Classical/Neoclassical Model

Graduate Macroeconomics I

ECON 309 -- Cunningham

A Simple Neoclassical Model

Assumptions

- **Market economy with private property.**
- **Markets are fully competitive.**
- **All variables in the model are either endogenous, or exogenous and supplied.**
- **Initially, there is no government.**
- **Except when indicated, the *general equilibrium assumptions* obtain.**
- **Two kinds of individual agents exist in this economy — firms and households.**

Agents

FIRMS:

- **-produce commodities**
- **-supply the commodities at the market price**
- **-demand labor, paying the market wage**
- **-undertake investment**

HOUSEHOLDS:

- **-Consume (purchase) commodities (at market prices)**
- **-Supply labor at a wage**
- **-Save**

Neoclassical Model, Continued

- **No agent suffers "money illusion;" therefore, the analysis is real, with the "price level" determined separately from the "relative prices."**
- **Firms and households are each homogeneous. Therefore, we collapse the analysis to that of a single "representative firm" and a "representative household," and aggregate to form the firm and household sectors.**
- **The commodities are also homogeneous, so that we consider a single commodity whose real quantity is "*Y*." (Usually, we use "*y*" for real output, and "*Y*" for nominal.**
- **Therefore, the price of the commodity *is* the price level, "*P*."**
- **There are three (3) markets in this economy:**
  - **Commodity Market**
  - **Labor Market**
  - **Capital Market (Loanable Funds or Bond Market)**

Neoclassical Model, Continued

- **The nominal wage is "*w*," and the real wage is therefore "*w/P*."**
- **The rate of interest (the price of capital) is "*r*." (The convention is to use "*i*" for the nominal interest rate and "*r*" for the real interest rate.**
- **There are three factors of production— capital (*K*), labor (*N*), and land (*L*). These factors are perfectly homogeneous. E.g., all workers look the same (have the same productivity and skills).**

  At times, we assume that some of these factors, *L* and sometimes *K*, are fixed. That is, $K=K_0$ and $L=L_0$. This leads to

$$Y = AF(K,L_0,N) = AF(K,N) = F(K,N)$$
$$= AF(K_0,L_0,N) = AF(N) = F(N)$$

Neoclassical Model, Continued

- **Firms are technically efficient. That is, they produce the maximum output possible from the factors.**
- **Diminishing returns apply to production. Mathematically, this is equivalent to:**

$$\frac{\partial F}{\partial N} > 0, \frac{\partial F}{\partial K} > 0$$

Positive marginal returns to labor and capital.

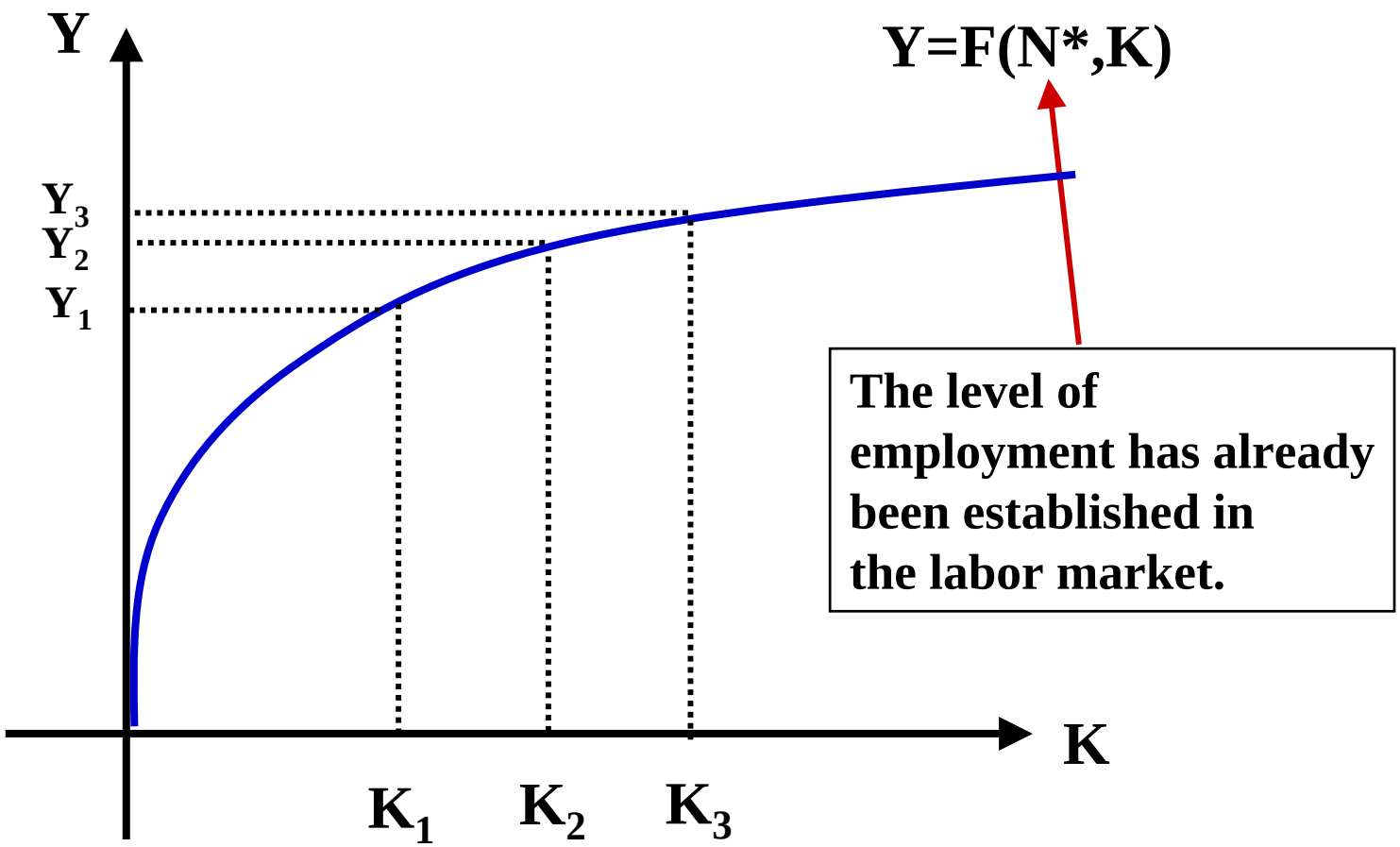
$$\frac{\partial^2 F}{\partial N^2} < 0, \frac{\partial^2 F}{\partial K^2} < 0$$

Diminishing marginal returns to labor and capital.

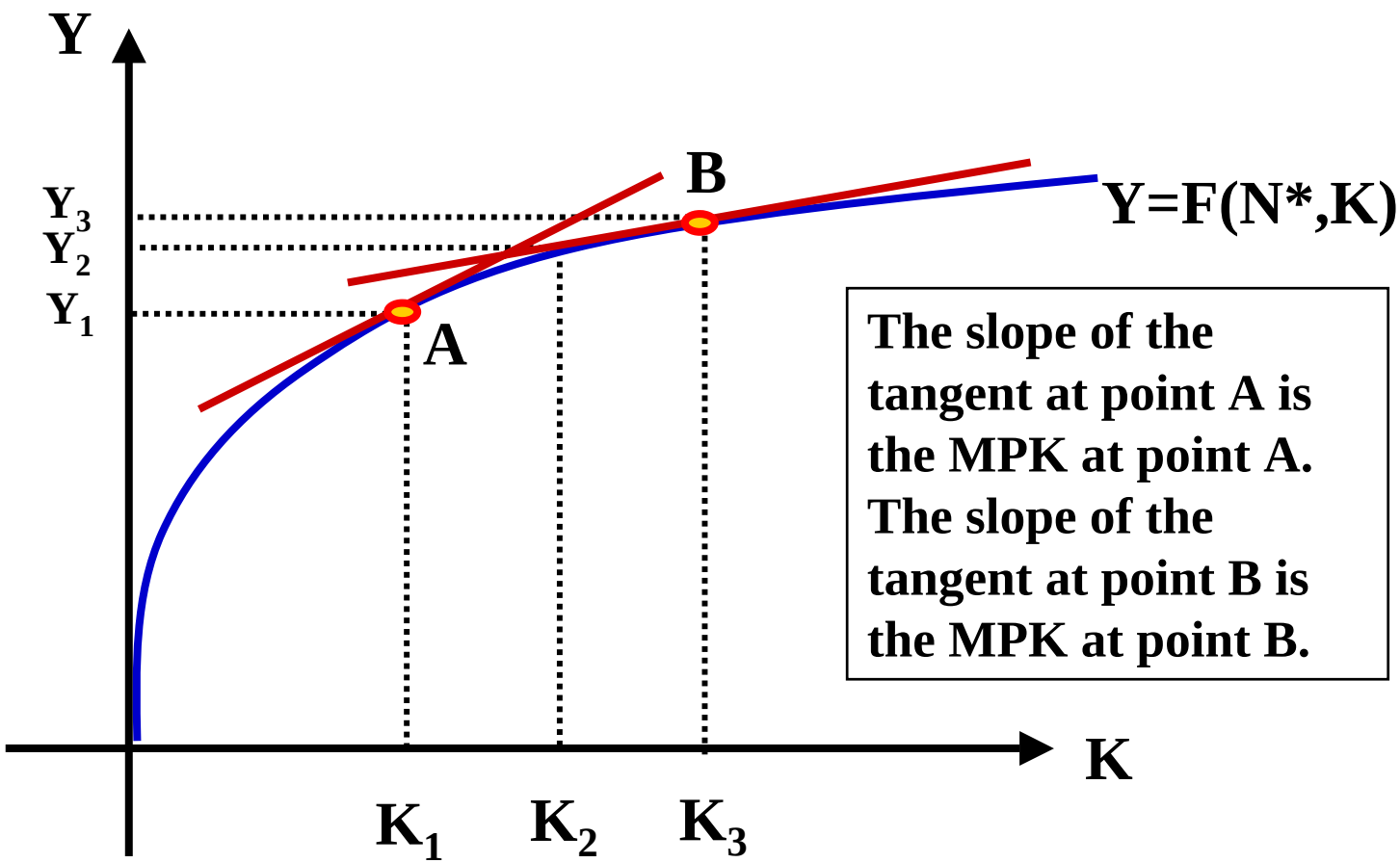
$$\frac{\partial^2 F}{\partial N \partial K} = \frac{\partial^2 F}{\partial K \partial N} = 0$$

Capital and labor marginal productivities are independent of one another.

