The New Keynesian Model

ECON 30020: Intermediate Macroeconomics

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Readings

- GLS Ch. 21 (the demand side)
- GLS Ch. 22 (the supply side)
- GLS Ch. 23 (effects of shocks)

New Keynesian Models

- At risk of oversimplification, *New Keynesian* models are the leading alternative to the neoclassical / RBC model
- "New" Keynesian: neoclassical backbone to these models. Just a twist on neoclassical model, not a fundamentally different framework. In the "medium run" / "long run" models are the same
- Basic difference: nominal rigidities. Wages and/or prices are imperfectly flexible
- Means:
  1. Money is non-neutral
  2. Demand shocks matter
  3. Equilibrium of the model is inefficient
  4. There is therefore scope for policy to improve outcomes in short run

Demand and Supply

- The demand side of the neoclassical and New Keynesian models are the same
- Differences arise on the supply side
- Two basic variants (or mixture of the two): price stickiness or nominal wage stickiness
- This will require some change in the labor market – either the firm (price stickiness) or household (wage stickiness) is off its supply or demand schedule
- We will focus on two versions of the sticky price model in class – the "Simple" sticky price model and "Partial" sticky price model

Review: Neoclassical Model

- Equilibrium conditions:

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

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

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

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

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

$$Y_t = C_t + I_t + G_t$$

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

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

- P_t is endogenous

New Keynesian Model

- Simple sticky price model:
  - $P_t = \bar{P}_t$ is now exogenous, rather than endogenous
  - Extreme form of price stickiness: price level completely pre-determined
  - Replace labor demand curve with $P_t = \bar{P}_t$. Firm (which sets price), has to hire labor to meet demand at $\bar{P}_t$ rather than to maximize its value
- Partial sticky price model:
  - $P_t = \bar{P}_t + \gamma(Y_t - Y_t^f)$
  - $\bar{P}_t$ is again the exogenous component of the price level. $\gamma \geq 0$ a parameter. Y_t^f the hypothetical equilibrium level of output in neoclassical model.
  - Nests simple sticky price model ($\gamma = 0$) and neoclassical model ($\gamma \to \infty$)
  - Again replace labor demand curve with this modified expression for the price level

Simple Sticky Price Model

- Equilibrium conditions:

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

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

$$P_t = \bar{P}_t$$

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

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

$$Y_t = C_t + I_t + G_t$$

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

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

- $\bar{P}_t$ is exogenous
- Only *one* equation different from neoclassical model!

Partial Sticky Price Model

- Equilibrium conditions:

$$C_t = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_t)$$
$$N_t = N^s(w_t, \theta_t)$$
$$P_t = \bar{P}_t + \gamma(Y_t - Y_t^f)$$
$$I_t = I^d(r_t, A_{t+1}, f_t, K_t)$$
$$Y_t = A_t F(K_t, N_t)$$
$$Y_t = C_t + I_t + G_t$$
$$M_t = P_t M^d(i_t, Y_t)$$
$$r_t = i_t - \pi_{t+1}^e$$

- $\bar{P}_t$ is exogenous
- Can think of Y_t^f as exogenous with respect to these equations – it is solution to the eight equations when we are on the labor demand curve in neoclassical model

Graphing the Equilibrium

- We will use the AD (aggregate demand) and AS (aggregate supply) curves to summarize the equilibrium
- AD: stands for aggregate demand. Set of (P_t, Y_t) pairs consistent with the following conditions:

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

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

$$Y_t = C_t + I_t + G_t$$

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

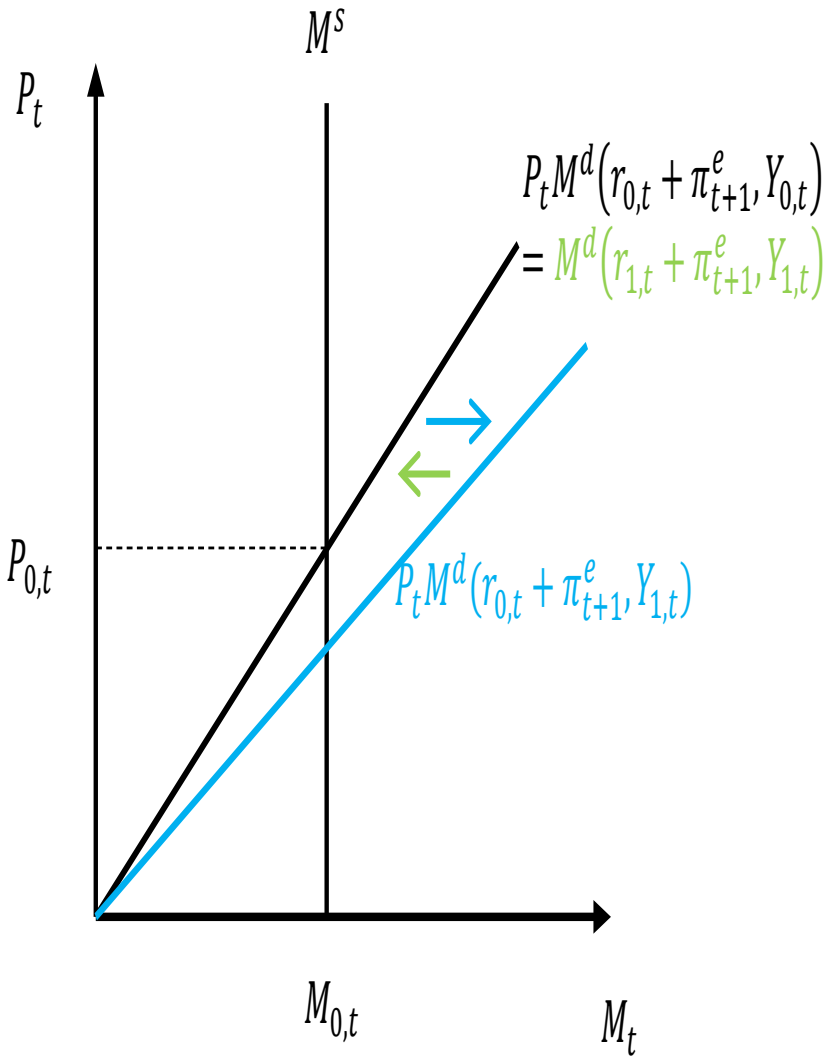
$$r_t = i_t - \pi^e_{t+1}$$

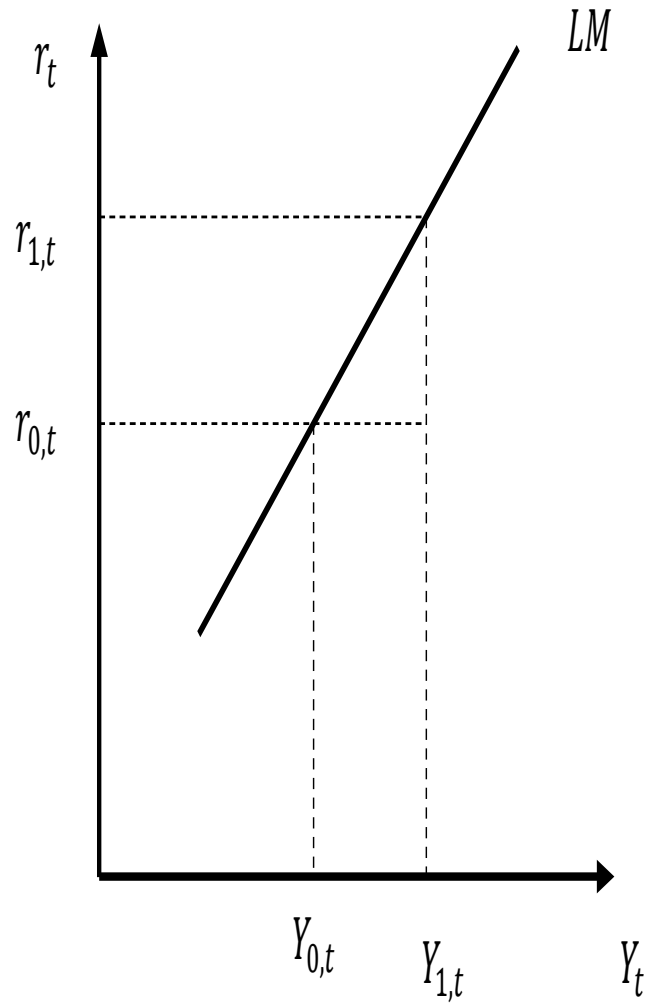
- Differently than before, AD curve summarizes *both* real demand (the first three equations, the *IS* curve) and nominal demand (the last two, what will be the *LM* curve)
- Classical dichotomy will no longer hold, so cannot separately analyze real and nominal sides of the economy
- Nevertheless, could define and use the AD curve in the neoclassical model

The IS and LM Curves

- The IS curve is *identical* to before: set of (r_t, Y_t) pairs where the first three of the conditions hold
- LM curve (liquidity = money) plots combinations of (r_t, Y_t) where last two equations hold. Combination of (r_t, Y_t) where money market clears
- 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
- Go through graphical derivation
- LM curve will shift if M_t, P_t, or π^e_{t+1} change
- Rule of thumb: LM curve shifts in the same direction as real balances, $\frac{M_t}{P_t}$

