Open Economy Macroeconomics, Aalto SB Spring ~~2017~~

International Setting: IS-LM Model

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General equilibrium model of an open economy

- Build a GE model of an open economy
- Generalization of the corresponding aggregate demand - supply framework of a closed economy
- Some important additional elements
- IS-curve: goods market equilibrium with the real exchange rate as the new element vis-á-vis the closed economy
- LM-curve. money market equilibrium
- **Assumption**: openness of the economy does not affect the supply side of the economy
    - classical vs Keynesian supply curve

IS-curve

- National income identity in an open economy

$$y = C + I + G + NX$$

where

$$\begin{aligned} y &= \text{aggregate (nation) real income} \\ C &= \text{private consumption expenditure} \\ I &= \text{(private) investment expenditure} \\ G &= \text{net public consumption expenditure} \\ NX &= \text{net exports} = \text{exports - imports} \end{aligned}$$

- Since savings equals income minus consumption we can rewrite the national income identity as (S = savings)

$$S - I - NX = G \tag{1}$$

IS-curve

- (1) is merely an accounting relationship telling nothing about what determines aggregate demand
- Need *behavioural assumptions*, ie. assumptions about factors that actually impinge upon the components of aggregate demand
- Savings: unspent income, potentially positively dependent on income y (as well as the real interest rate)
- Investment: depends negatively on the real interest rate R (cost of capital!)
- Government spending: assume determined exogenously ("outside our model", ie. non-modelled)
- Net exports: depends on the real exchange rate $Q = \frac{SP^f}{P}$ as well as on foreign and domestic real income
  - imports depend negatively on Q and positively on domestic real income y ($\Longleftarrow$ *marginal prospensity to consume*)
  - exports depend positively on Q and positively on foreign real income y^f

IS-curve

- Incorporate all these assumption into (1) and specialize to simple linear forms:

$$by + zR - hQ = G_0 \qquad (1')$$

- $b.z$ and h are *behavioural parameters*, the coefficients of the unknowns; they are all positive
- Note that a *real depreciation*, ie. an increase in Q will a) increase volume of exports, b) reduce volume of imports; but net exports - trade balance - is equal to

$$NX = X - QM$$

hence although X (M) increases (decreases), QM can increase even to the extent that a real depreciation worsen the trade balance

- Need an assumption: **Marshall - Lerner condition** or the sum of export and import price elasticity exceeds one $\longrightarrow$ trade balance improves after real depreciation

IS-curve

- Fix the real exchange rate at Q_0 for the moment:

$$by + zR = G_0 + hQ_0$$

  so as to concentrate on the role of the pair (y, R) in equilibrating goods market (and, in the end, the whole economy)
- At given (G_0, Q_0), the rhs of the above equation is constant: hence, and increase in the real interest rate R requires a reduction in the real income for the goods market to remain in equilibrium
- Consequently, by changing the real interest rate rate we can trace out the path for the real income that maintains equilibrium in the goods market $\longrightarrow$ **IS-curve**
- Draw this as in the following figure: vertical axis real interest rate R, horizontal axis real income y

IS-curve; graphical representation

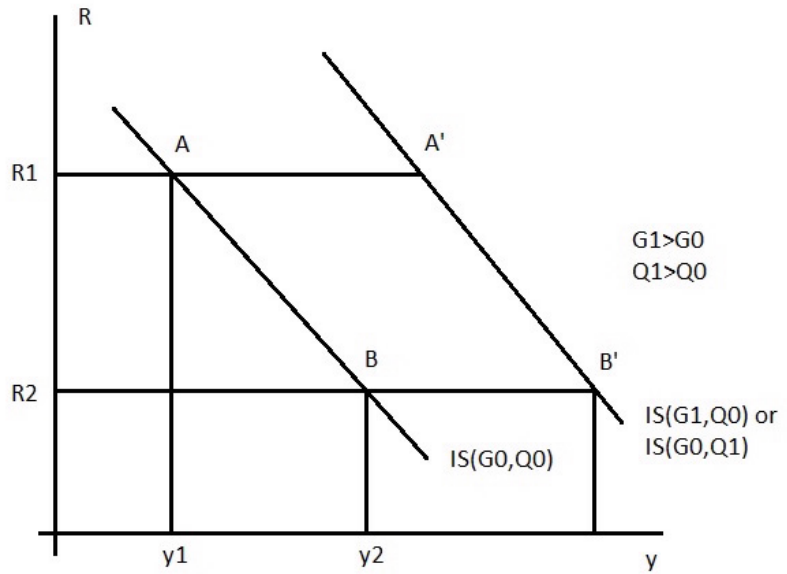


Figure: Goods market equilibria (y,R) in an IS-LM model.