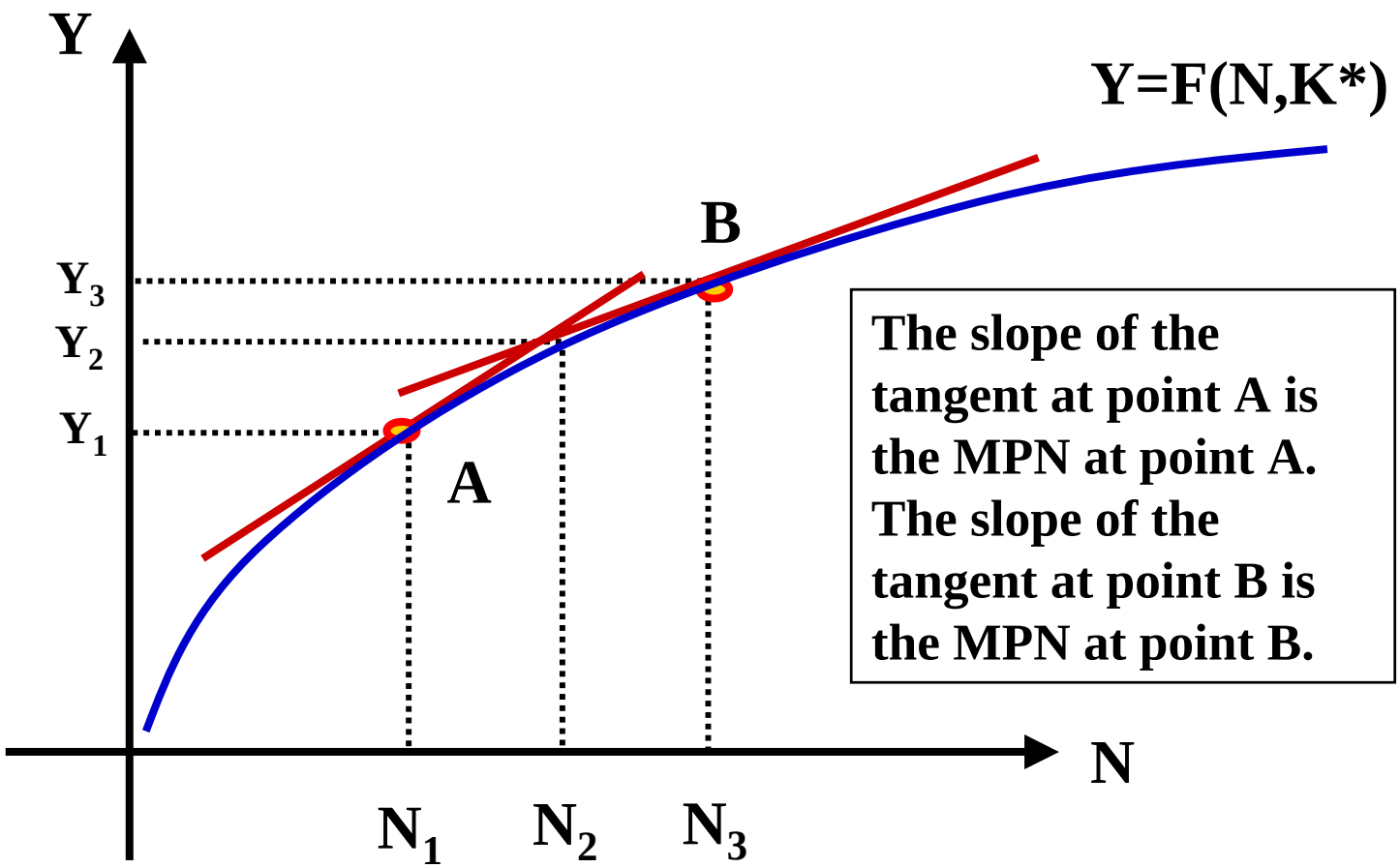
Production Function



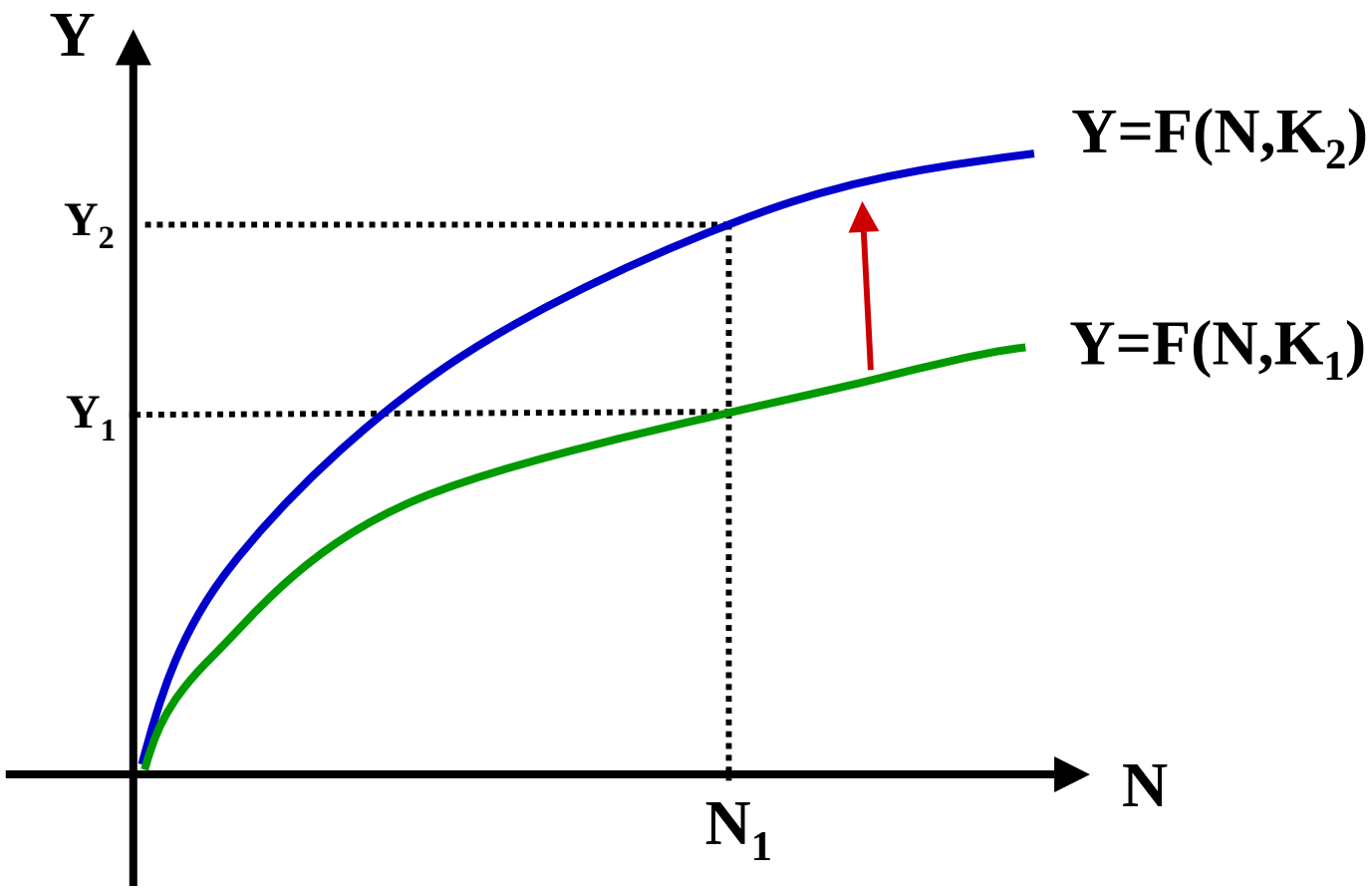
Production Function: MPK



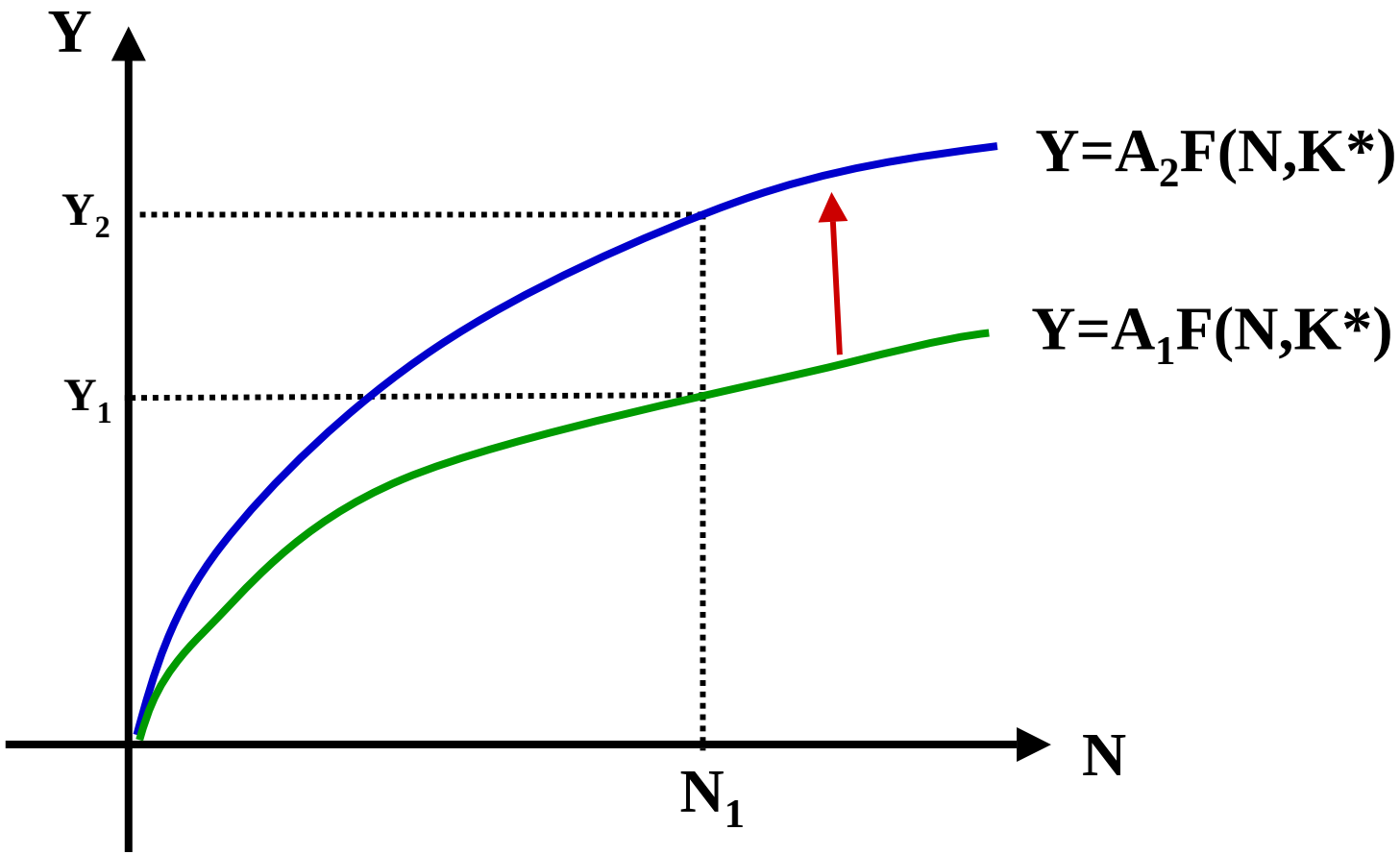
Production Function: MPN



Capital Change



Technology Change



The Model

The Firm Profit Maximizes

We begin with a representative firm: The firm's profit function is $\pi = PY - wN - Pr(K - K_0)$

Maximize profit: Assume A=1, Y=F(N,K) and construct expressions for change in profit relative to changes in employment (N) and capital (K) and set to zero. Solve. First Order Conditions:

$d\pi = P(dY) - w\,dN = 0$

$d\pi = P(dY) - Pr\,dK = 0$

The firm is profit- maximizing when these conditions are met.

$dY/dN = w/P$

$dY/dK = r$

Marginal Product of Labor = Real Wage

Marginal Product of Capital = Real Interest Rate

Theory of Distribution

- **This is a theory of distribution.** It explains how output is shared by the various agents. Workers (households) are paid according to what they actually contribute to the production process (on the margin). Capital is also paid according to its contribution (on the margin).
- This implies that for the real wage of workers to rise (their real buying power to increase) while prices remain stable, real labor productivity must also rise.