Deriving the LM Curve

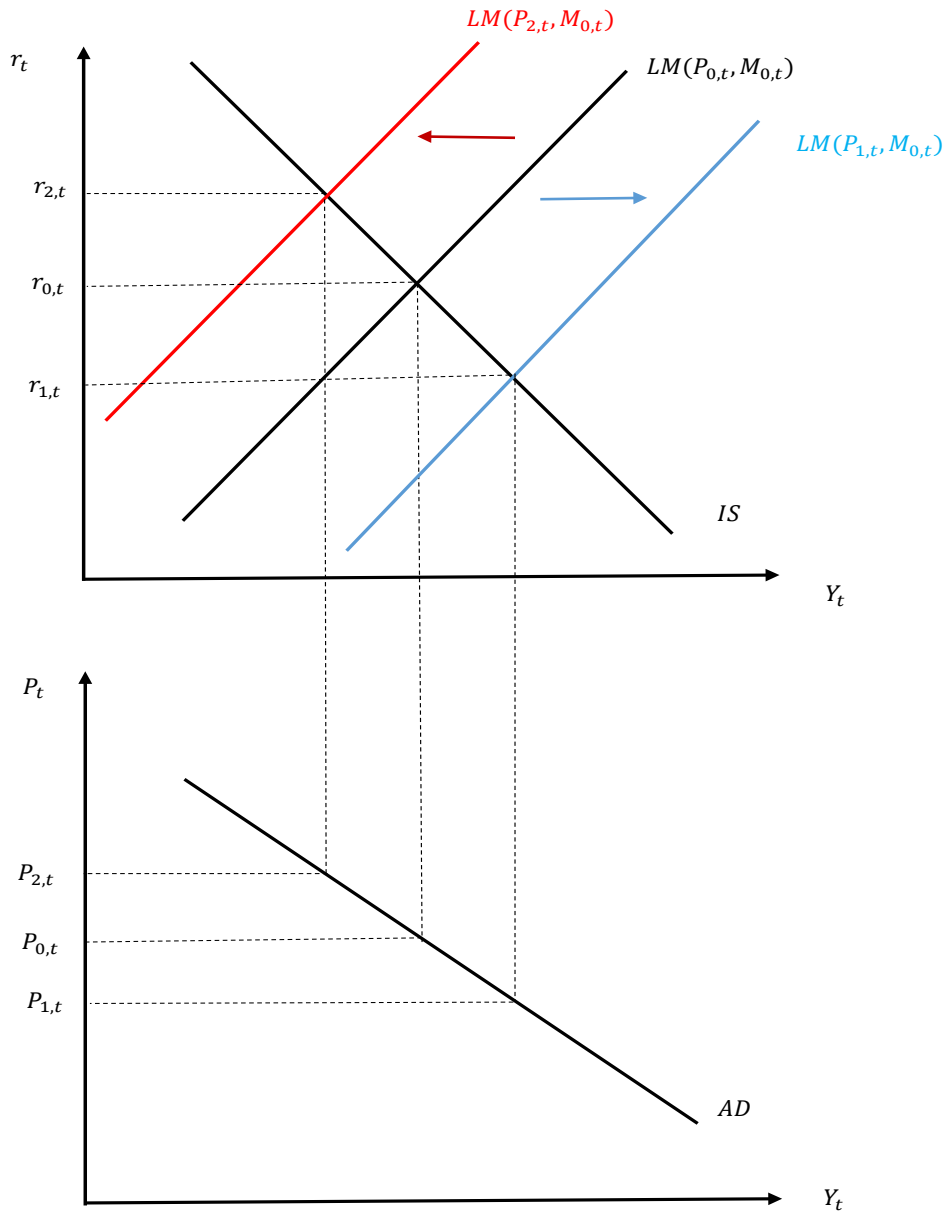




The AD Curve

- The AD curve is the set of (P_t, Y_t) pairs where the economy is on both the IS and LM curves
- 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
- Go through graphical derivation

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)
  - f_t or G_{t+1} decrease (IS shifts)
- 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

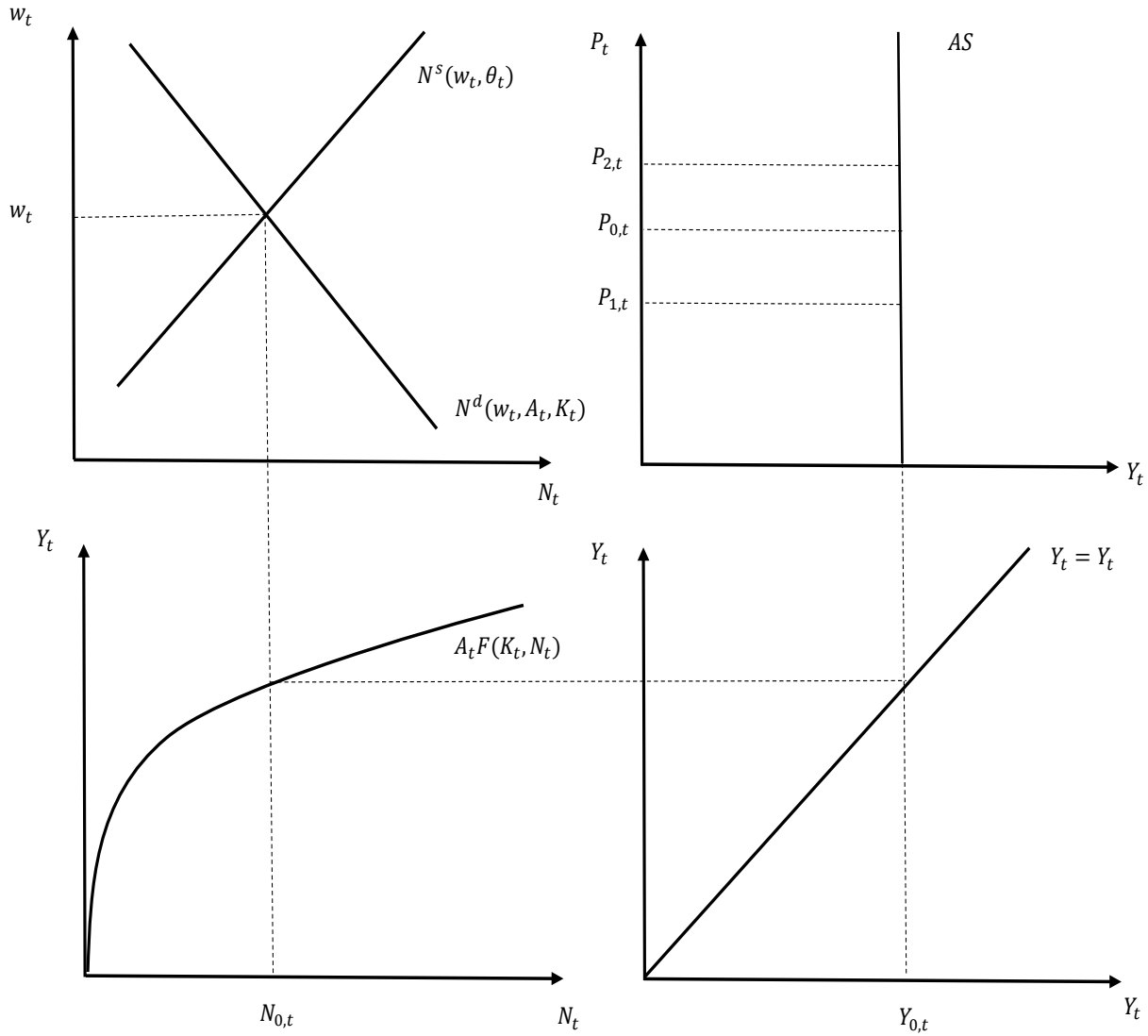
The Supply Side

- 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 neoclassical model as well as the New Keynesian model:

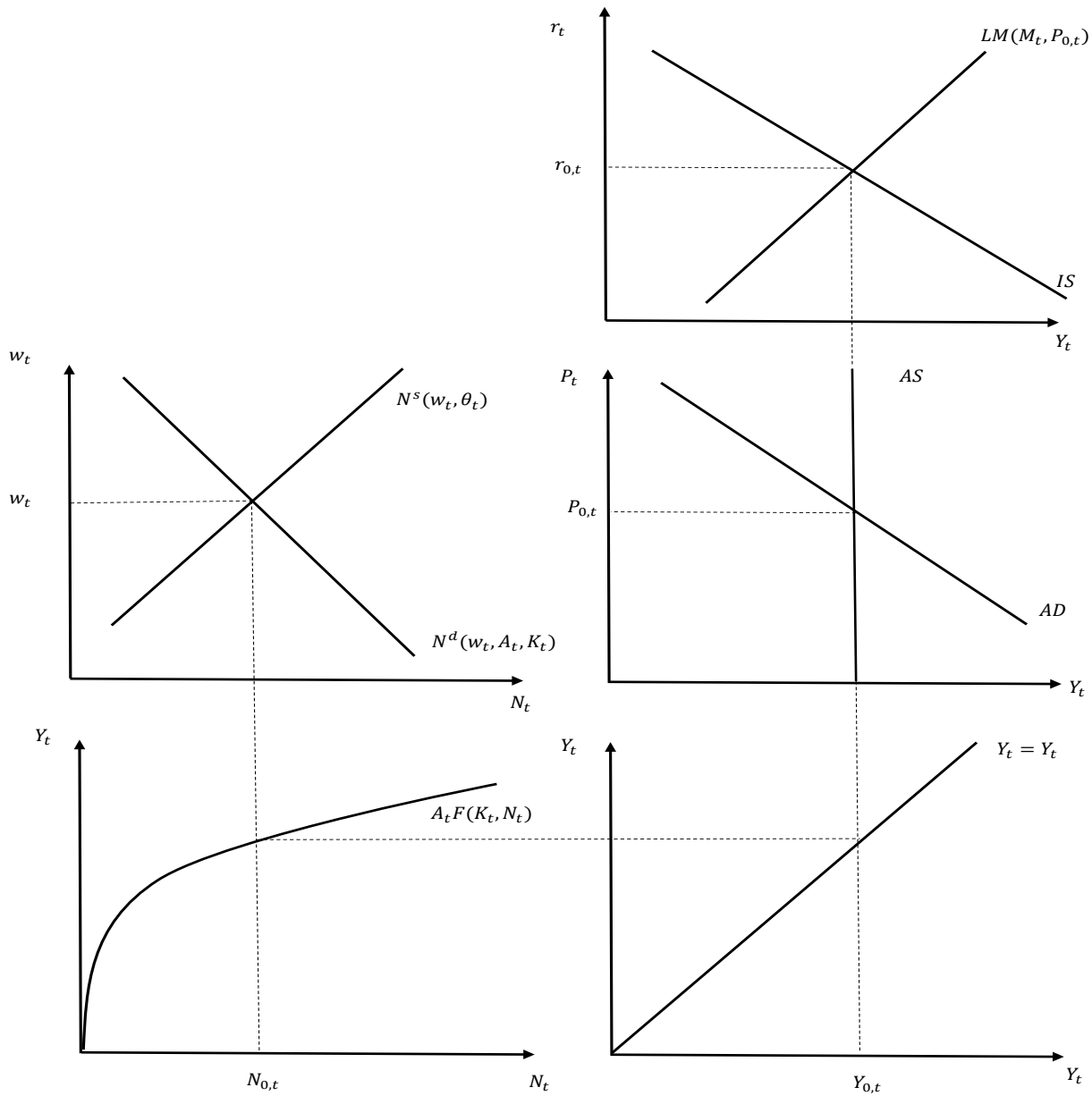
$$N_t = N^s(w_t, \theta_t)$$
$$N_t = N^d(w_t, A_t, K_t)$$
$$Y_t = A_t F(K_t, N_t)$$