Money market equilibrium: LM-curve

- To determine money market equilibrium, we need to define 'money'
- This is not as easy as look at first sight
- But, money serves four purposes:
  - medium of exchange
  - store of value
  - numeraire
  - debt settlement
- Our perspective on money comes mainly from the two first above
- Equilibrium needs demand and supply; start with the demand for money

Money market equilibrium: Demand for money

- Money is used for transaction purposes; hence the amount of money demanded depends on the volume of transactions in the economy
  - this is proxied by real income y: money demand depends positively on real income
- From the perspective of the store of value function of money, note the following

Definition

Opportunity cost of holding money is the return that could have been earned by holding an (interest bearing) asset less liquid than money (liquidity cost)

- Hence, by holding money, you lose the return from other, less liquid assets, be it interest or other forms of return
- If we proxy the opportunity cost of holding money by the nominal interest rate r we can write the money demand function as

Money market equilibrium: Demand for money

$$\frac{M^d}{P} = L\left(\underset{+}{y}, \underset{-}{r}\right)$$

where we have emphasized the fact that we are dealing with the demand for **real money balances** $\frac{M^d}{P}$

- To simplify further, use linear forms

$$\frac{M^d}{P} = ky - lr, \quad k, l > 0$$

Money market equilibrium: Supply of money

- To understand how the supply of money is determined, we need to understand the mechanics of government budget finance
- Suppose the government wants to run a budget deficit, ie. spend more than its revenues; how is this financed?
- As at the individual level, the government can finance its budget deficit by reducing its net assets, ie. by borrowing from others thereby increasing its liabilities
- Assume, for simplicity, that the government does not have accumulated assets; hence to finance the deficit borrow from others in one form or other

$$G - T = \text{ budget deficit } = \text{ total government borrowing}$$

where G and T denote government expenditure and (Tax) revenues respectively

- Borrowing from others? Like individuals?

Money market equilibrium: Supply of money

- governments have one more option available to them not available to individuals: they can issue a security that the public is willing to accept as money

- Hence

$$G - T = \Delta MB + \Delta B$$

where MB is the quantity of money (Monetary Base) in existence and B is the amount of non-monetary government debt (Bonds) in existence; Δ denotes change

- Hence, government budget constraint is the identity that expresses the fact that all government spending over any period of time must be financed by taxation, by issuing currency or by issuing non-monetary debt (bonds).

Money market equilibrium: Supply of money

- **Supply of money in an open economy**: start with the central bank (CB) balance sheet

Assets		Liabilities	
Gold and forex reserves	FX	Currency issued	MB
Loans to government	LG		

- Continue with commercial banks:

Assets		Liabilities	
Currency+Deposits in CB	MB^b	Deposits by public	D
Loans to the private sector	L		

Money market equilibrium: Supply of money

- Finally, the consolidated banking sector:

Assets		Liabilities	
Gold and forex reserves	MB^b	Currency in circulation	MB^p
Domestic Credit = L+LG	DC	Deposits by public	D
Money Supply: FX+DC	M^s	Money Supply: MB^p+D	M^s

- Above: currency in circulation = MB - MB^b
- So, how does a government finance deficit spending?

Money market equilibrium: Supply of money

- Using conventional (income) taxes, naturally
- But if the government decides NOT to raise taxes to finance its deficit spending, then it could approach the CB for a loan
  - in return, the government is forced to sign IOUs promising to pay the CB at some future date $\Longleftarrow$ government securities
- This transaction is represented in the asset side of the CB's accounts by the item 'Lending to government', consisting of the accumulation of government securities held by the CB
- The loan takes the form of printing currency, which can be used by the government for its additional expenditure
- Note that currency printed counts as a *liability* of the CB although the CB is not obliged to redeem banknotes in any meaningful sense
- Note also that the supply of *currency*, ie. money supply in a very narrow sense, is increased through this operation
  - ΔMB refers to the change in the quantity of currency issued or base money

