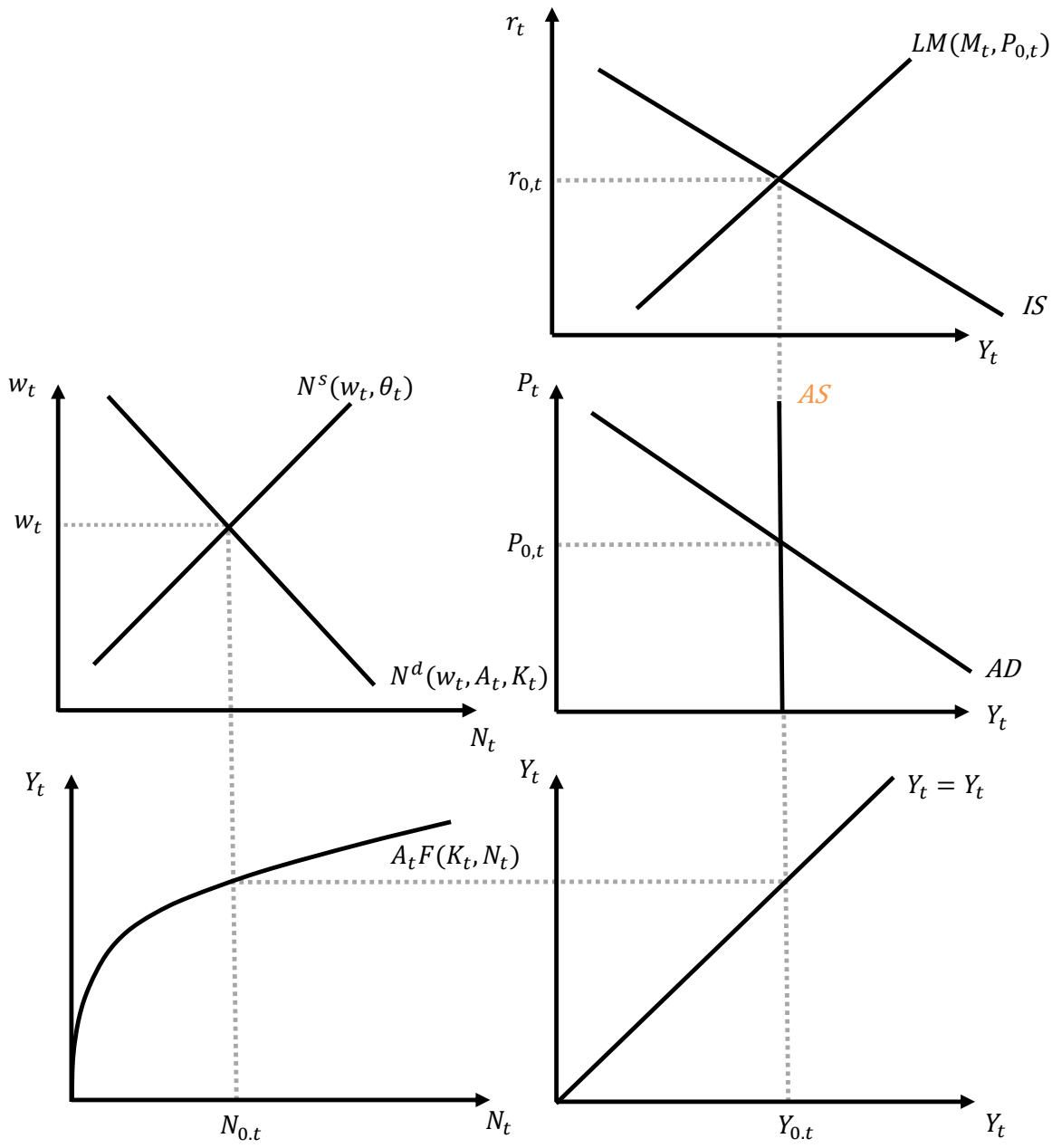- Can use the AS curve to summarize the RBC model as well as the New Keynesian model:

$$N_t = N^s(w_t, \theta_t)$$
$$N_t = N^d(w_t, A_t, K_t)$$
$$Y_t = A_t F(K_t, N_t)$$

- Since P_t does not appear in these equations, the AS curve would be vertical in the neoclassical model

Neoclassical IS-LM-AD-AS Equilibrium

Sticky Price Model

- In the sticky price model, assume that $P_t = \bar{P}_t$ is predetermined and hence exogenous

- Extreme form of price stickiness: price level completely pre-determined

- With a fixed nominal price level, it is impossible for all three equations of the supply side to hold simultaneously.

  - Given the price of goods which is fixed, the firm produces as much output as is demanded at that price.