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

The Neoclassical AS Curve



Neoclassical IS-LM-AD-AS Equilibrium



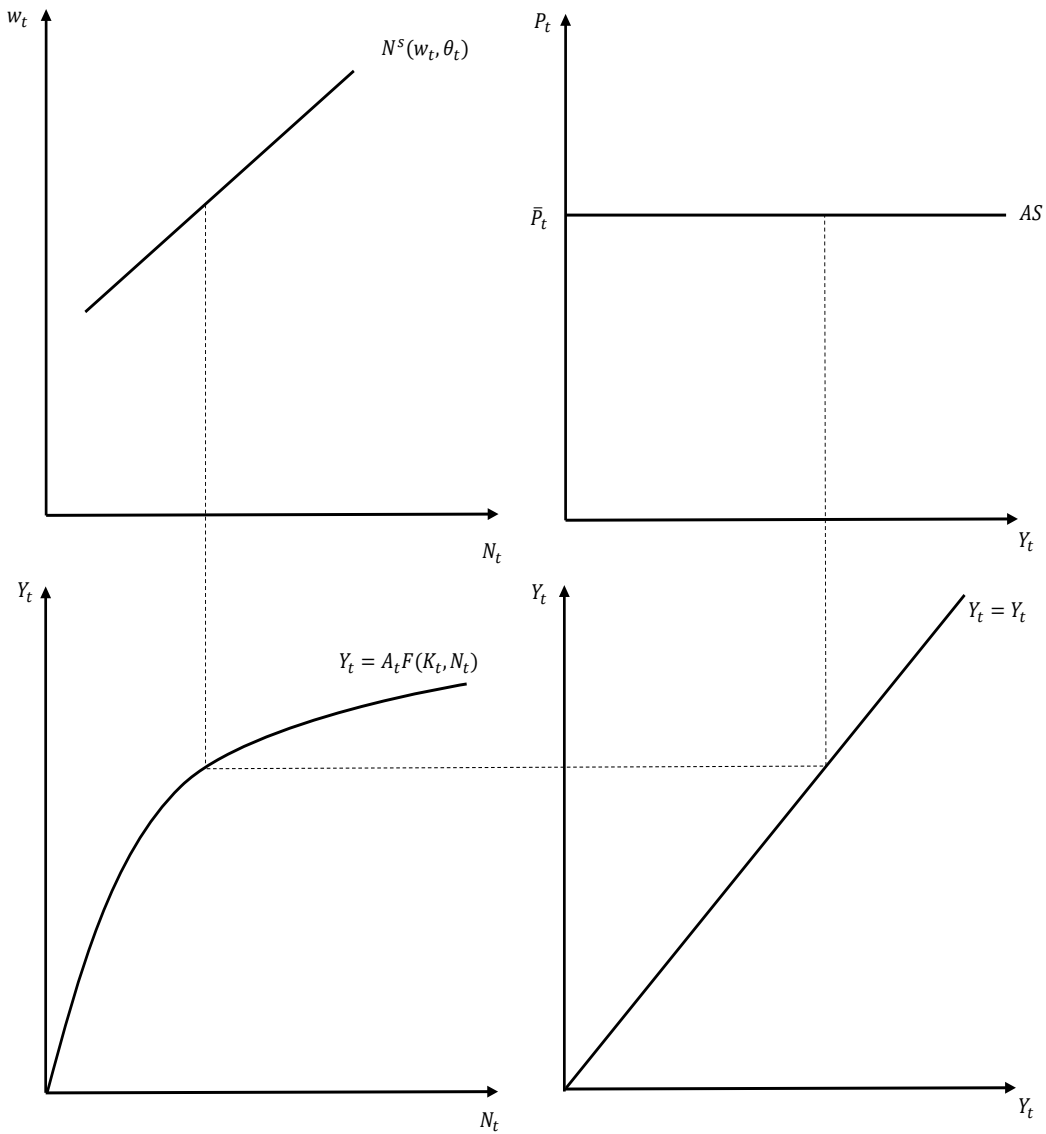
Simple Sticky Price Model

- In simple sticky price model, assume that $P_t = \bar{P}_t$ is predetermined and hence exogenous (think something like menu costs)
- Replace labor demand with this condition: firm has to meet demand at P_t, cannot optimally choose labor conditional on this
- Conditions:

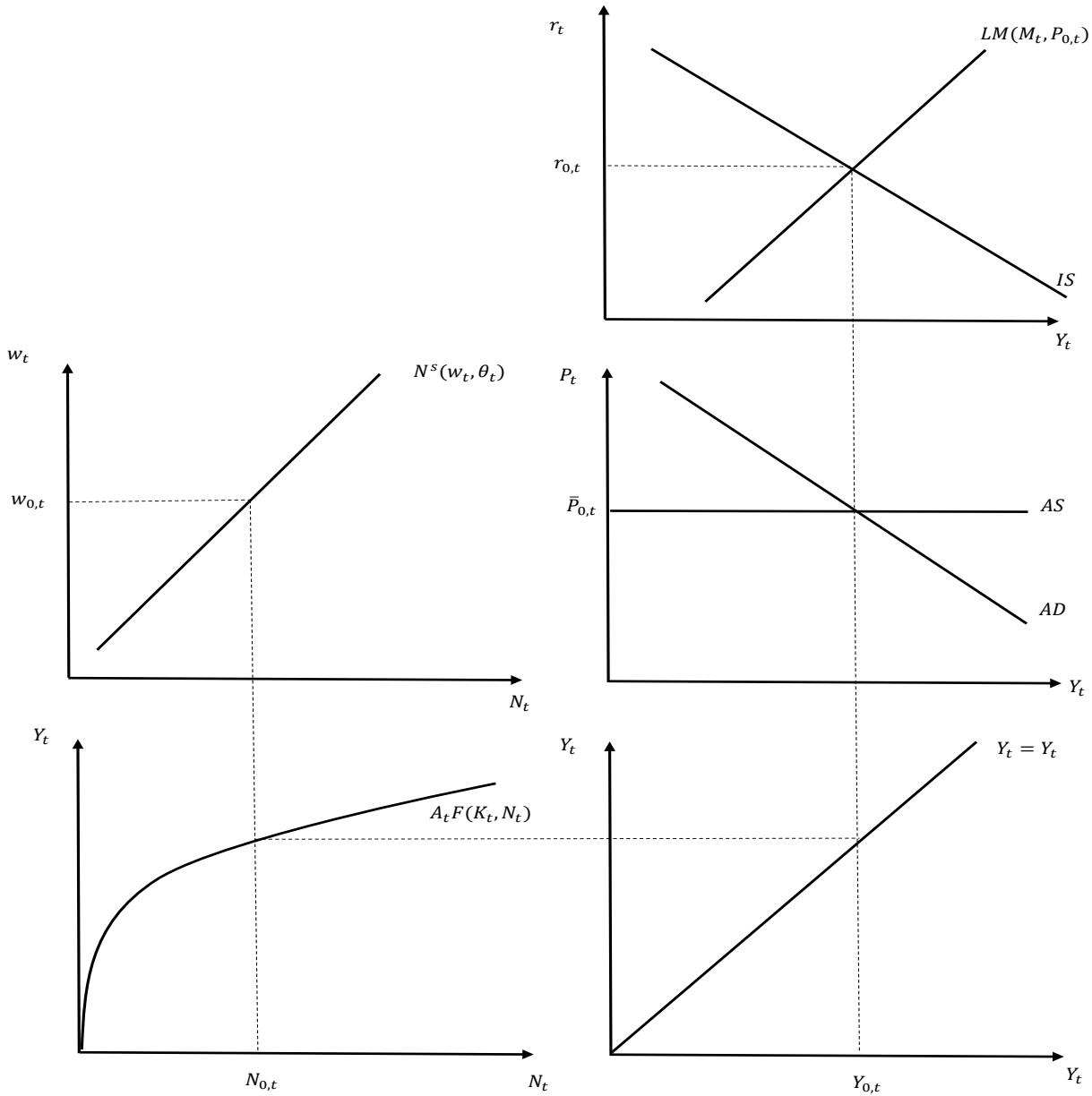
$$N_t = N^s(w_t, \theta_t)$$
$$P_t = \bar{P}_t$$
$$Y_t = A_t F(K_t, N_t)$$