Money market equilibrium: Supply of money and the government

- Of course, the government can take a loan from the CB either to buy back its IOUs from their holders among the non-bank public
- The MB will change also through this operation
- Above: we are talking about *open market operations* to distinguish this from transactions conducted behind closed doors (between the CB and the government)
- Governments can reverse the process
  - issue debt to raise cash from the non-bank public (open market sale)
  - spend the proceeds $\longrightarrow$ effect on MB nil
  - repay debt to CB $\longrightarrow$ reduce MB

Money market equilibrium: Supply of money and commercial banking sector

- Simplified liabilities side: only deposits D by public with the banking sector
- Deposited funds had to be put to work: banks lend
  - bank cannot lend all deposited funds $\longrightarrow$ must hold cash reserves
    - bank customers may want to liquidate their deposits for cash on demand
  - MB^b represents these precautionary reserves
    - these are kept at manageable level via deposits to the CB
  - hence no balance sheet distinction is made between currency actually in a commercial bank's till at any moment and the amount it has available on deposit with its bank, the CB!

Money market equilibrium: Supply of money and consolidated balance sheet for the whole banking sector

- Derive the **consolidated balance sheet of the whole banking sector**
- Central Bank

$$FX + LG = MB$$

- Commercial banks

$$MB^b + L = D$$

- Add these balance sheet equations

$$FX + MB^b + \underbrace{(LG + L)}_{DC} = MB + D$$

or

$$FX + DC = MB - MB^b + D$$

- DC = total lending by the banking sector, Domestic Credit

Money market equilibrium: Money supply identity

- The part of the total monetary base not in the vaults of banks, $MB - MB^b$, is **money in circulation**; denote this by MB^p
- RHS: money in circulation + deposits in the banks, ie. **money stock** M^s
- Hence

$$FX + DC = M^s$$

- Money supply is identically equal to the sum of domestic credit generated by the banking sector + the value of the country's reserves (of gold and foreign currency held at the CB)
- Note: the above is an *identity* (relationship true by definition), ie. cannot be disputed or disproved

Money market equilibrium: Money supply identity

- What does it tell?
  - lhs: the process by which the money stock is generated or backed
  - hence the identity tells us that every unit of domestic money must originate either in lending by the banking sector (DC) or in the reserves of foreign money
- Expansion of the money supply: each additional domesticy currency must have been generated by an expansion of domestic credit or by an increase in the reserves (of gold and foreign exchange)
- DC and FX are qualitatively different
  - DC directly or indirectly amenable to control by domestic monetary authority
  - FX perhaps not a policy variable - ECB does not print dollars or yen to put in the reserves!

Money market equilibrium: Money supply identity

- Foreign exchange reserves: buffer stock of intl money available, when necessary, to purchase the domestic currency so as to support the exchange rate
- Changes in reserves: generated by imbalances between endogenous demand and supply in the currency markets
- Two conclusions from this:
  - no point in hoarding reserves unless a country intends to peg its exchange rate
  - BoP: an analysis of the flow supply and demand in the currency markets; hence, a BoP deficit has to be offset by reductions in reserves
- Thus, which ever factors underlie BoP determination, underlie also changes in the reserves

$$\Delta FX + \Delta DC = \Delta M^s$$

- $\Delta FX = 0 \rightarrow \Delta M^s - \Delta DC = 0$, ie. changes in the domestic money stock originate exclusively in domestic credit expansion (/contraction)

Money market equilibrium: Pure float (again)

Definition

A (pure or clean) floating exchange rate regime is one where the BoP for official financing is identically zero, because the monetary authority either holds no foreign currency reserves or never uses them to intervene in currency markets

- Since any change in the money supply is due entirely to DC expansion/contraction, an additional element needs to be added to the above definition

Fact

Under floating, domestic money stock changes only as a result of changes in the lending behaviour of the domestic banking system. Since the volume of lending can be controlled by the authorities, so can the money supply. In this sense, the money supply is a policy instrument at the disposal of the country's monetary authority

Money market equilibrium: Fixed exchange rates (again)

- In contrast

Definition

Under a fixed exchange rate regime (incl. dirty/managed float) the BoP for official financing is NOT identically zero, the surplus/deficit being covered by the domestic monetary authority's use of the foreign exchange reserves to intervene in currency markets