Labor Demand

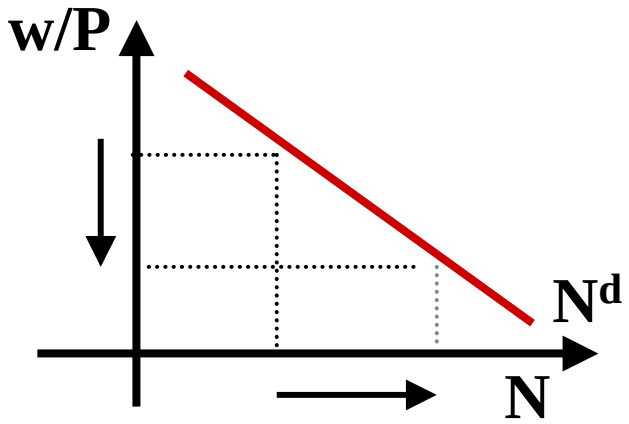
If we differentiate the first result with respect to real wages (w/P), we have by the chain rule: $\frac{\partial^2 F}{\partial N^2}\frac{\partial N}{\partial\left(\frac{w}{P}\right)} = 1$

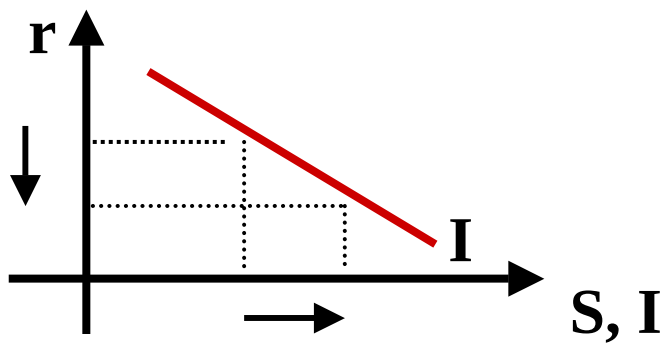
divide by the first term: $\frac{\partial N}{\partial\left(\frac{w}{P}\right)} = \frac{1}{\partial^2 F / \partial N^2}$

but by assumption $\frac{\partial^2 F}{\partial N^2} < 0$

therefore $\frac{\partial N}{\partial\left(\frac{w}{P}\right)} < 0$ **Labor demand slopes downward.**

Implications





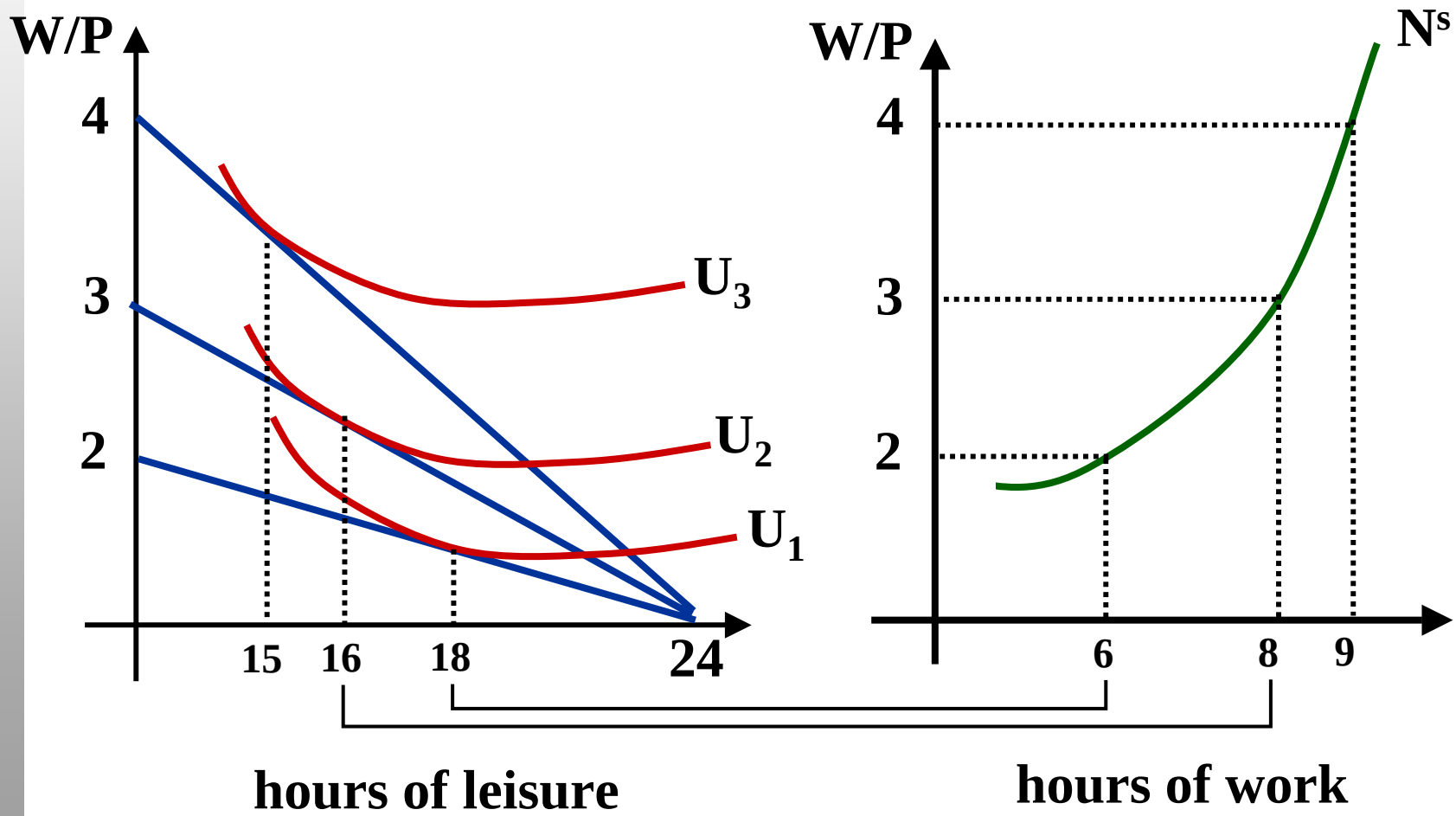
Cet. Par., labor demand by firms rises as real wages fall. Labor demand slopes downward.

We can show similarly, cet. par., that investment demand by firms rises as interest rates fall. The investment curve slopes downward.

Households Optimize

- **The representative household maximizes utility.**
- **Since utility is assumed to result from consumption only, this turns out to be the same as maximize real income.**
- **If utility were maximized in a multi-period model, we would analyze the *intertemporal optimization* choices associated with electing whether to consume now or later, with the disutility of foregoing current consumption offset by interest income on savings. In this single-period model, the intertemporal aspects of the decision making process are captured by the interest rate.**
- **This amounts to the *abstinence theory of interest* espoused by William Nassau Senior in the 1800s.**
    - **People are thought to prefer current to future consumption, but a higher interest rate makes it more likely for households to choose to postpone consumption in favor of higher real consumption later as a result of interest income.**

Micro Analysis of Labor Supply



Households Optimizing Income

Household income is given as the sum of wage income, interest income, and distributed profits:

$$PY = wN^s + iB^d + \pi$$

or

$$Y = \frac{w}{P}N^s + i\frac{B^d}{P} + \frac{\pi}{P}$$

Recall that $Y=C+S$, $S = \frac{\Delta B^d}{P}$. This is a budget constraint; it forces the household to balance income and expenditures.

Households Optimize (2)

Differentiating with respect to N^s yields: $\frac{\partial Y}{\partial N^s} = \frac{w}{P}$

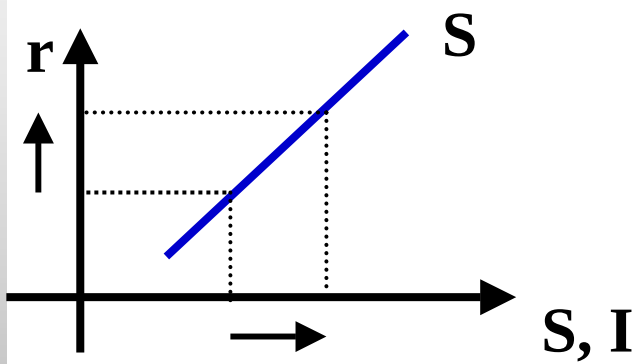
If we proceed with the optimization as in the firm case, we find:

$$N^s = N^s\overbrace{\left(\frac{w}{P}\right)}^{(+)}$$

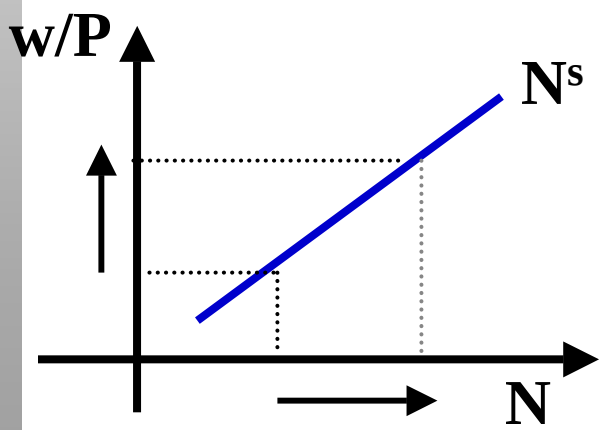
And $S = S\overbrace{(r)}^{(+)}$ since $i/P = r$.

which implies (from the budget constraint): $C = C\overbrace{(r)}^{(-)}$

Implications

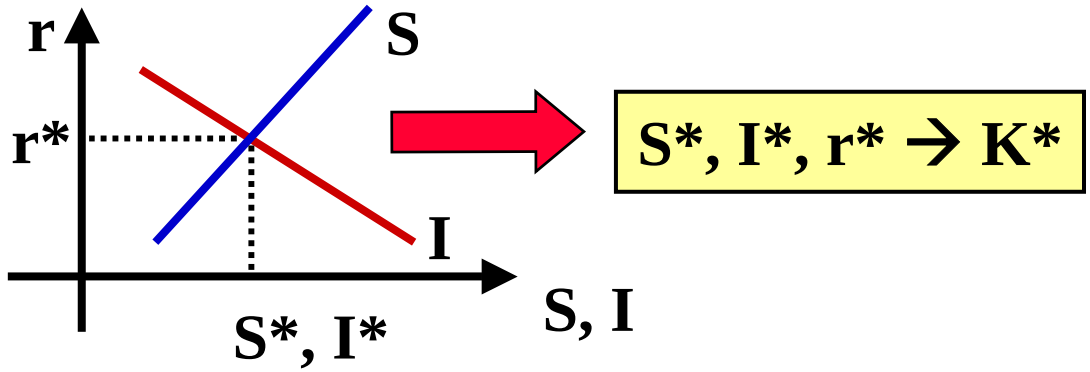


Cet. Par., saving by households increases as interest rates rise. The saving curve slopes upward.



Cet. Par., labor supply by households rise as real wages rise. Labor supply slopes upward.