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

The Simple Sticky Price AS Curve



Simple Sticky Price IS-LM-AD-AS Equilibrium



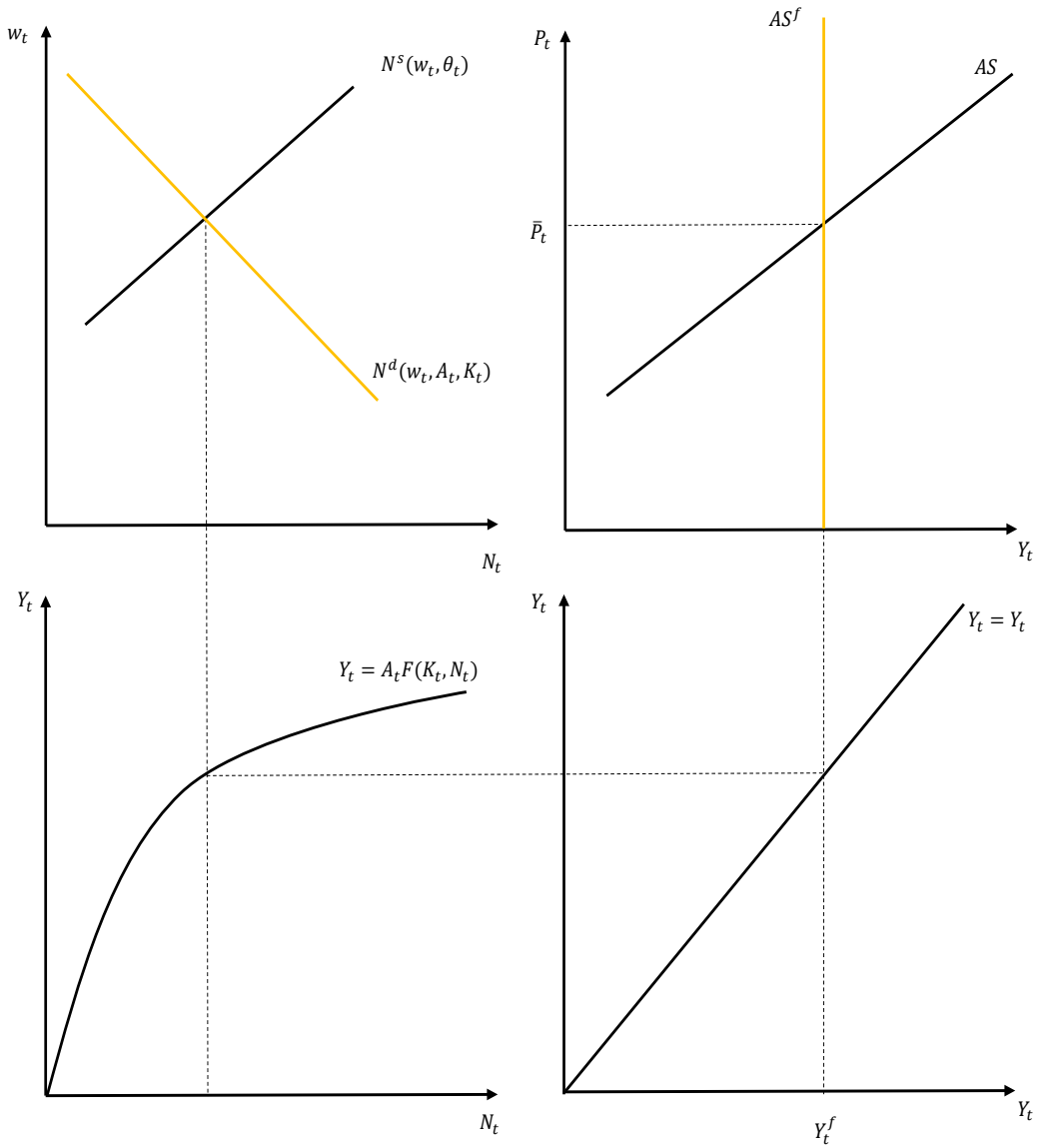
Partial Sticky Price Model

- In partial sticky price model, P_t is "partially" sticky but also depends on "output gap": $P_t = \bar{P}_t + \gamma(Y_t - Y_t^f)$
- Replace labor demand with this condition: firm has to meet demand at P_t, cannot optimally choose labor conditional on this
- Conditions:

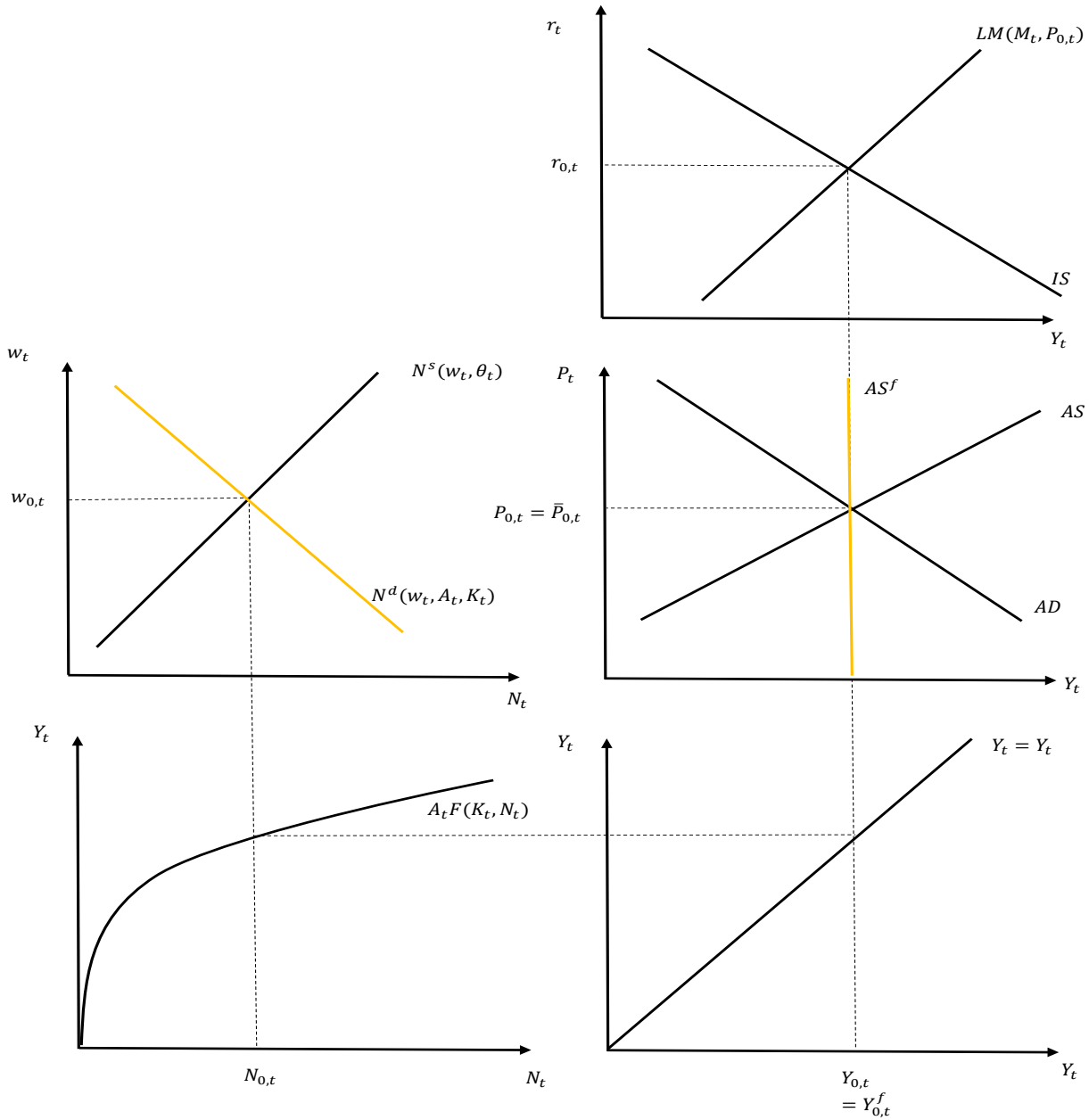
$$N_t = N^s(w_t, \theta_t)$$
$$P_t = \bar{P}_t + \gamma(Y_t - Y_t^f)$$
$$Y_t = A_t F(K_t, N_t)$$

- The AS curve will be upward-sloping with slope determined by γ
- Crosses point $P_t = \bar{P}_t$ at $Y_t = Y_t^f$, where Y_t^f can graphically be found where labor supply intersects hypothetical labor demand
- AS^f: hypothetical neoclassical AS curve (sometimes called LRAS)