- Under a fixed exchange rate system ΔM^s can result either from the change in volume of bank lending or from the change in foreign currency reserves or both
- Since the change in foreign currency reserves cannot be controlled by the domestic monetary authority, neither can changes in the money supply
- Hence, under fixed exchange rates, money supply cannot be regarded as a policy instrument

Money market equilibrium: LM curve

- Monetary policy in an open economy has a meaning which depends on exchange rate arrangements:
  - float $\longrightarrow$ management of money supply and
  - fixed exchange rates $\longrightarrow$ control of banking system's lending - ie. domestic credit
- To represent equilibria in the (domestic) money market, we need to derive the **LM-curve** (Liquidity - Money)
  - equilibrium in the money market: money demand = money supply
- Money demand has been derived, so money market equilibrium reads

$$\frac{M^s}{P} = \frac{M^d}{P} = ky - lr$$

- Note: the interpretation of the LHS depends now on the exchange rate regime

Money market equilibrium: LM curve

- Assume now that the money stock and the price level is fixed initially at the level M_0^s and P_0 resp

$$\frac{M_0^s}{P_0} = ky - lr$$

- Now: what is the relationship between income and interest rate that sustain money market equilibria at fixed money stock and price level?
- Clearly, if income y rises, then the interest rate r has to increase too for the money markets to remain in equilibrium
  - intuition: money demand increases (falls) as income (interest rate) increases
- We can represent the implied money market equilibria graphically as in the following figure

Money market equilibrium: LM curve

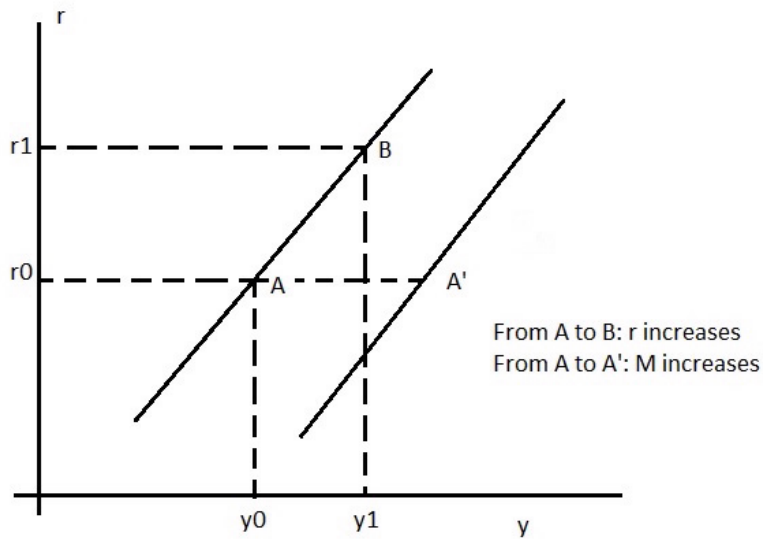


Figure: Money market equilibria: an increase in the money supply.

Money market equilibrium: A change in money supply

- Hence the locus of (y, r) -points (LM-curve) that sustains money market equilibria is increasing in the (y, r) -space
- Changes in the money supply will **shift** the LM-curve
  - an increase in the money supply from M_0 to M_1 will shift the LM-curve down and to the right
    - for a given interest rate r income has to increase for the money markets to be in equilibrium
- Also, changes in the price level will shift the LM-curve: a **fall** in the price level has qualitatively the same effect as an **increase** in the nominal money stock
- *Macroeconomic equilibrium* is now defined as the combination of the (real) interest rate and real income that simulataneously clears (equilibrates) both the goods and money market
  - graphically: IS- and LM-curves intersect at the equilibrium value of r and y