  - The firm chooses N_t to meet demand, rather than to maximize profit. It is therefore off of its labor demand curve.

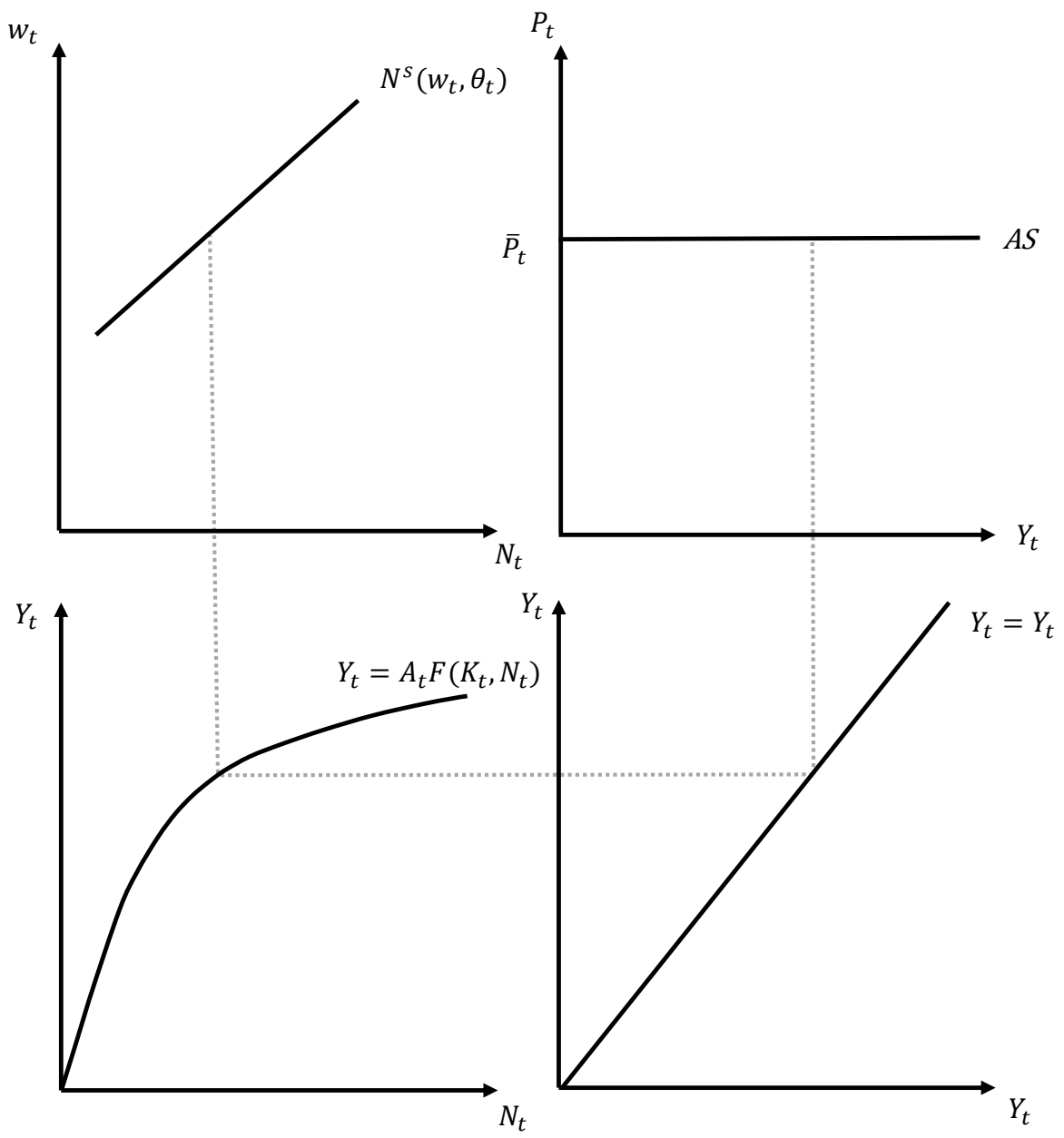 - Replace labor demand curve with $P_t = \bar{P}_t$.