The Partial Sticky Price AS Curve



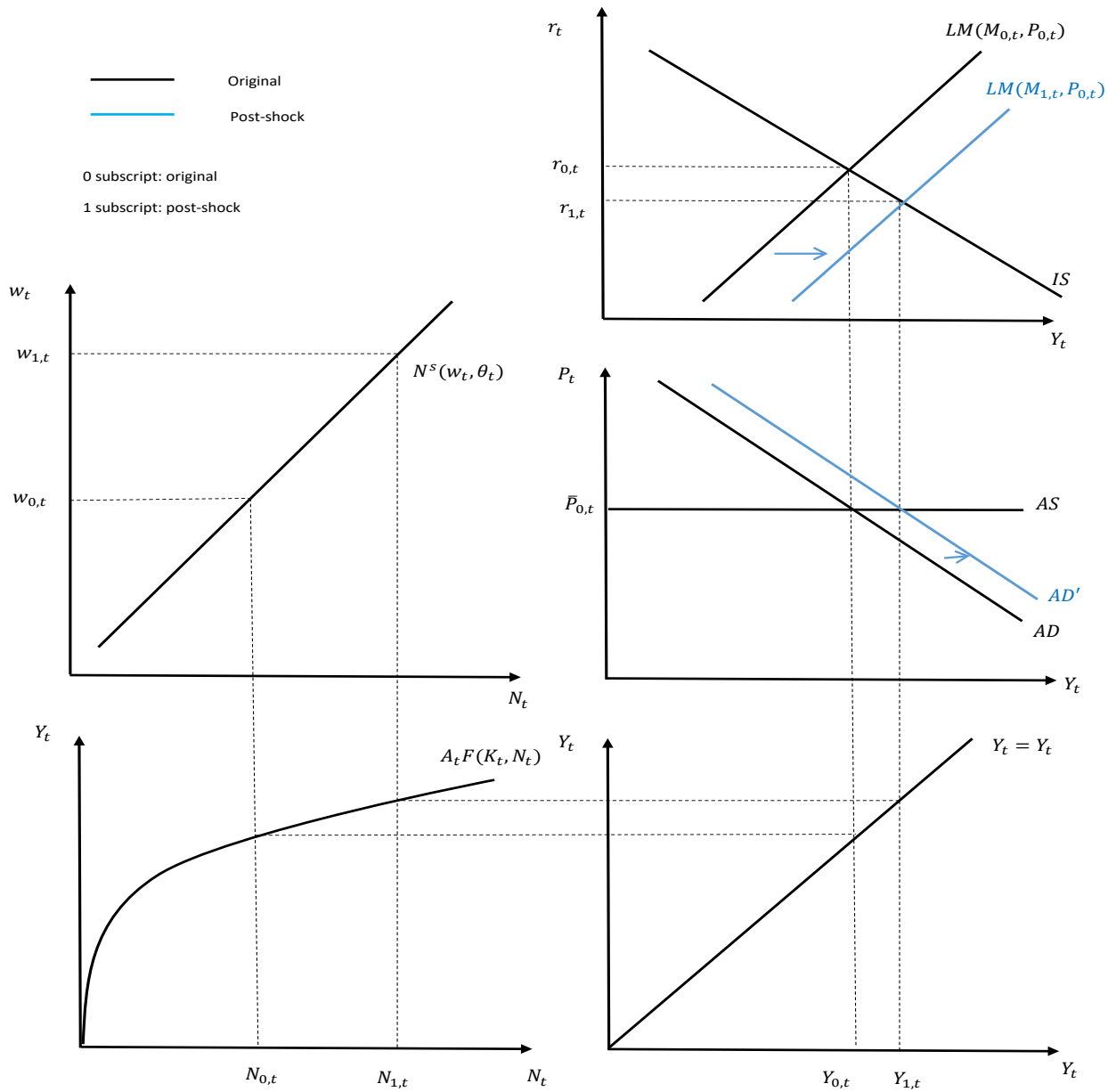
Partial Sticky Price IS-LM-AD-AS Equilibrium



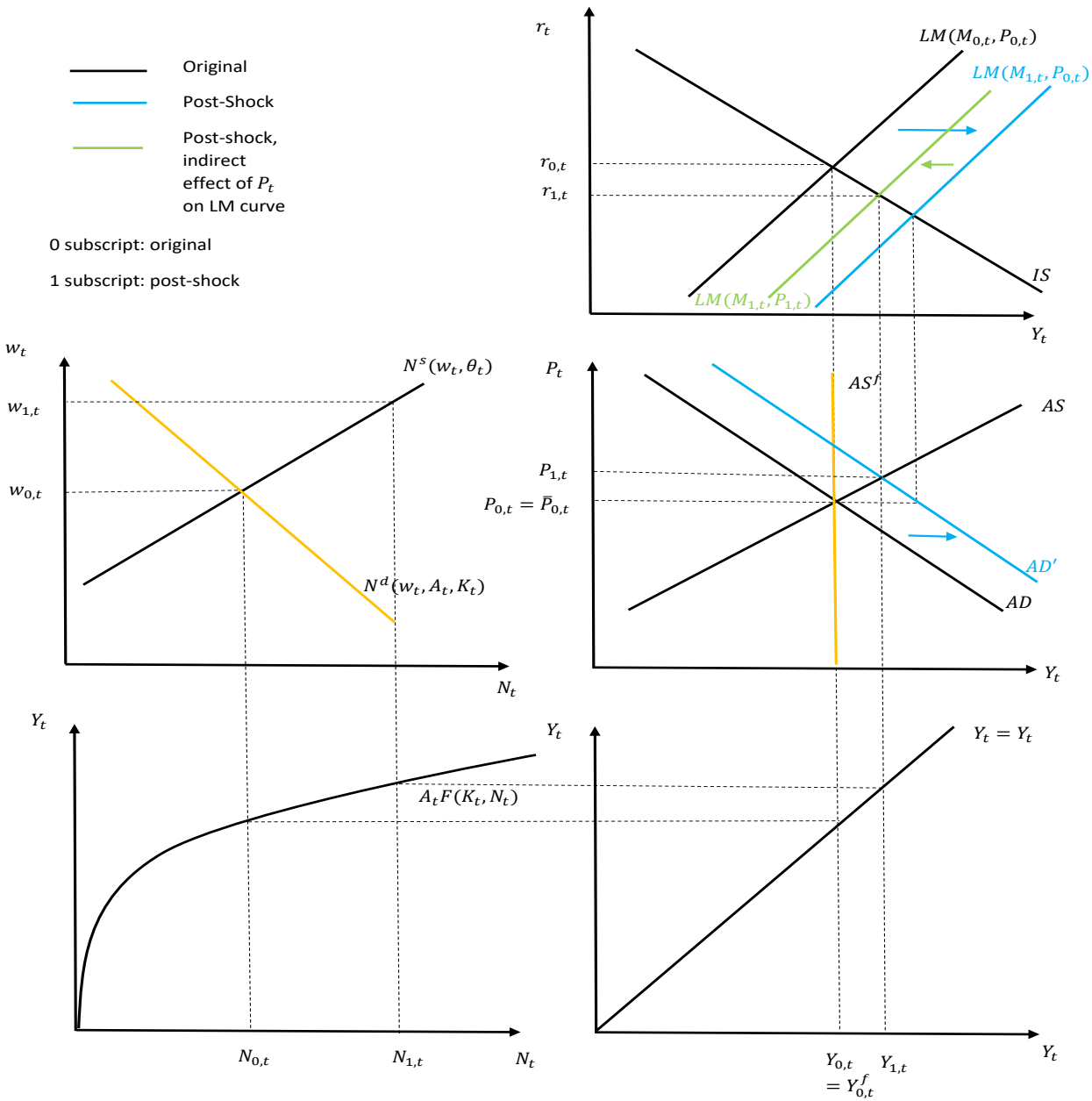
Monetary Non-Neutrality

- Whereas in the neoclassical model Y_t is *supply determined*, in the New Keynesian model output is (fully or partially) *demand determined*
- First, figure out what Y_t is (where AD and AS intersect), and then figure out what N_t must be to support that
- An increase in M_t shifts the LM curve to the right, and hence the AD curve to the right as well
- With a non-vertical AS curve, this results in a higher Y_t and lower r_t
- The lower r_t stimulates I_t; lower r_t plus higher Y_t means C_t is higher
- To support higher Y_t, N_t must rise
- To induce household to work more, w_t must rise