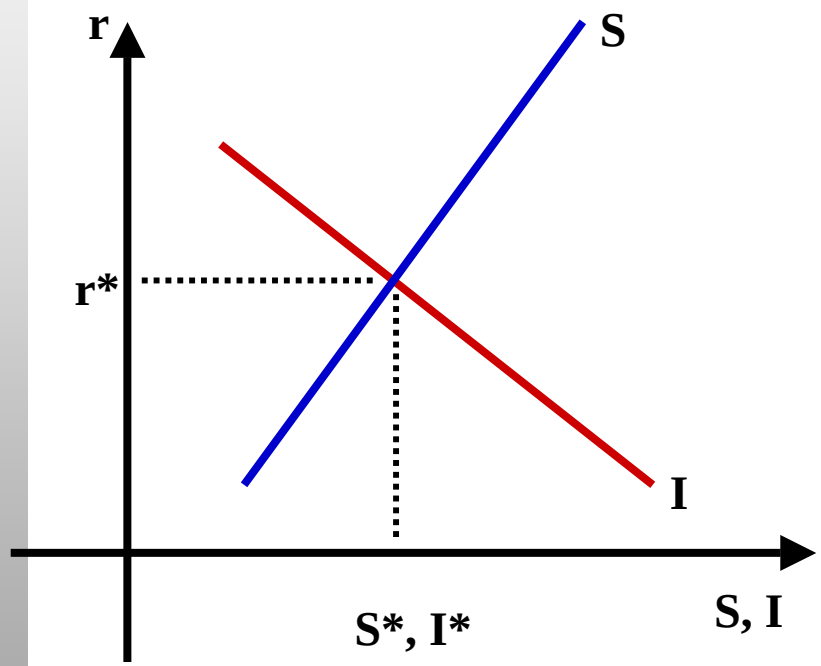
Capital Market Summary

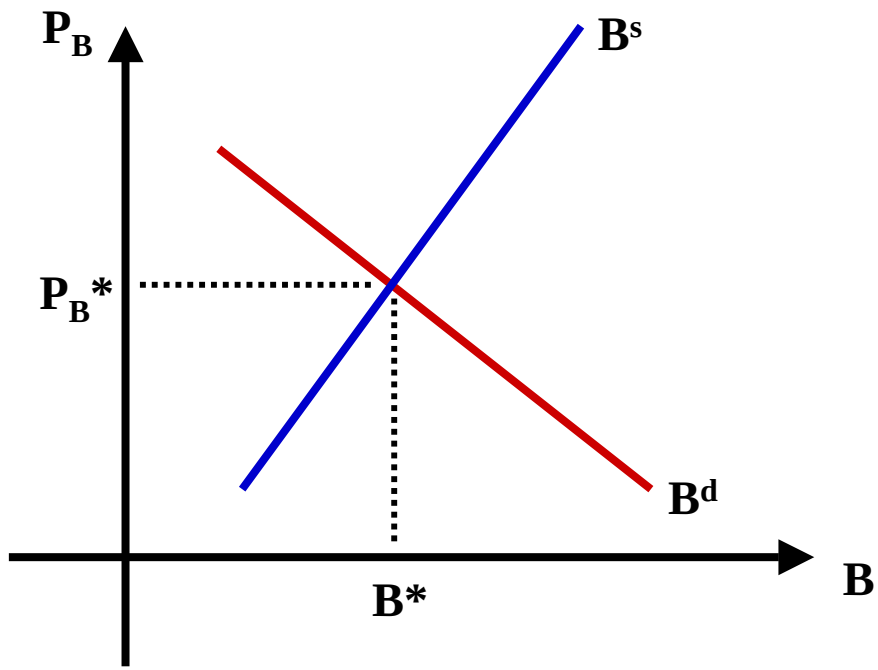


$$I(r^*) = S(r^*)$$

Here r^* is the Wicksellian *natural rate of interest*, S^* and I^* are equilibrium savings and investment. In this market claims on capital are traded.

Capital Market/Bond Market/Loanable Funds Market

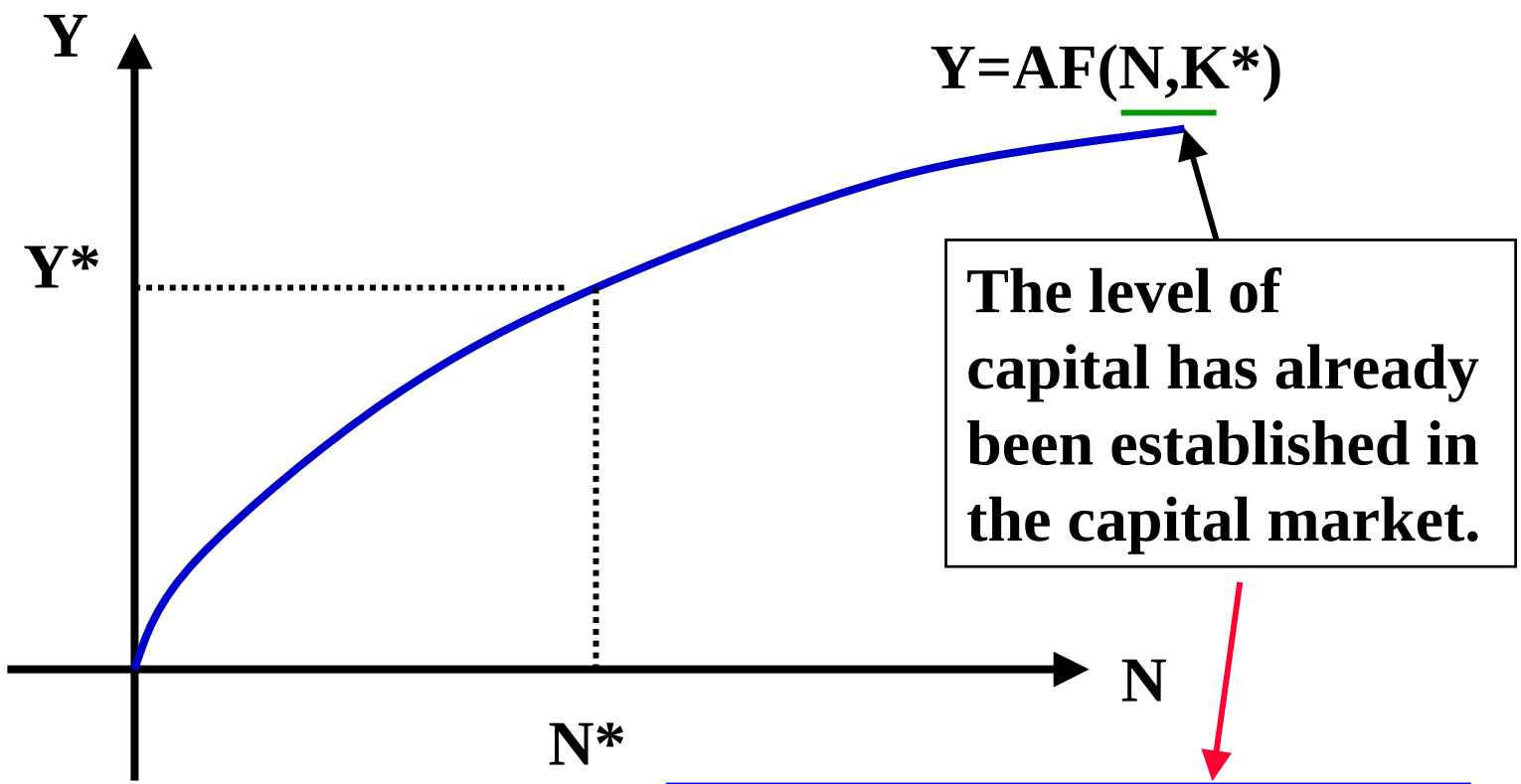




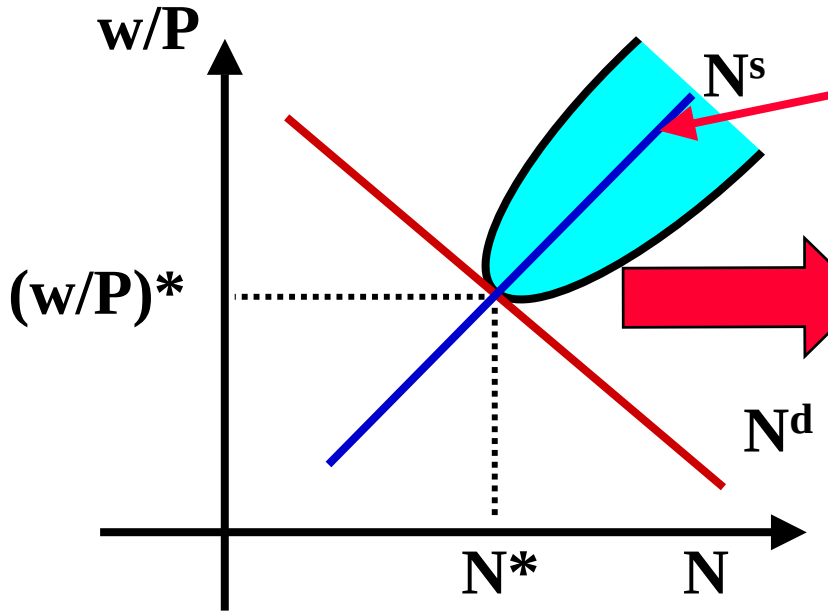
Note: Investment (I) is the change in the amount (stock) of capital.

Saving = supply of funds = bond demand
Investment = demand for funds = bond supply

Production Function



Labor Market Summary

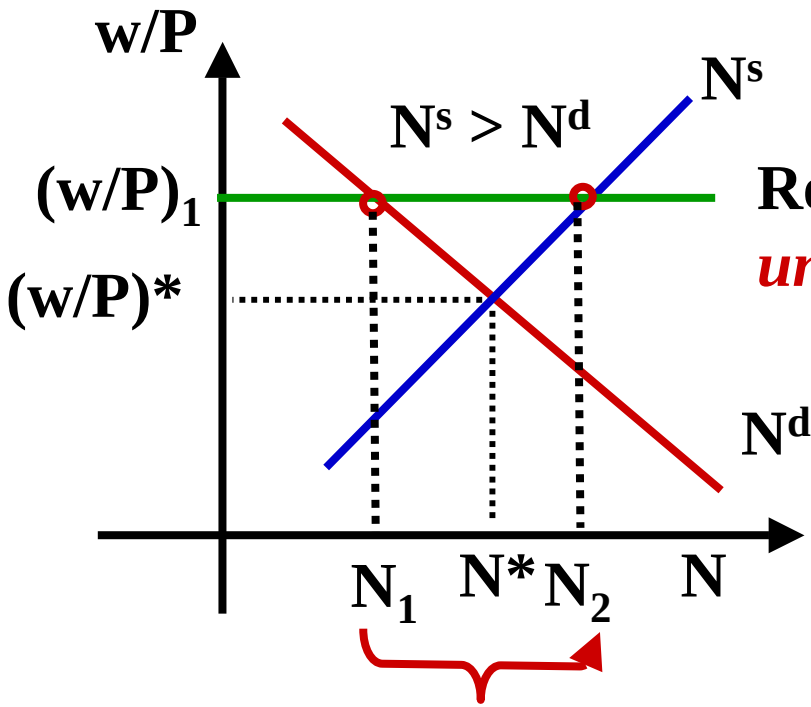


Voluntary Unemployment

(w/P)*, N*

$$N^d\left[\left(\frac{w}{P}\right)^*\right] = N^s\left[\left(\frac{w}{P}\right)^*\right] = N^*$$