  - Conditions:
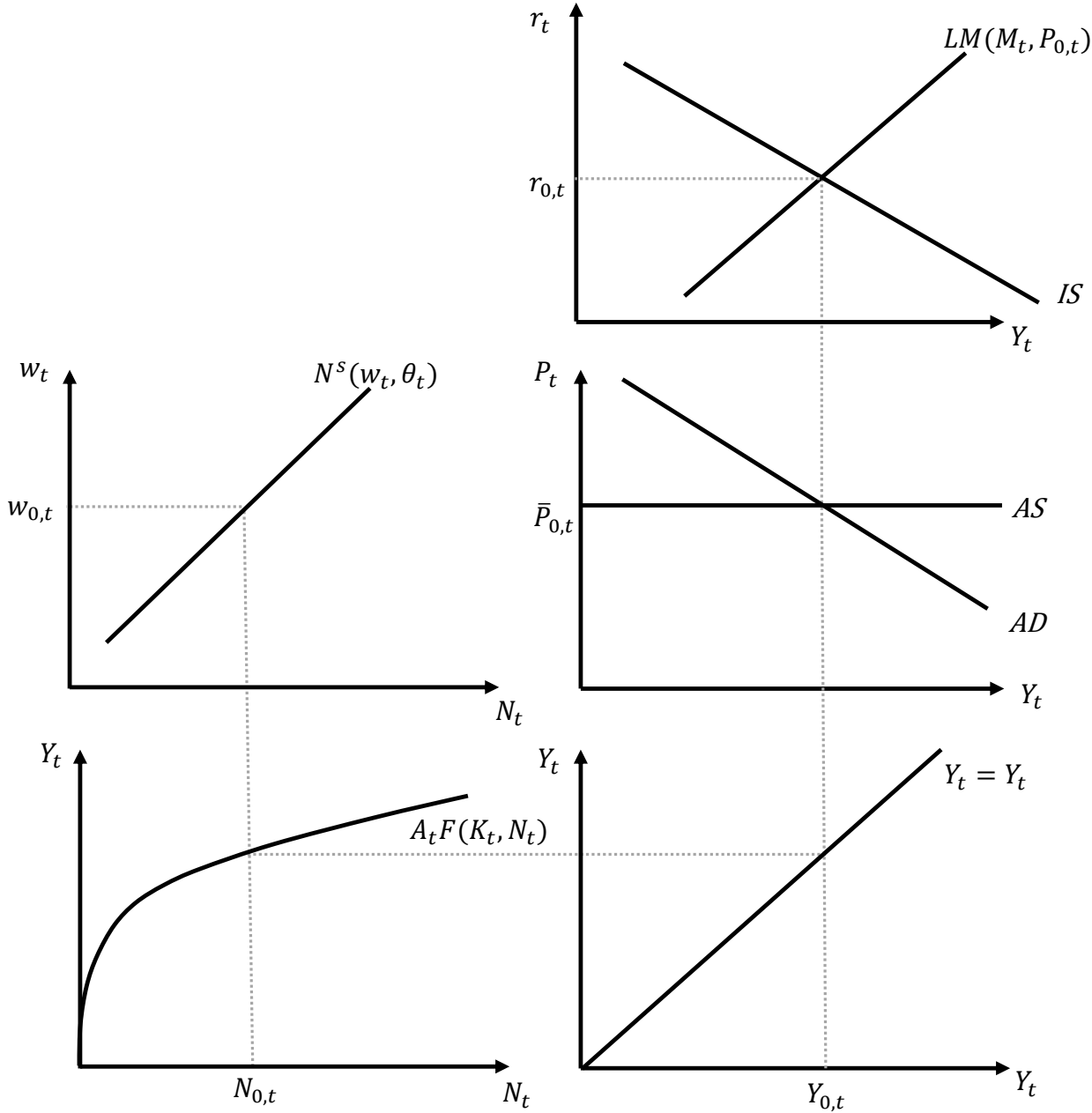$$N_t = N^s(w_t, \theta_t)$$
$$P_t = \bar{P}_t$$
$$Y_t = A_t F(K_t, N_t)$$

- The AS curve will just be horizontal at $\bar{P}_t$. Can only shift if $\bar{P}_t$ changes exogenously.