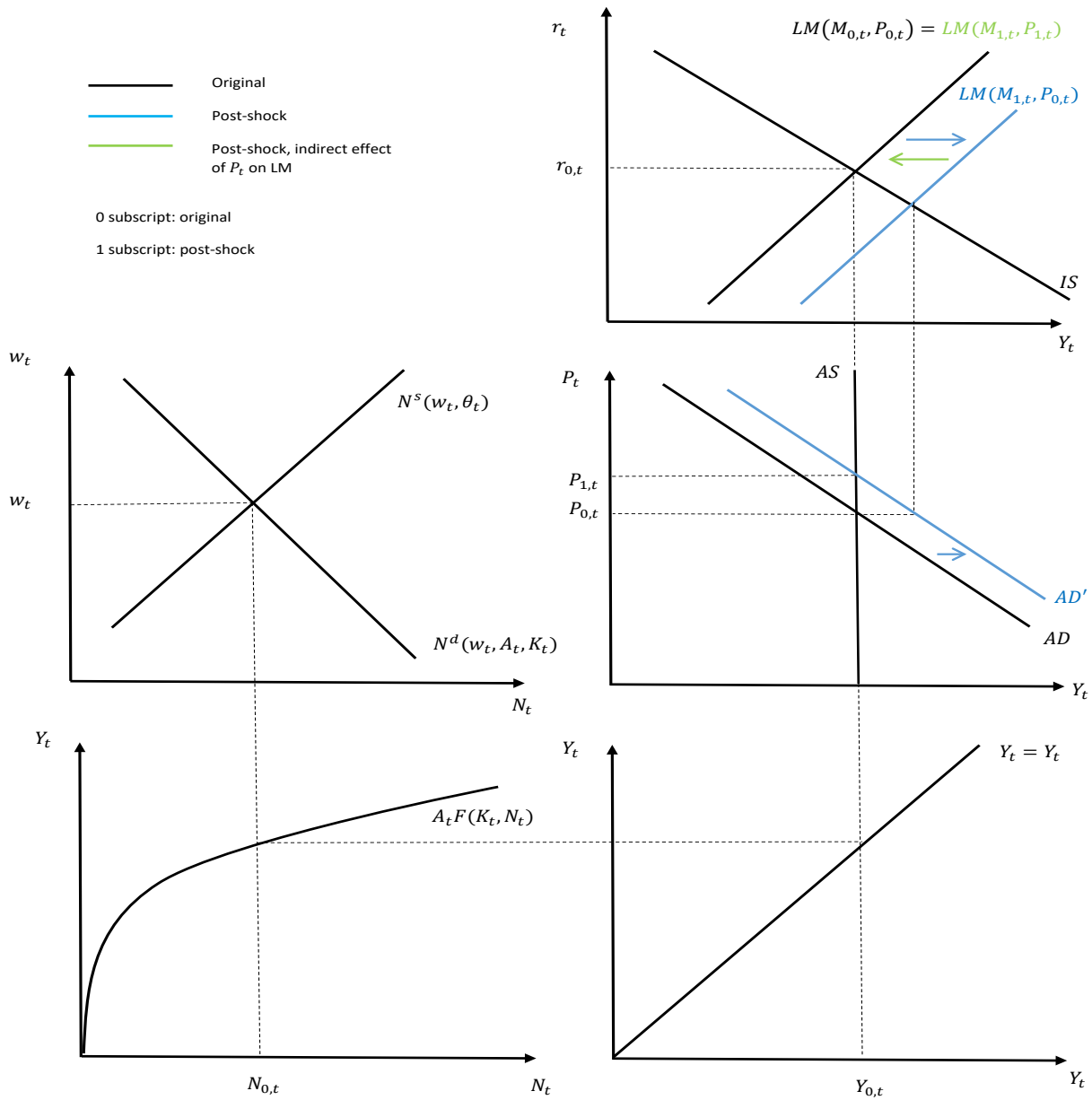
Increase in M_t: Graphically in Simple Sticky Price Model



Increase in M_t: Graphically in Partial Sticky Price Model



Increase in M_t: Graphically in Neoclassical Model



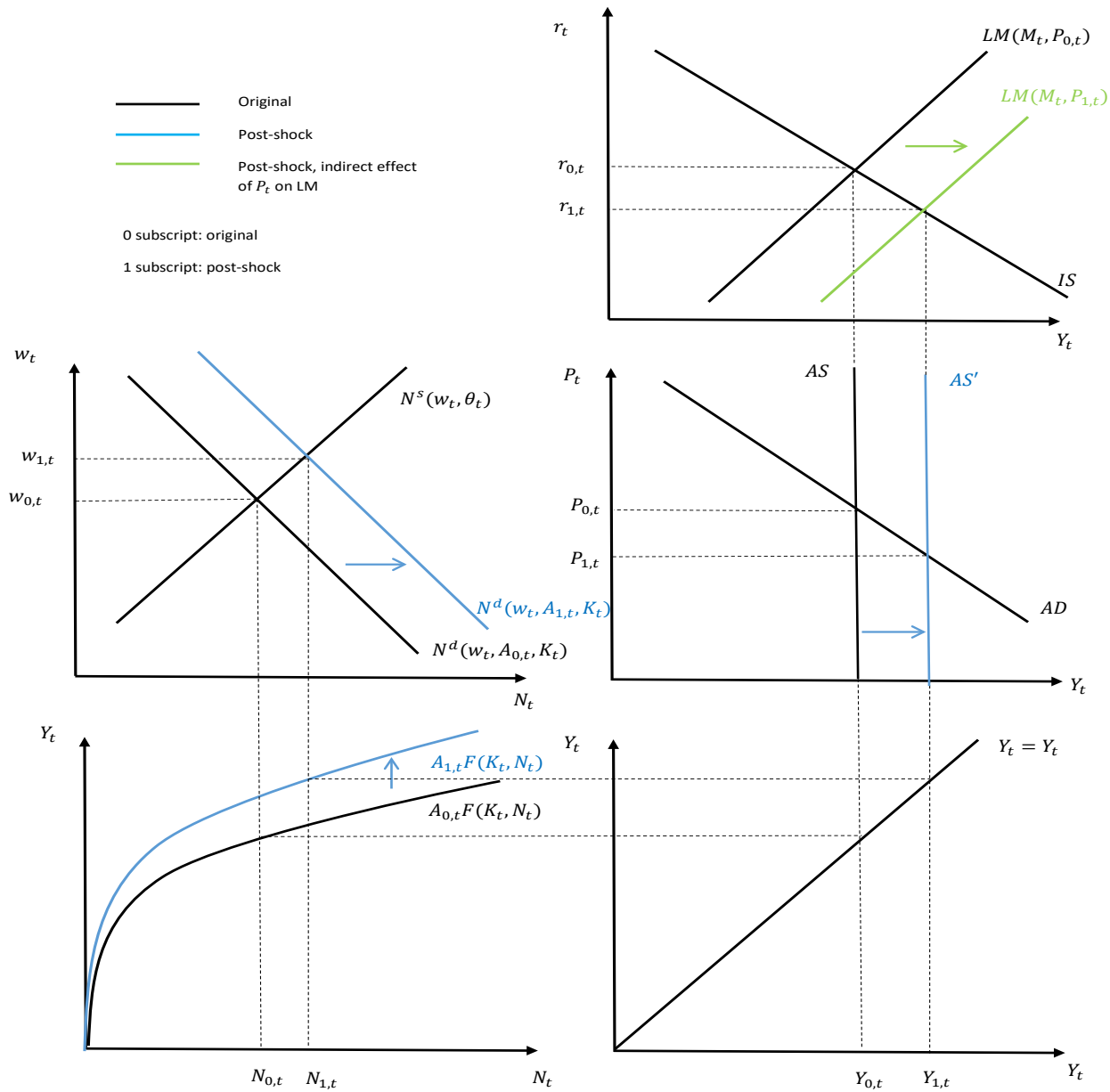
Monetary Non-Neutrality

- A change in the money supply affects real variables in New Keynesian model
- Has bigger effect on real variables the flatter is the AS curve (i.e. the smaller is γ)
- Nests two cases: $\gamma = 0$ simply sticky price, $\gamma \to \infty$ is neoclassical (where money is neutral)
- Intuition: if P_t is imperfectly flexible, then changes in M_t must cause real balances, $\frac{M_t}{P_t}$, to change
- But for money market to clear this requires changes in r_t and Y_t
- Amount r_t and Y_t must change depends on how much real balances move, which depends on how sticky P_t is