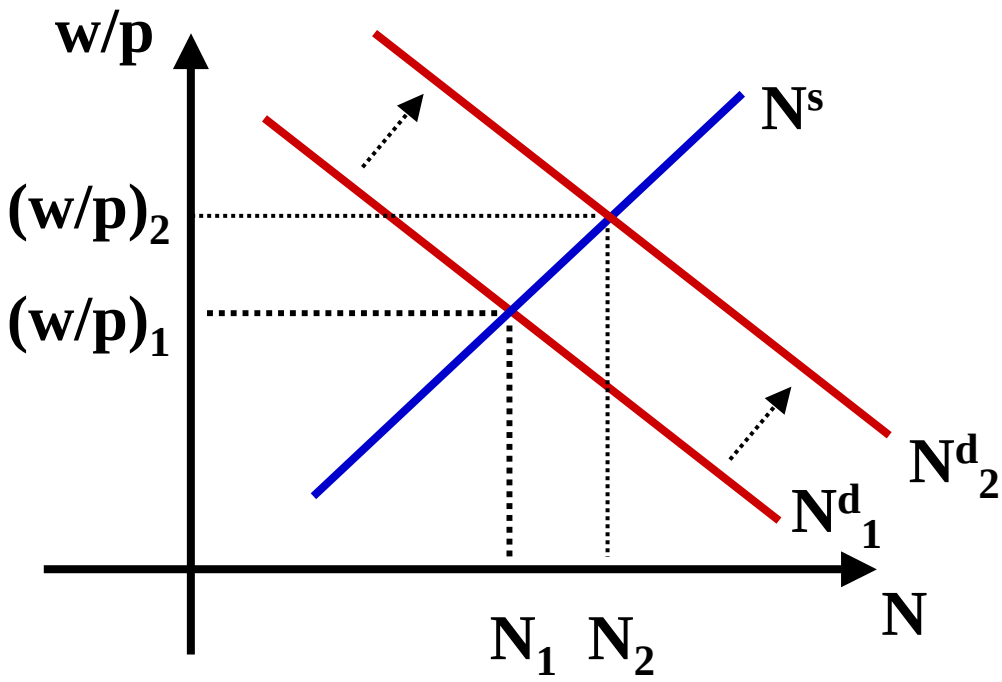
Involuntary Unemployment



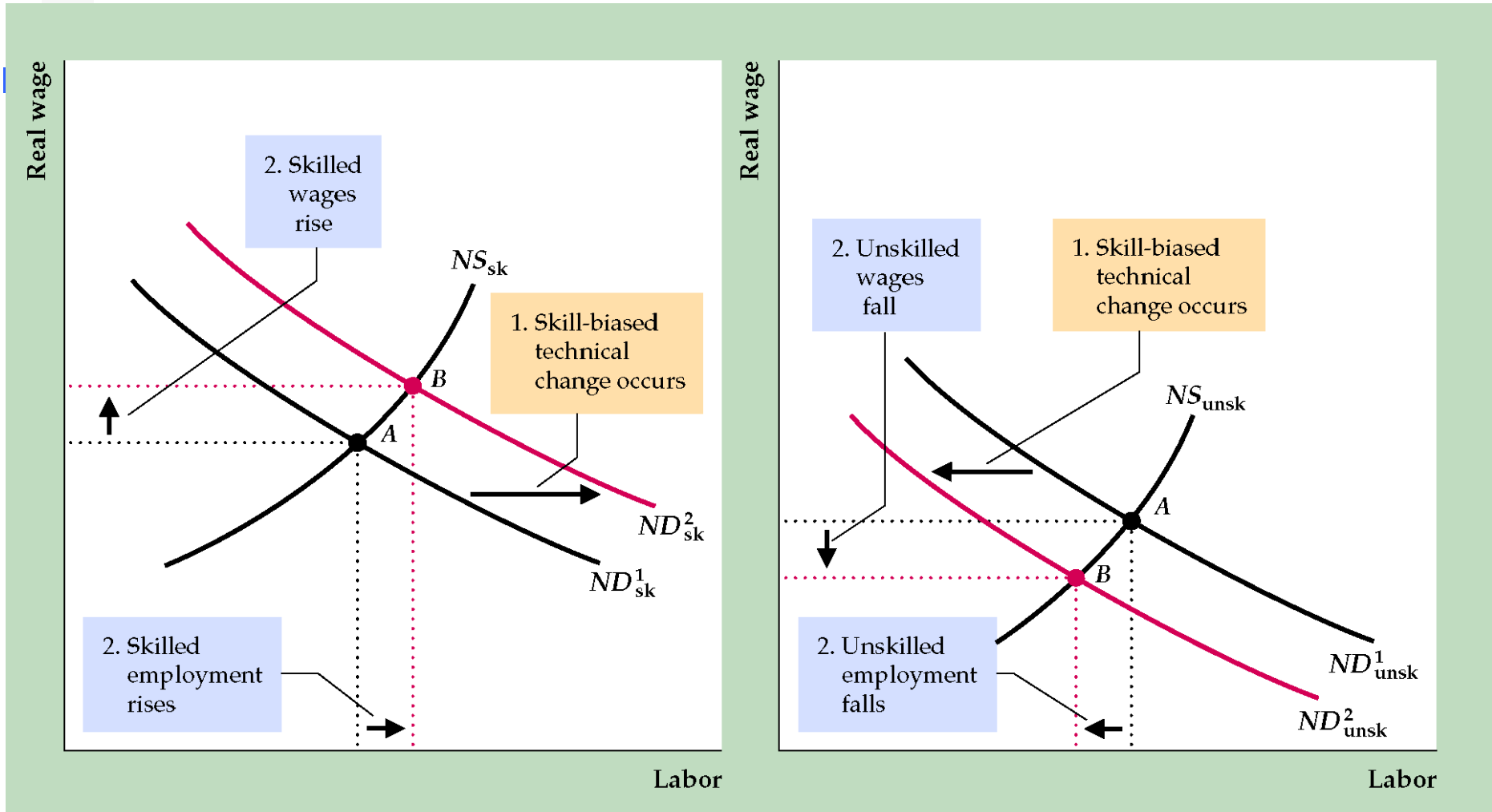
Results in *involuntary unemployment*

Effect of an Increase in Labor Productivity

1. **Labor is more productive.**
2. **Firms increase demand for labor.**
3. **Employment increasese and wages are bid upward.**