Macroeconomic equilibrium

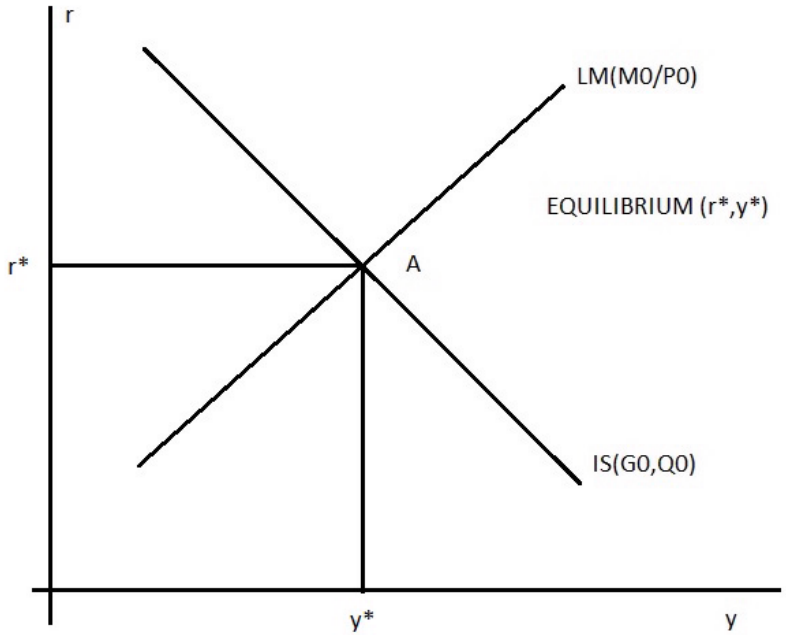


Figure: Macroeconomic equilibrium in an IS-LM model.

Macroeconomic equilibrium and aggregate demand

- Note: by the Fisher equation nominal interest rate is equal to the sum of the real interest rate and expected inflation rate, $r = R + \mathbb{E}\pi$; we take inflation expectations as given (constant) not affected by other variables so that we can use nonimal and real interest rate interchangeably
- You can use the IS-LM model to derive the aggregate demand relation for the economy (see next graph)
  - aggregate demand = relationship between the aggregate price level and output

Aggregate Demand

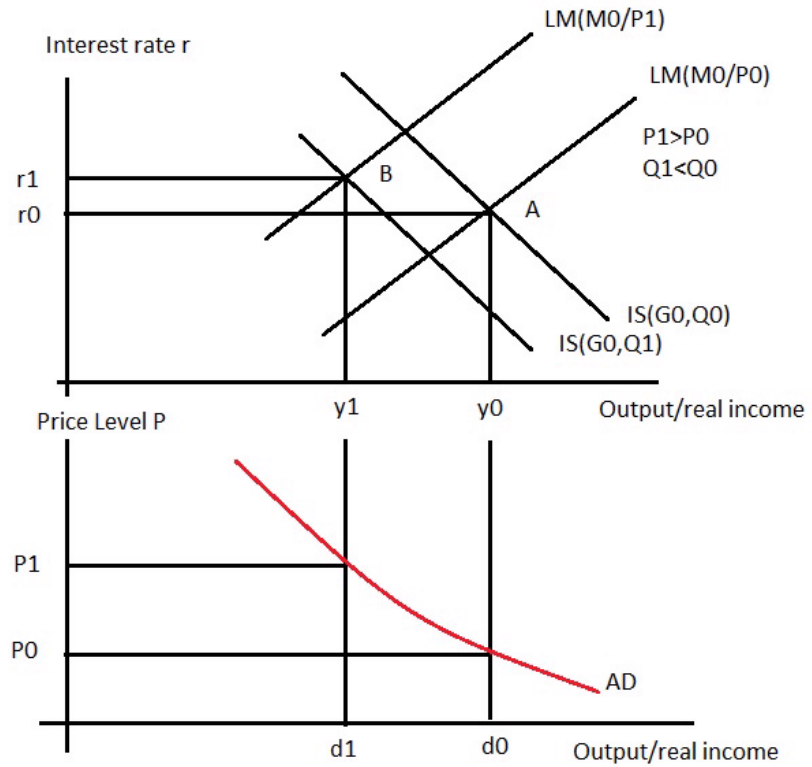


Figure: Deriving aggregate demand in the IS-LM model.