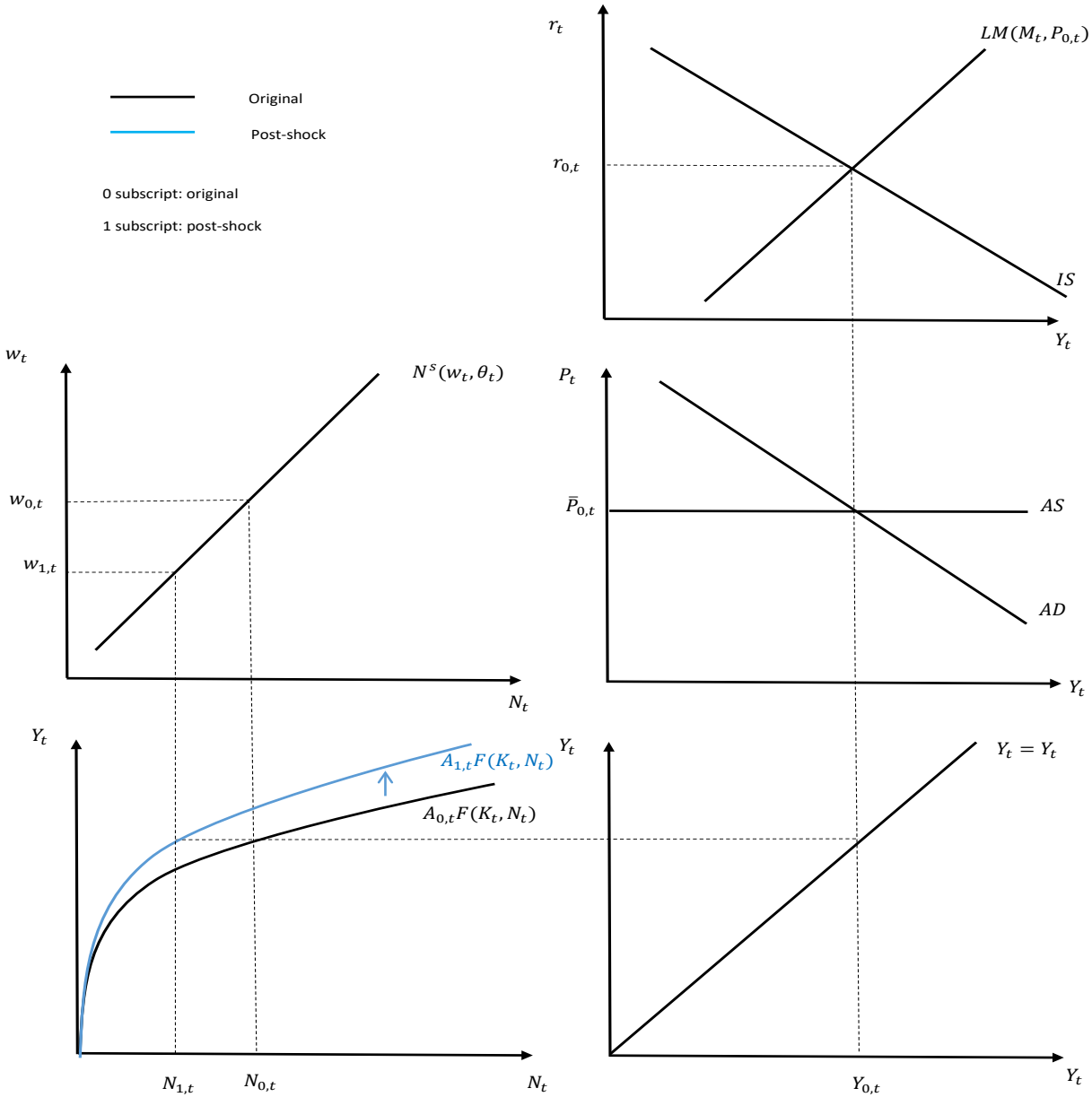
Supply Shocks

- Supply shocks (A_t, θ_t, or K_t) cause the AS curve to shift
- General rule of thumb: if price level is sticky (so AS curve is non-vertical), output reacts *less* to supply shocks
- Extent to which it reacts less depends upon slope of AS curve

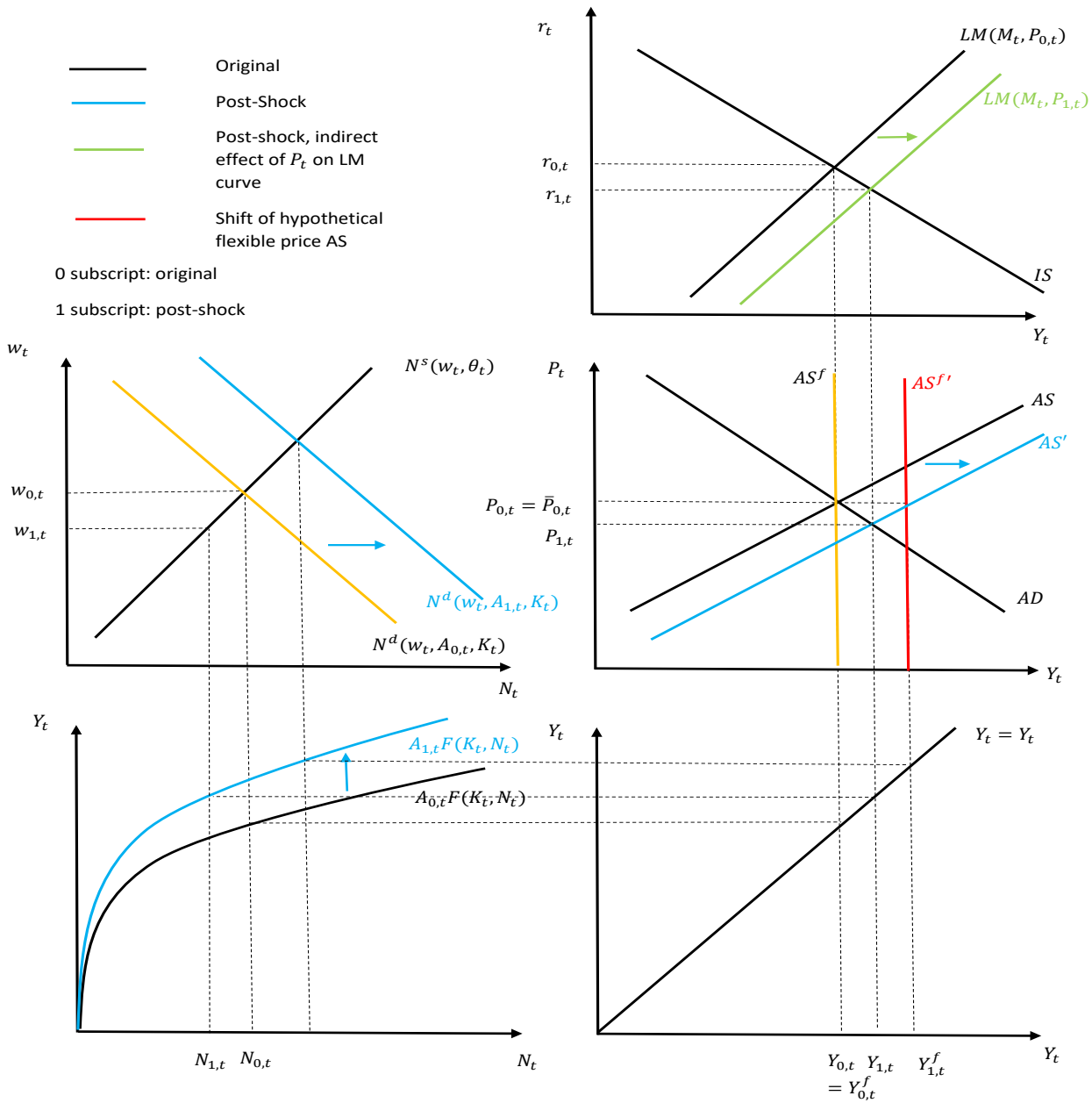
Increase in A_t: Graphically in Neoclassical Model



Increase in A_t: Simple Sticky Price Model



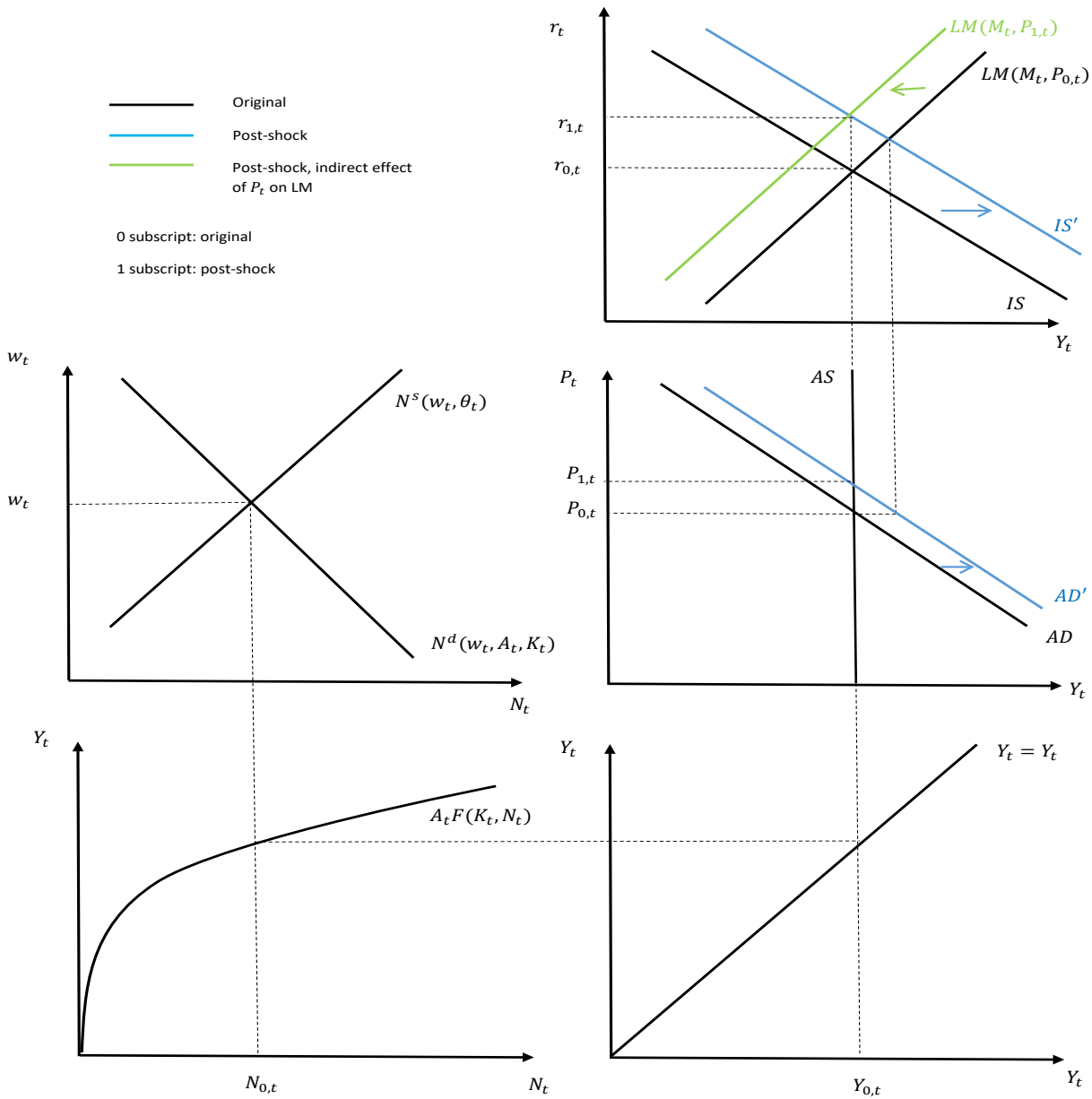
Increase in A_t: Partial Sticky Price Model