The effects of skill-biased technical change on wage inequality

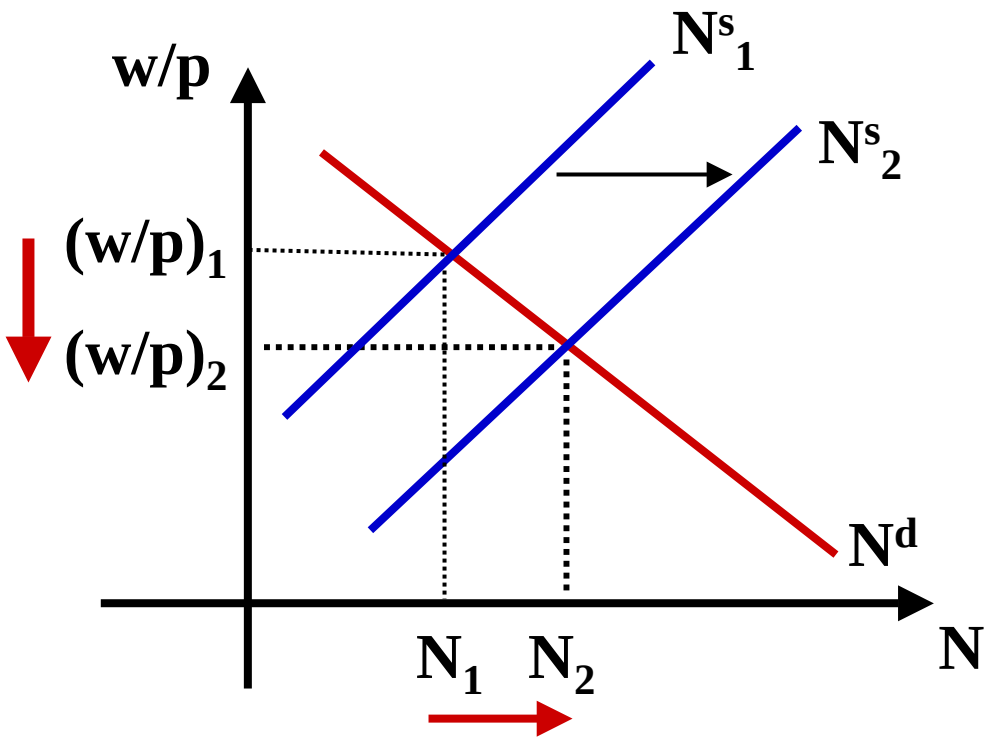


(a) Skilled workers

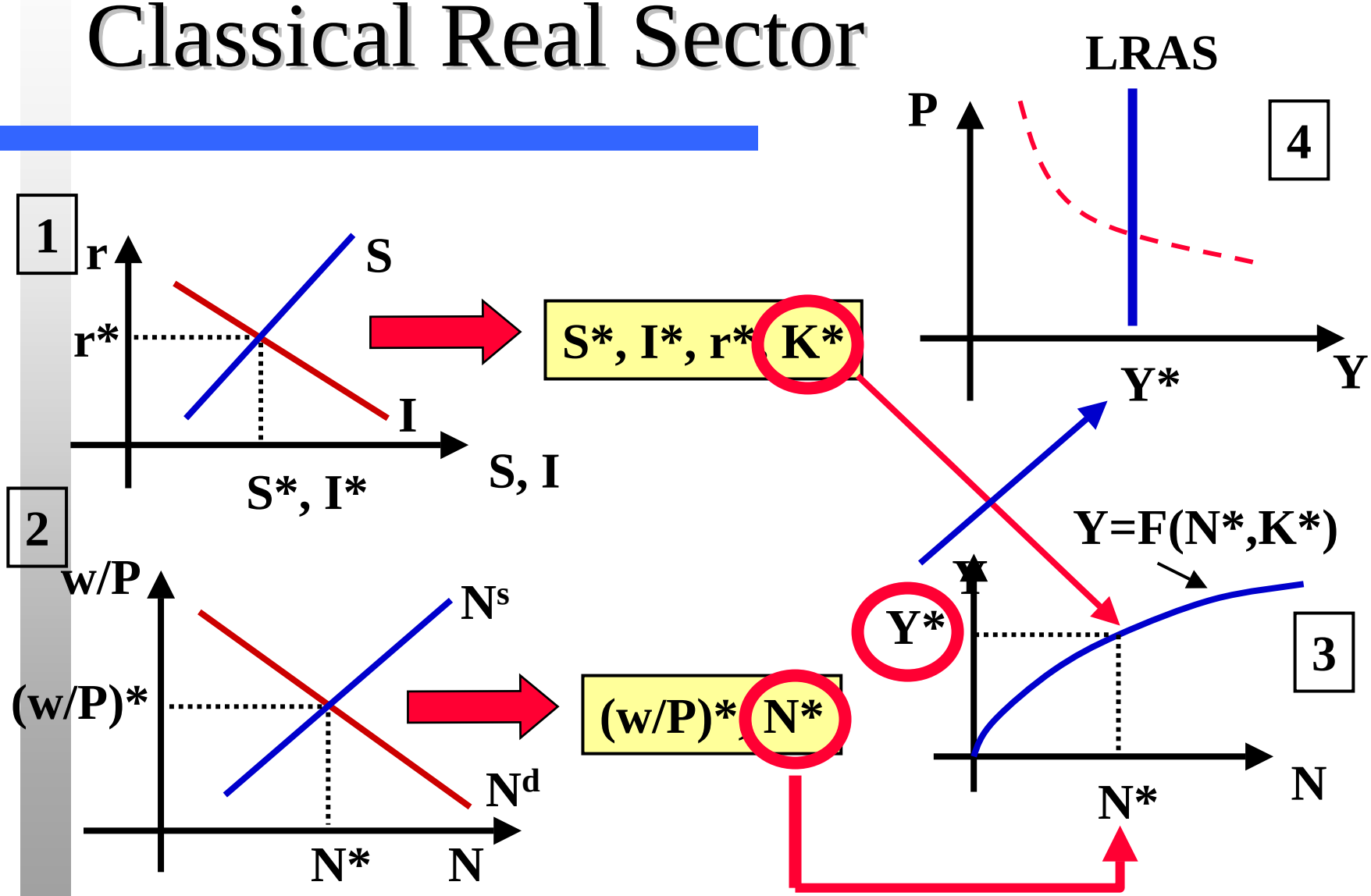
(b) Unskilled workers

Personal Income Tax Cut

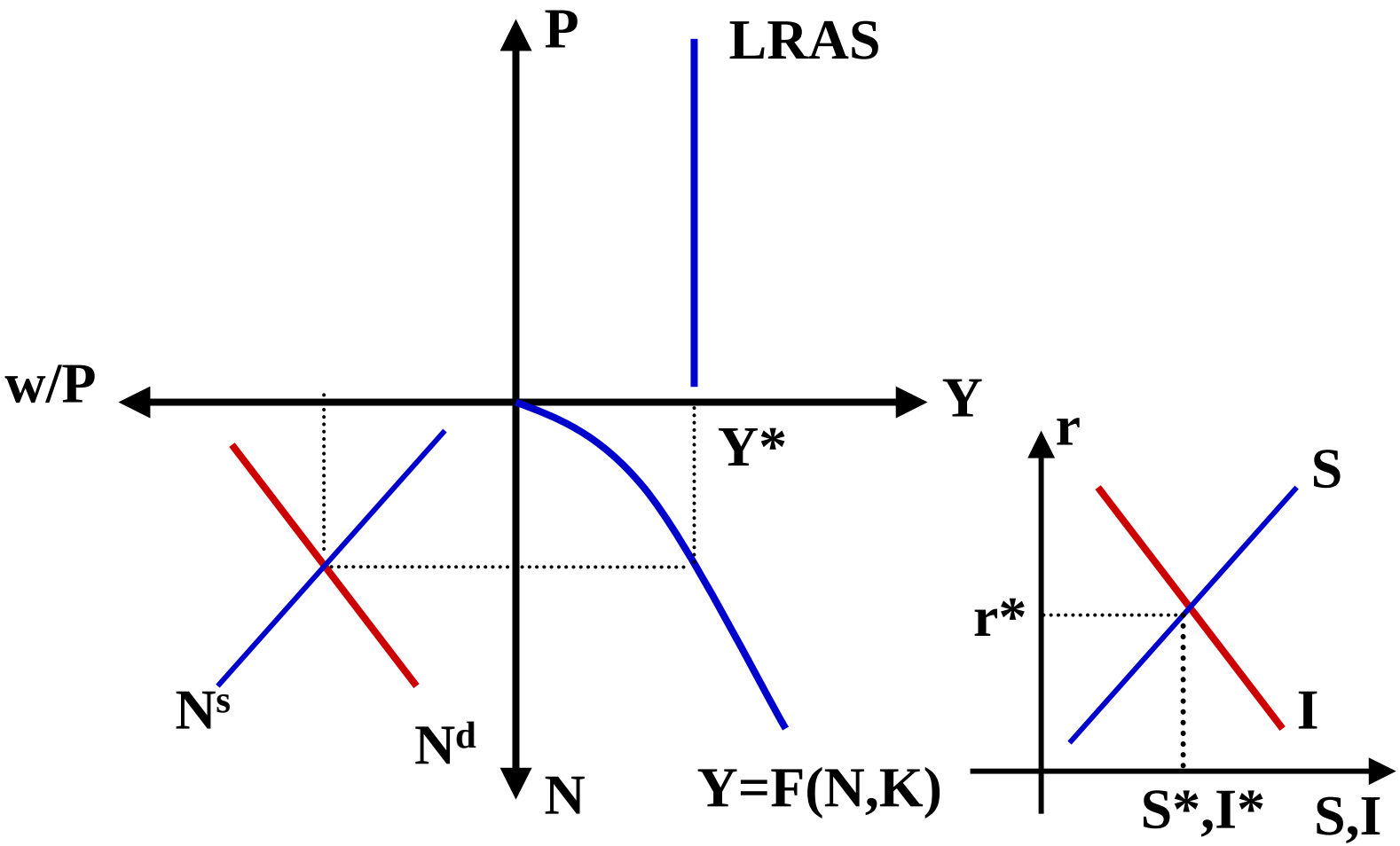
1. **The same real wage is more attractive to workers.**
2. **Labor supply increases.**
3. **Employment increases and wages fall.**
4. **Unemployment Rate falls.**



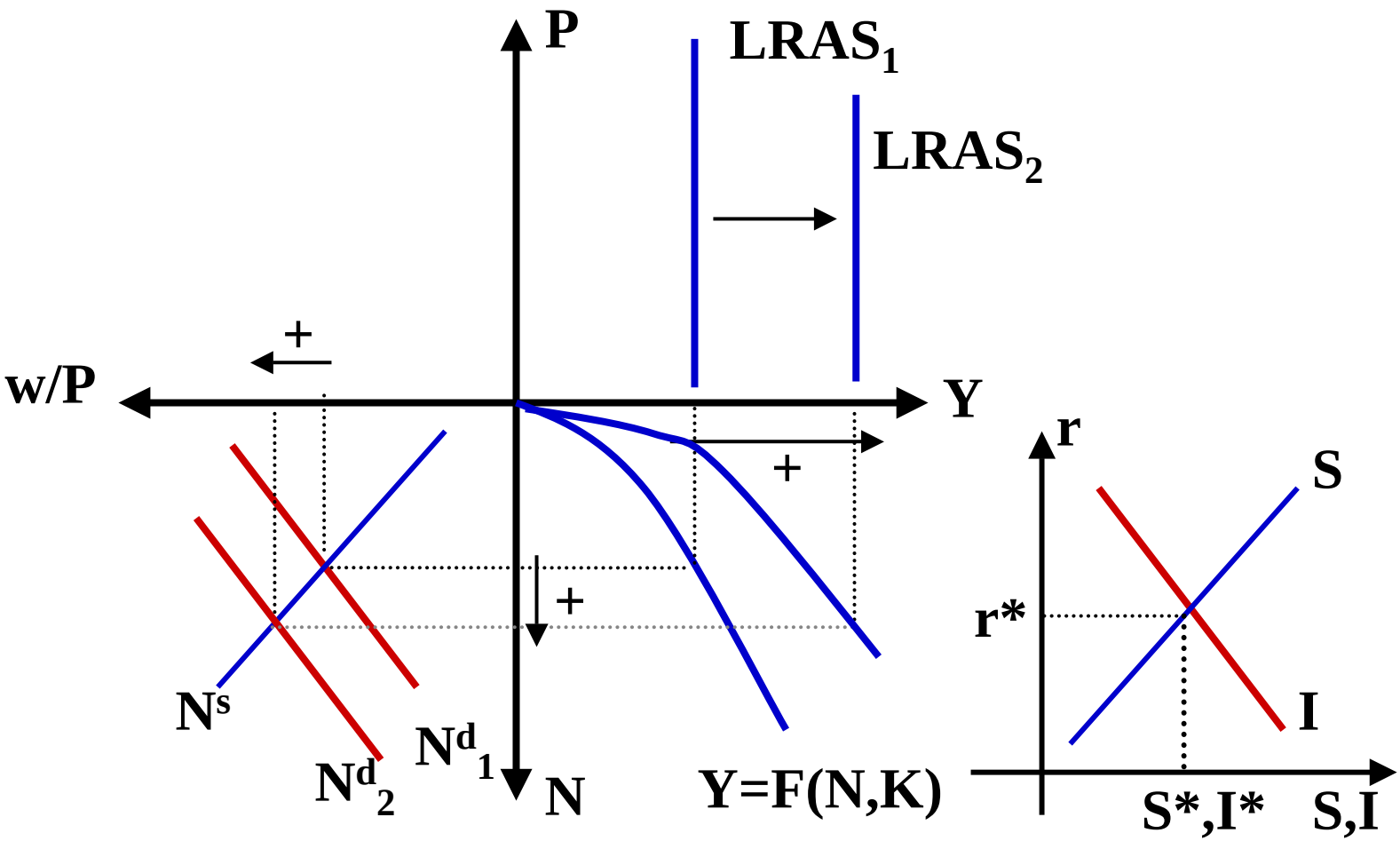
Classical Real Sector



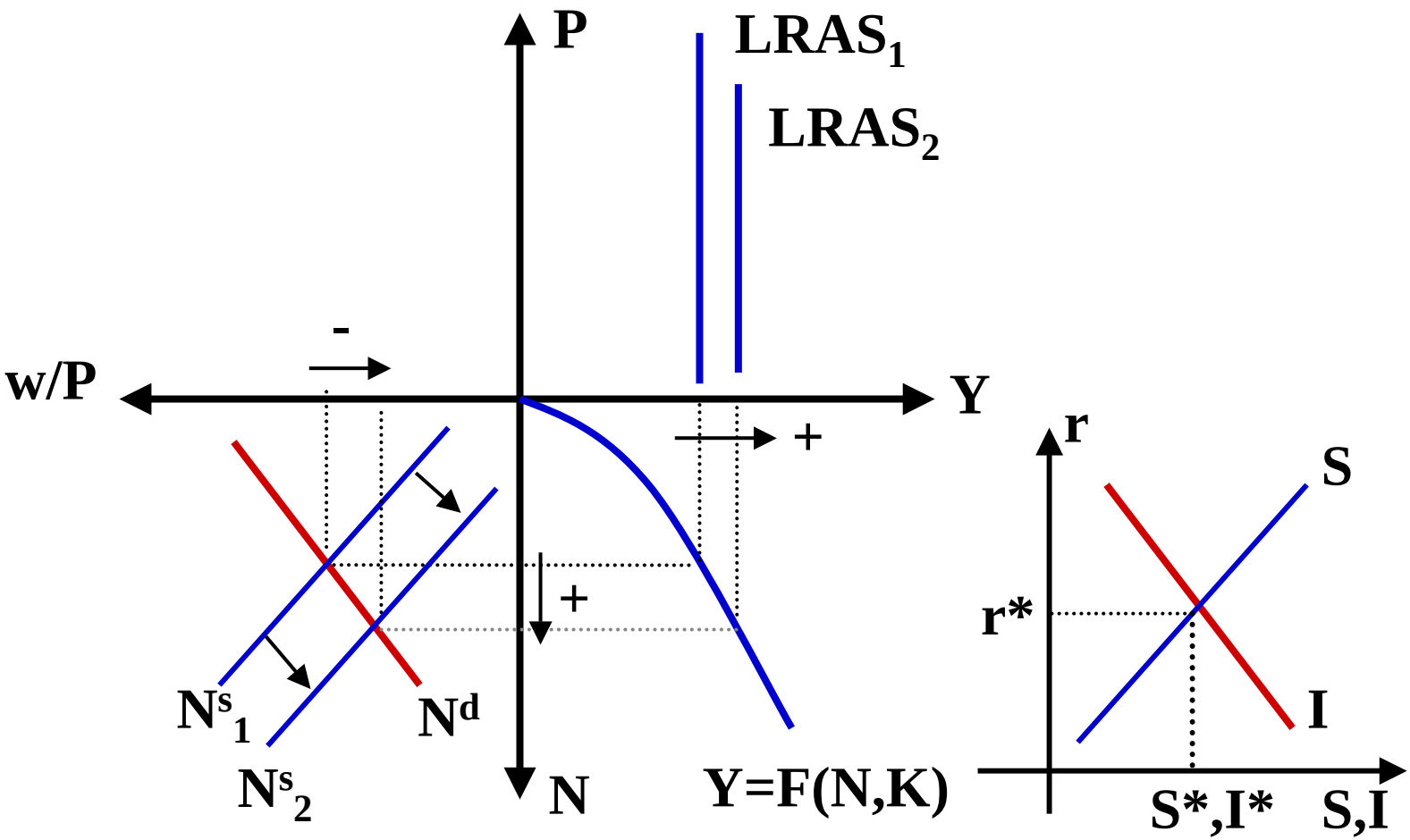
Classical Dichotomy



Increase in Labor Productivity



Supply-side Tax Cut



Quantity Theory of Money

- **The theory: for a given level of output, the price level is proportional to the quantity of money.**
- **This theory is made explicit in the equation of exchange.**