Meaning of 'equilibrium'

- Question: what would be the equilibrium level of income y_0 if government spending amounted to G_0, the money supply were set at M_0^s, the price level at P_0 and the real exchange rate at Q_0?
- 'Equilibrium income'?
  - exercise caution in interpreting this in the current context
    - level of income consistent with the equality of planned spending and income and of demand and supply of money
  - broad definition, but not yet sufficient for a complete equilibrium
  - for the latter we need some notion of the productive capacity of the economy, ie. aggregate supply, and the relation between income determined above and the productive capacity
    - e.g. it could well be that the income derived above exceeds the maximum potential output level of the economy!
- Hence, refer to the income level derived from the IS-LM model above as aggregate demand, denoted by d

Equilibrium

- Now, start with the price level P_0, government expenditure G_0, money stock M_0^s and real exchange rate Q_0
- Increase the price level to $P_1 > P_0 \longrightarrow$ real money stock $\frac{M_0^s}{P_0}$ falls to $\frac{M_0^s}{P_1}$ $\longrightarrow$ LM-curve shifts up and to the left in the above figure $(LM(\frac{M_0^s}{P_1}))$
- This is not all: real exchange rate $Q = \frac{SP^f}{P}$ falls from $Q_0 = \frac{S_0 P_0^f}{P_0}$ to $Q = \frac{S_0 P_0^f}{P_1}$ **assuming no change in the nominal exchange rate and foreign price level** $\longrightarrow$ loss in competitiveness of the domestic economy
- IS-curve shifts down and to the left in the above figure $(IS(G_0, Q_1))$
- New equilibrium $A \longrightarrow B$: interest rate has increased to r_1 and output (income) fallen to d_1
- An increase in the price level and a fall output: aggregate demand relationship!