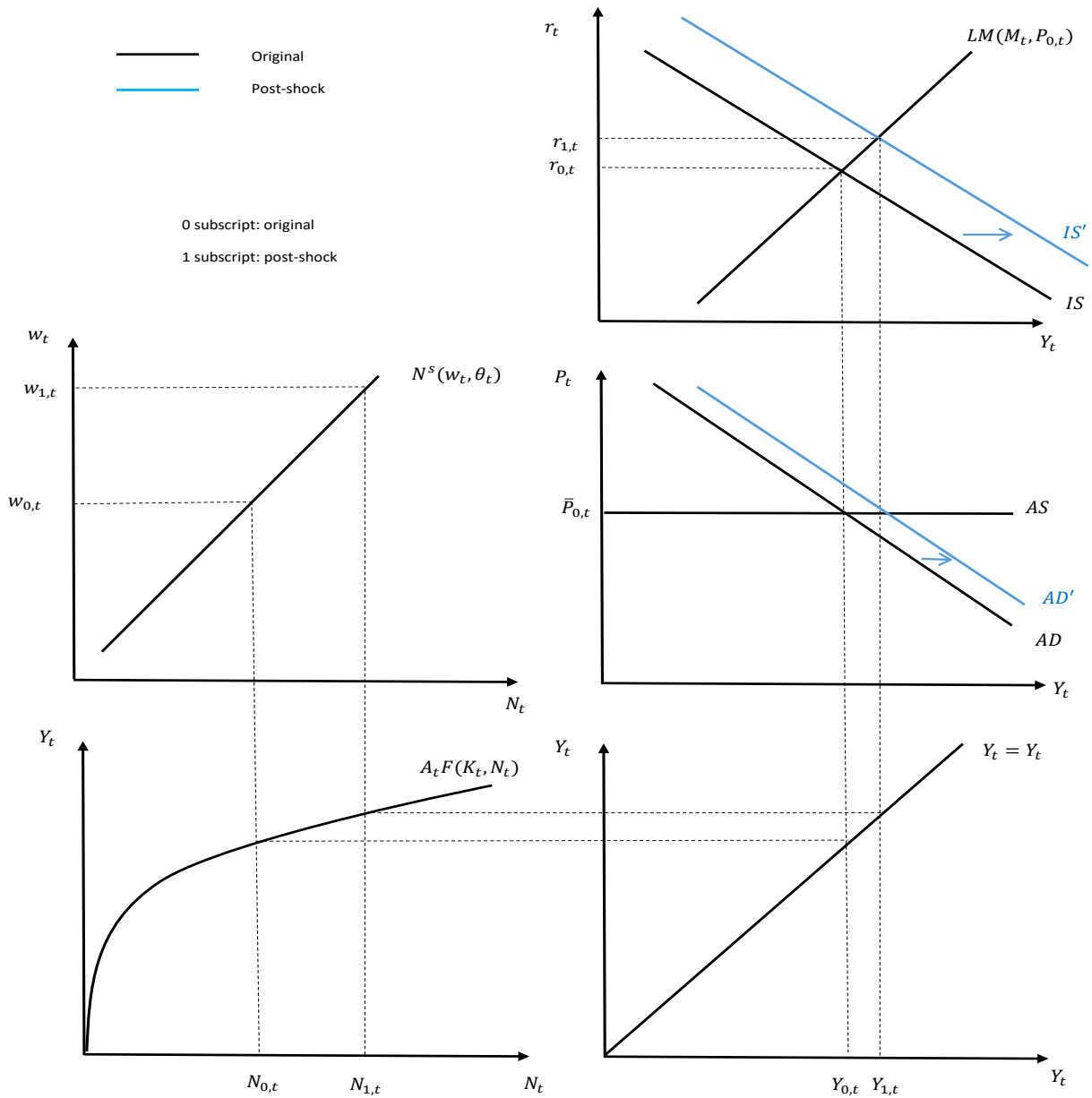
Economy Reacts Differently to Supply Shocks

- Output (and other real variables) *under-react* to supply shock the stickier are prices (i.e. the flatter is the AS curve)
- In extreme case, output don't react at all to productivity shock (simple sticky price model), so N_t falls.
- Basic intuition: for money market to clear (i.e. to be on LM curve), $\frac{M_t}{P_t}$ must fall. But if P_t is restricted in how much it can fall, r_t and Y_t must react less

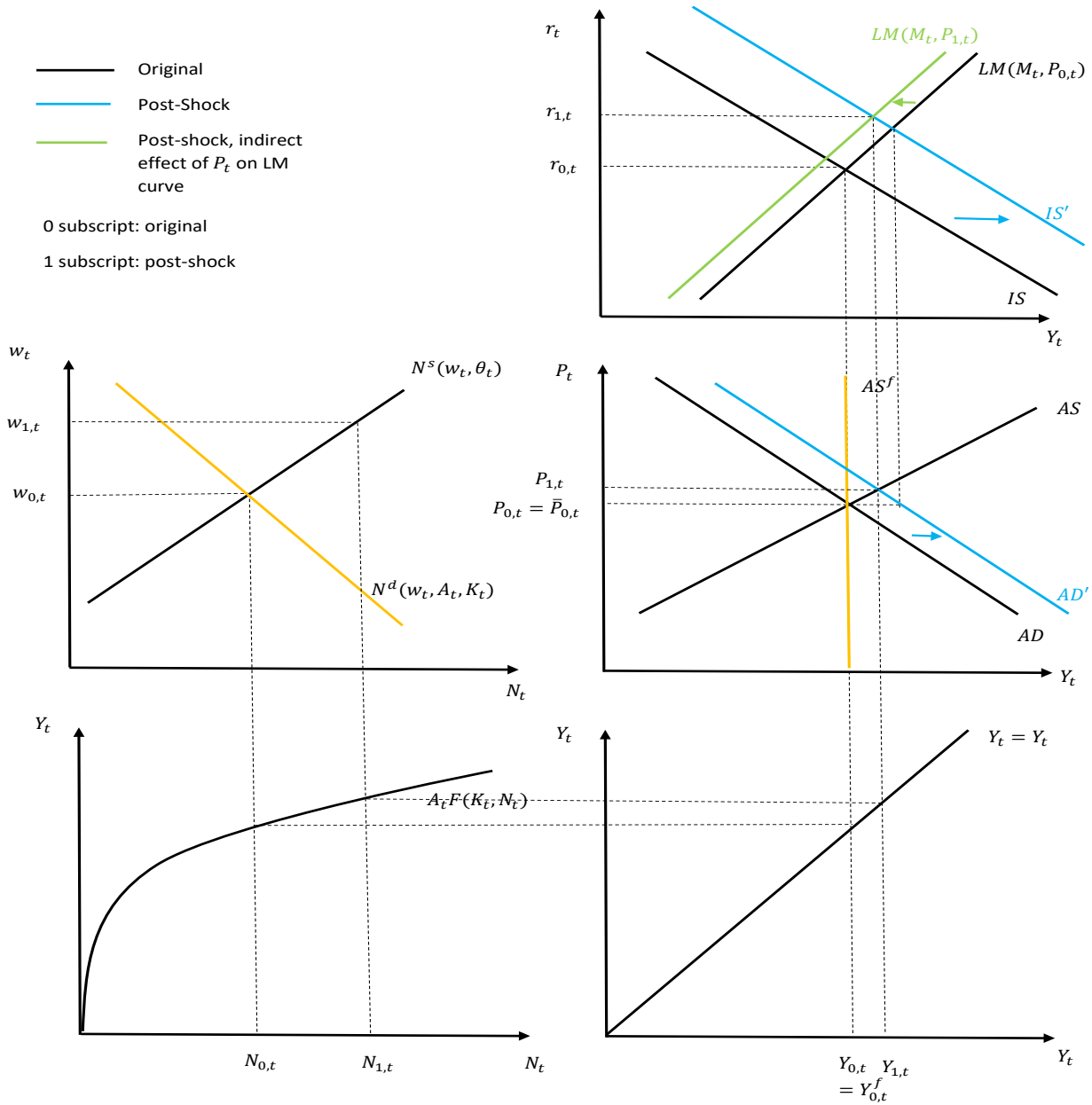
Positive *IS* Shock: Graphically in Neoclassical Model



Positive *IS* Shock: Simple Sticky Price Model



Positive *IS* Shock: Partial Sticky Price Model



Demand Shocks Matter

- Output reacts to *IS* shocks, the more so the flatter is the *AS* curve
- In contrast, r_t under-reacts relative to neoclassical case
- Intuition. $\frac{M_t}{P_t}$ needs to fall and r_t to rise to implement neoclassical equilibrium after a positive *IS* shock (e.g. increase in A_{t+1} or decrease in f_t)
- But if P_t can't fall, r_t can't rise as much and Y_t must rise for money market to clear

Conclusion

- The New Keynesian model is the same as the neoclassical model except P_t is not perfectly flexible
- Means AS is non-vertical and not on labor demand curve
- Money is non-neutral, demand shocks matter, and economy reacts differently to supply shocks
- Coming agenda:
  1. Think about dynamics – how does P_t adjust so as to converge to neoclassical equilibrium as economy transitions from short run to medium run?
  2. Think about policy – if Y_t^f is efficient, no guarantee that $Y_t = Y_t^f$. Scope for policy
  3. Think about constraints on policy – the zero lower bound (ZLB) on nominal interest rate