Equation of Exchange (1)

Fisher's transactions model:

$$MV_T = P_T T$$

M = the stock of money in circulation (money supply)
V_T = the circular velocity of transactions (velocity of money); also called the transactions velocity of circulation

$$V_T = \frac{P_T T}{M}$$

P_T = Price index for goods traded
T = Real value of transactions

Velocity of Circulation

- **The velocity of money is the average number of times per period (year) a unit of currency (dollar) is used in making a transaction.**
- **The velocity of money is governed by the nature and sophistication of the payments system in the society, and therefore changes slowly over time.**
- **The velocity of money is not related to any of the other variables in the model, so can be considered exogenous or fixed with respect to these equations.**

Equation of Exchange (2)

Income (output) model:

$$MV_Y = PY$$

M = the stock of money in circulation (money supply)
V_Y = the circular velocity of income (velocity of money); also called the income velocity of circulation

$$V_Y = \frac{PY}{M}$$

P = Price index for goods traded
Y = Real Income (GDP)

Velocity of Money

- **The income velocity of money is the average number of times per period (year) a unit of currency (dollar) is spent in producing GDP (total economic activity).**
- **As with the transactions velocity of money:**
  - **The income velocity of money is governed by the nature and sophistication of the payments system in the society, and therefore changes slowly over time.**
  - **The income velocity of money is not related to any of the other variables in the model, so can be considered exogenous or fixed with respect to these equations.**

Equation of Exchange (3)

Cambridge "cash-balances" model:

$$M = kPY$$

M = the stock of money in circulation (money supply)
k = Cambridge "cash-balances constant"-- the average holding period of each unit of the currency (dollar)

$$k = \frac{1}{V}$$

P = Price index for goods traded
Y = Real Income (GDP)

Eq. Of Exchange (3) Continued

- **The Cambridge model is closer to a modern theory of money demand.**
- **Implies that people hold money even if they only have a transactions motive.**
- **Challenged by John Maynard Keynes.**

Eq. Of Exchange (3) Continued

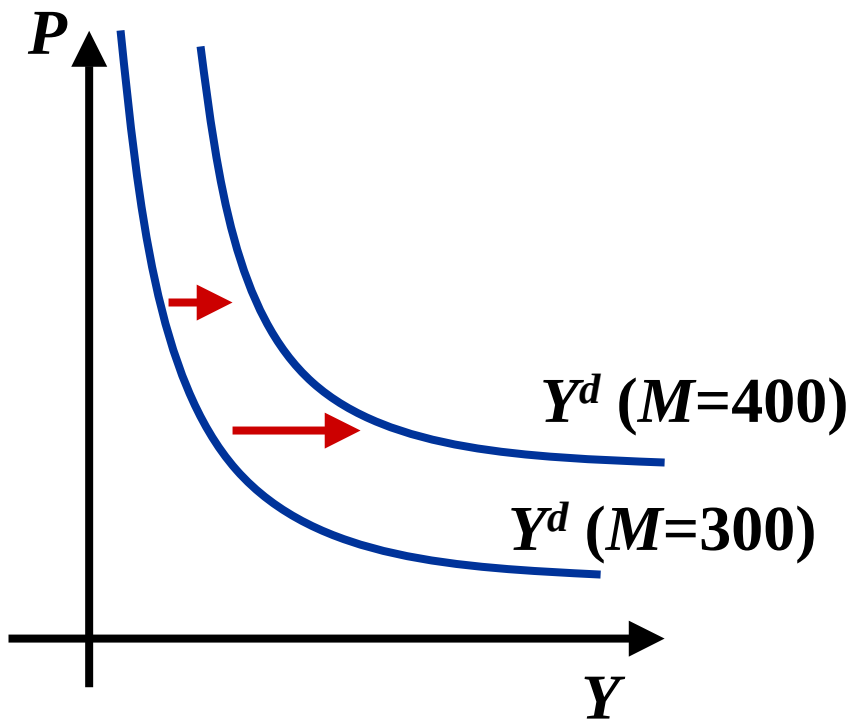
- **If $M = kPY$, and k and Y are determined separately from money (M) and prices (P), then**
- **$M\uparrow \Rightarrow P\uparrow$. All else equal, inflation (rising prices) is caused by increasing the money supply.**
- **The price level is proportional to the money supply.**

On to Aggregate Demand

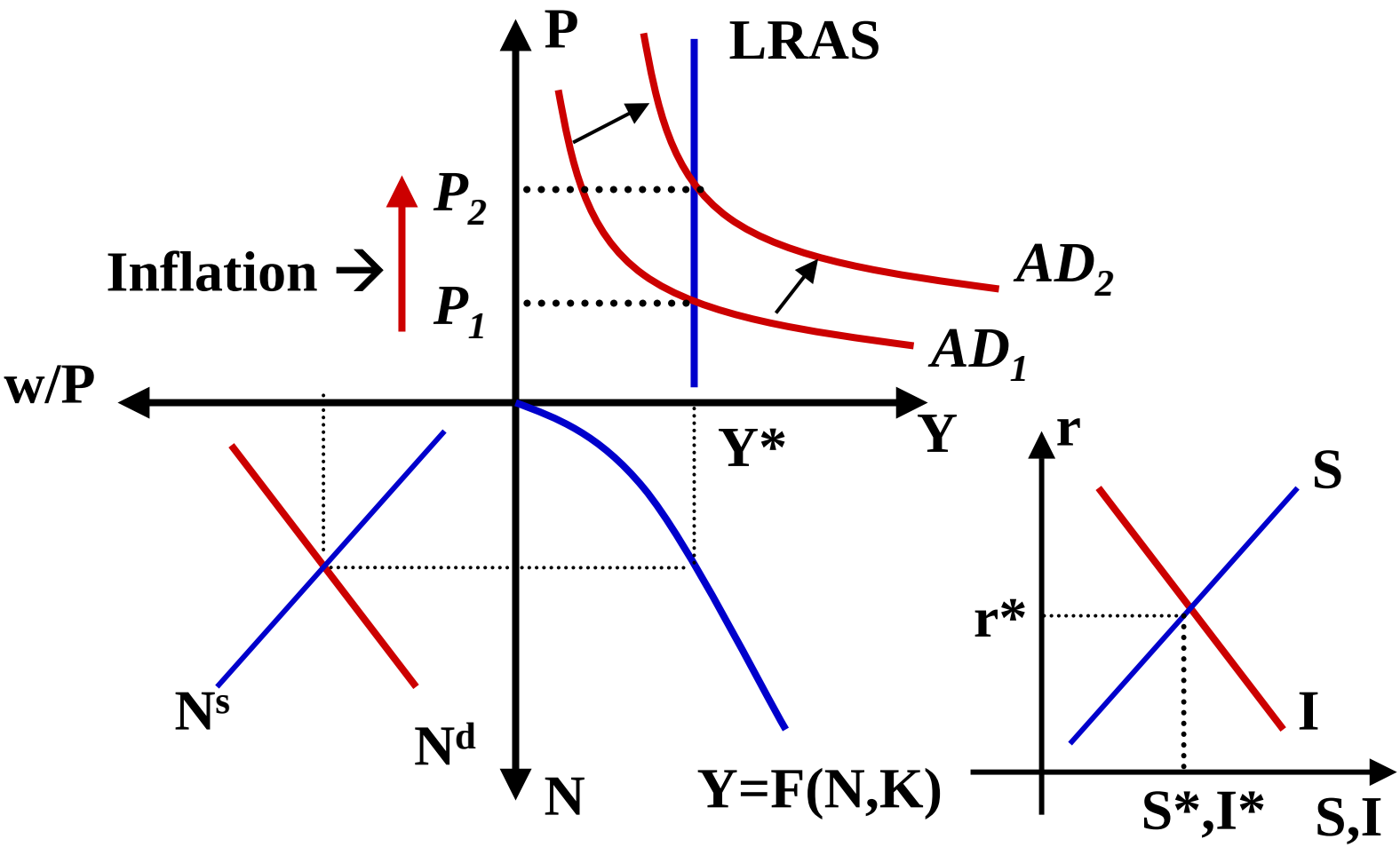
If $M = kPY$, *then* $P = \frac{M}{kY}$.

But M and k exogenous to Y. This means that P is inversely related to $1/Y$. This is the equation of a hyperbola, and is an equation that relates the price level to GDP.

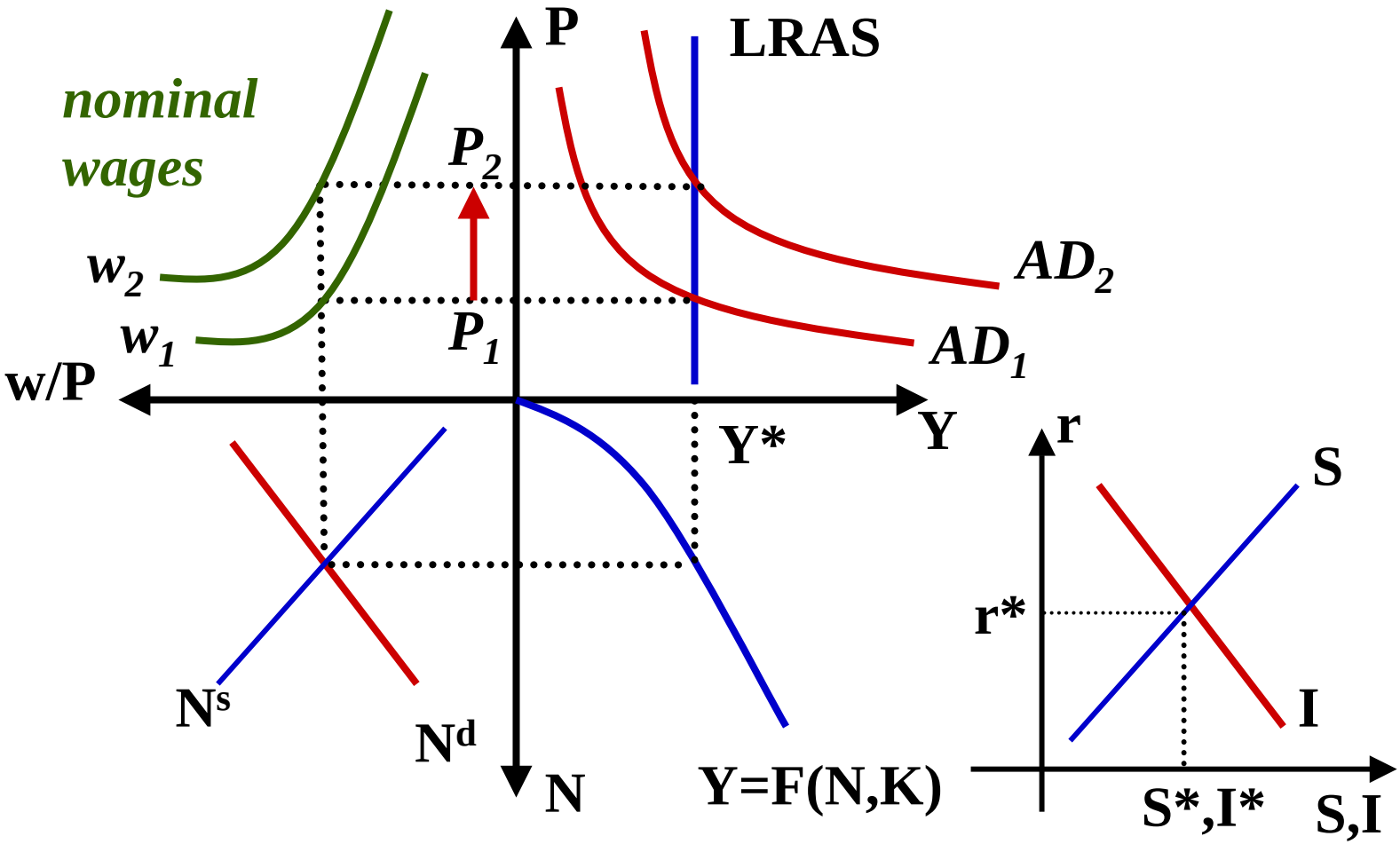
It is Aggregate Demand!