- Equilibrium is demand determined in the NK model rather than supply determined as in the RBC model.
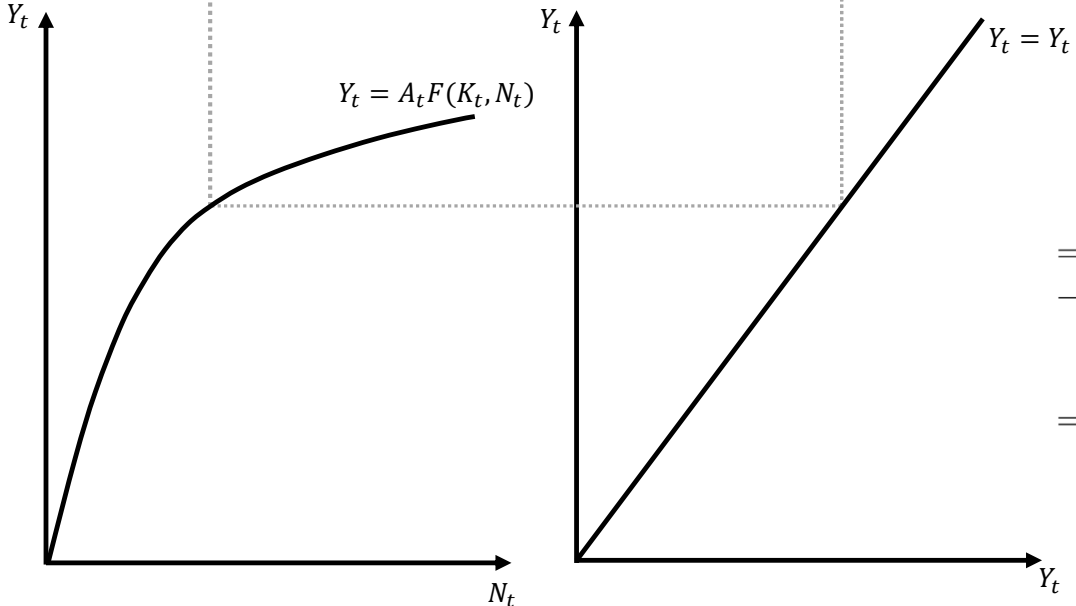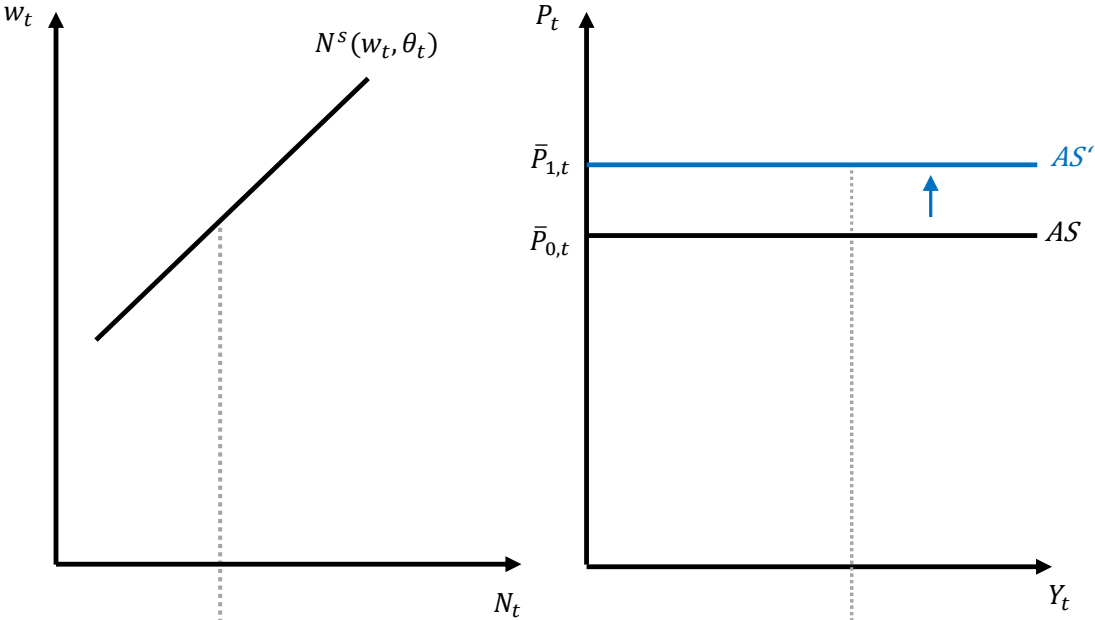
The Sticky Price AS Curve

Sticky Price IS-LM-AD-AS Equilibrium

Shift of the Sticky Price AS Curve: Increase in $\bar{P}_t$

Change in Variable	Direction of Shift of AS
$\uparrow A_t$	No Shift
$\uparrow \theta_t$	No Shift
$\uparrow \bar{P}_t$	Up

Summary

- The demand side in New Keynesian models is identical to the Neoclassical model. Because the New Keynesian model features monetary non-neutrality, we adopt an alter native graphical depiction so as to allow real and nominal variables to be simultaneously determined: IS-LM.

- Referencing back to the neoclassical model, the three equations characterizing the supply side of the economy are the labor demand curve, the labor supply curve, and the production function. Because P_t does not appear in any of these three curves, the neoclassical AS curve is vertical.

- New Keynesian models differ from the neoclassical counterpart in assuming some kind of nominal rigidity. This generates a non-vertical AS curve.

- In the sticky price model, we assume that the price level is exogenous. This means, rather mechanically, that the AS curve is horizontal. The firm is off its labor demand curve.

- It is important to note that the New Keynesian model differs in only one small dimension from the RBC model. We replace the labor demand curve with a fixed price. Otherwise, the models are identical. But this makes the equilibrium output completely demand driven, while it is supply driven in the RBC model.