Adding Money (1)



Adding Money (2)



Classical Model in Equations

(1) $N^s = N^s(\overset{+}{\frac{w}{P}})$

(2) $N^d = N^d(\frac{w}{P})$

(3) $N^s(\frac{w}{P}) = N^d(\frac{w}{P}) \Rightarrow N^*, (\frac{w}{P})^*$

(4) $I = I(\overset{-}{r})$

(5) $S = S(\overset{+}{r})$

(6) $I(r) = S(r) \Rightarrow I^*, S^*, r^*$

(7) $Y = F(N^*, K^*) \Rightarrow Y^*$

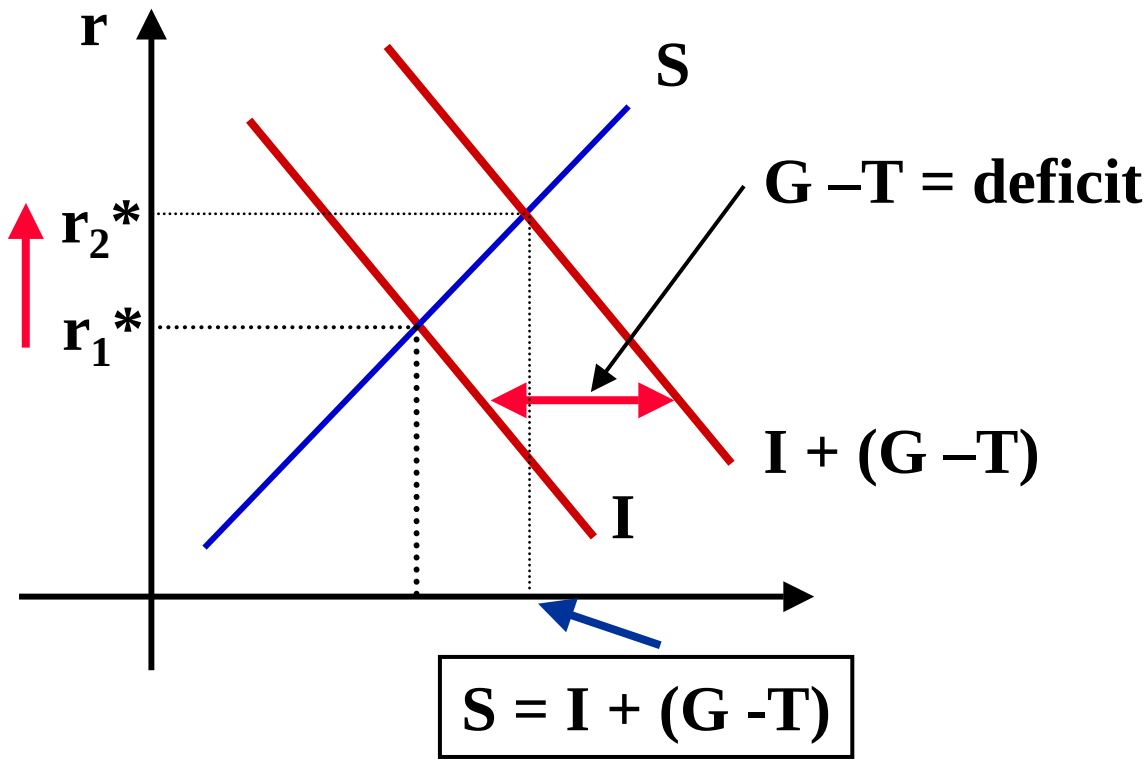
(8) $C = Y^* - S^* \Rightarrow C = C(r^*) \Rightarrow C^*$

(9) $P = {M_0}/{kY^*} \Rightarrow P^*$

(10) $(\frac{w}{P})^* \times P^* = w^*$

Expanding the Capital Market

Bond financed government spending raises interest rates, crowding out private business investment.



Gov't Increases Spending

- **Effect on Output & Employment:**
  - **In the classical model, GDP and employment are determined without any consideration of what the level of government spending is.**
  - **Therefore, government spending has no impact on output or employment.**

Gov't Increases Spending, Details (1)

- **Effect if Taxes are not changed:**
  - **S = I + (G - T); the spending is bond financed.**
  - **If G = T before the increase in spending, if G↑ but T is unchanged, then G – T > 0.**
  - **The demand for loanable funds increases by (G – T), shifting to the right.**
  - **r↑ leading to I↓ , S(r)↑ and C(r)↓.**
  - **It turns out that I↓ + C(r)↓ = G↑.**
  - **The increase resulting from increases in G is just offset by decreases in I and C. Government spending crowds out private sector spending.**

Gov't Increases Spending, Details (2)

- **Effect if the spending is financed by money creation:**
  - **There is still no reason for output and employment decisions to change.**
  - **AS (total output) does not change.**
  - **The AD curve will shift to the right as the money supply is increased.**
  - **The price level will rise--inflation.**

Piercing the Veil

- **Classical Economics is based on agents evaluating everything *in real terms*.**
- **Agents are thought to "pierce the veil of money" and make all decisions based upon the underlying *reals*.**
- **Agents seek to maintain their buying power (in real, after-tax terms) because they only work to buy (real) things.**

Effects of Taxes and Inflation

- **In the face of inflation or income tax increases, they will:**
  - **Seek increases in nominal wages to maintain their buying power, or**
  - **Reduce their supply of labor.**
- **In the face of a income tax cut, or reduction of the price level, they will:**
  - **Increase their supply of labor.**

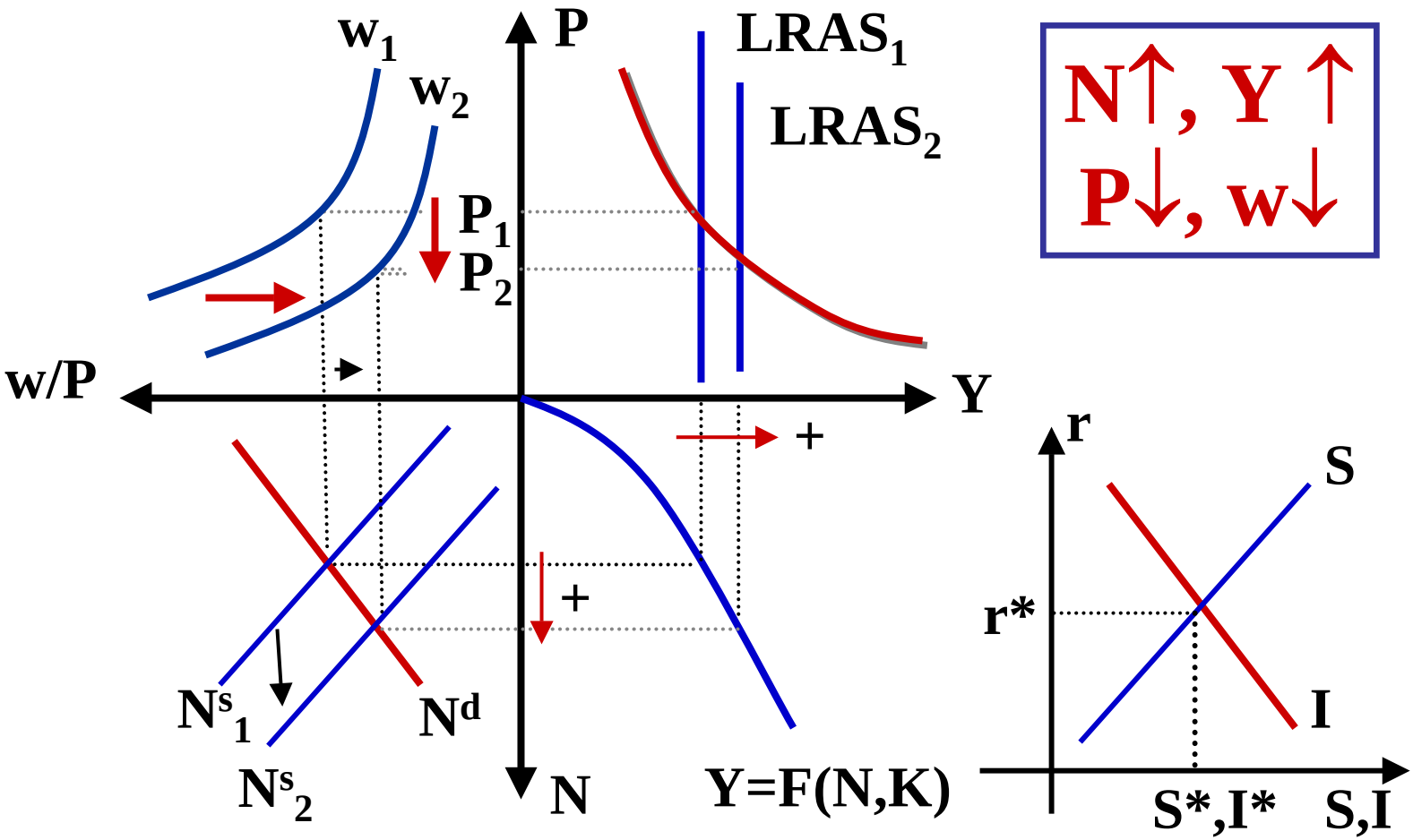
Tax Policies

- **If income taxes are cut,**
  - **Demand-side analysis:**
    - **Tax revenues fall**
    - **Budget deficit occurs (G – T > 0)**
    - **New consumption is crowded out.**
  - **Supply side analysis:**
    - **because**

$$N^s = N^s\left[(1-t)\frac{w}{P}\right]$$

    - **Labor supply increases, increasing output.**

Supply-side Effects of Tax Cut



Monetary Policy

- **Has an effect on inflation only.**
- ***"Inflation is everywhere and at all times a monetary phenomenon!"***