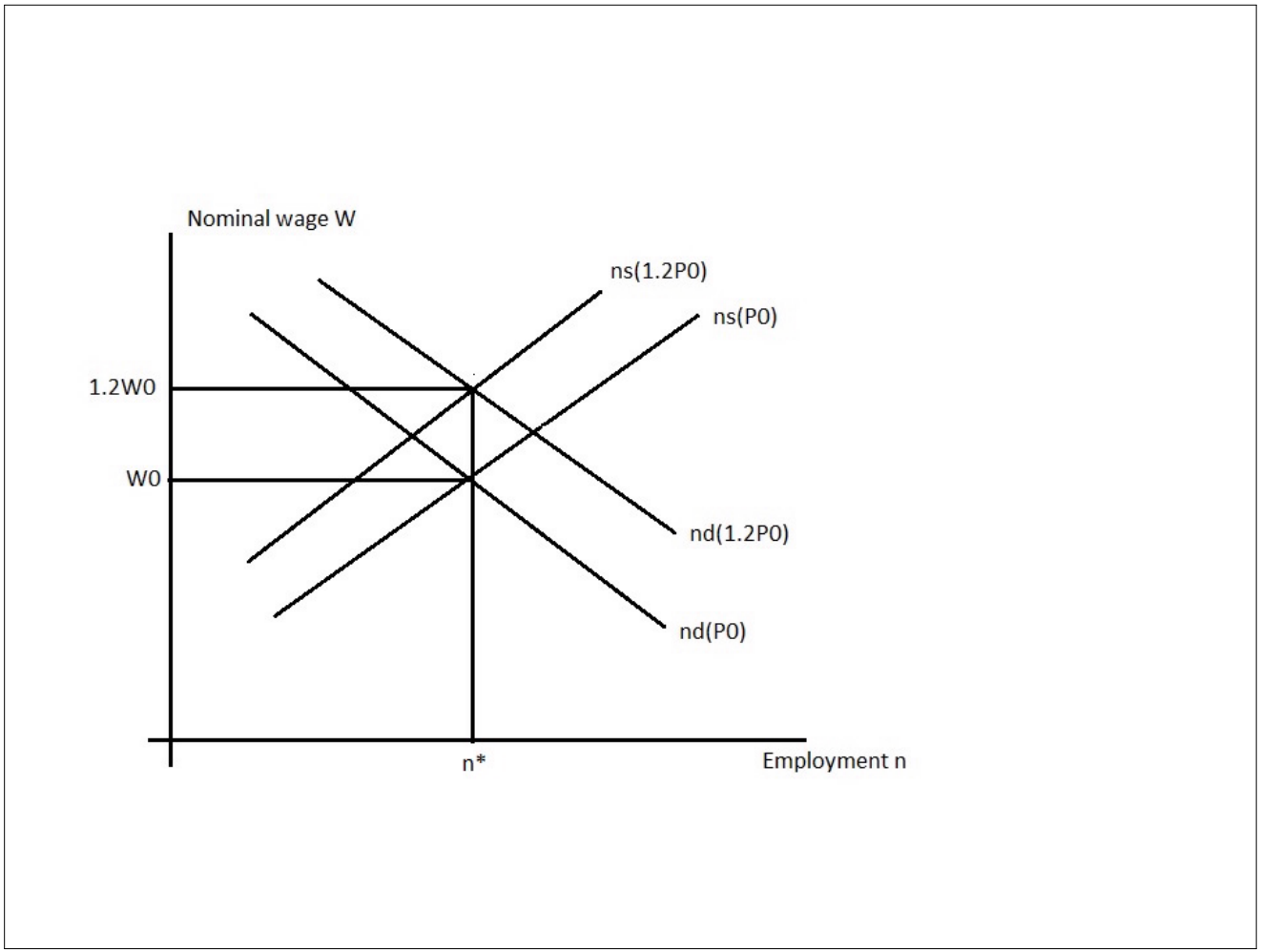
Flexible prices

- Assume: capital stock (quantity of equipment, plant and machinery) of the economy is given at any moment in time $\longrightarrow$ output depends only on labour input
- Profit maximizing firm: demand labour to the point where the value of its marginal product is equal to the money wage (marginal cost)
- Marginal product of labour is diminishing in the amount of labour
- If employers are competitive (and given the proper conditions for aggregation), demand for labour in the economy is a decreasing function of the nominal wage at any given price level
- If the price increases by e.g. 20 %, firms would pay the labour force exactly 20 % higher wages, since, other things equal, the marginal hour of work would produce proportionately greater addition to revenue than previously (NB! Employment was at the optimal, profit-max level prior to the price level increase)

Flexible prices

- Household choose a utility maximizing combination of work and pleasure: in a freely competitive labour mkts, they will offer labour services (hours) to the point were the monetary benefit (in terms of consumption), as measured by the wage, from supplying the last man hour is equal to their subjective assessment of its leisure value
- Or, the utility value of the wage equals the marginal utility of leisure
- Marginal utility of leisure is increasing in the number of hours worked as there is less time for leisure
- Hence, at any price level the number of hours supplied by households will be an increasing functions of the nominal wage
- If the price level increases e.g. by 20%, any given money wage will buy 20% less consumption (goods); hence households will supply the same amount of hours at exactly 20% higher money wage leaving the real wage constant
- Equilibrium real wage is the wage that equalizes labour demand and supply (see next graph)

Flex Wage Labour Mkt



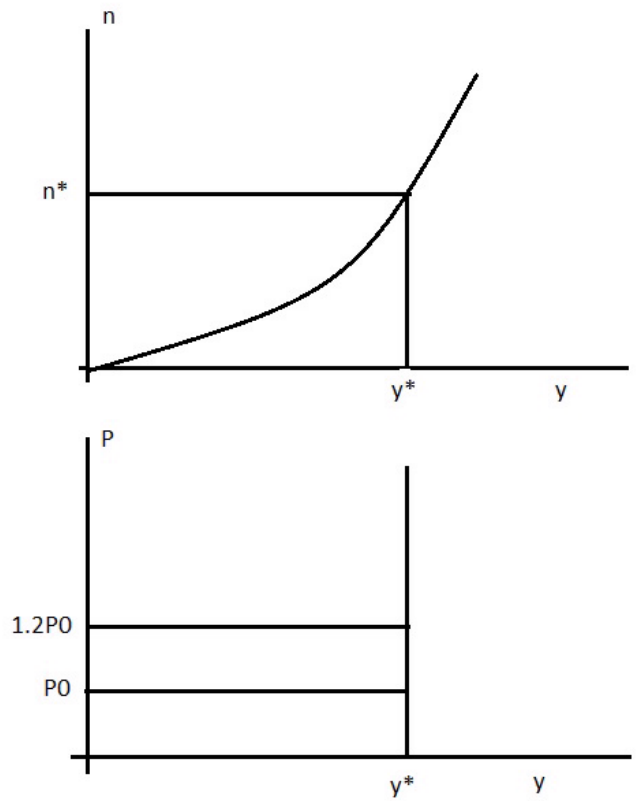
Classical/flex price aggregate output

- Hence: if prices and wages are flexible and costlessly adjusting, changes in the price level has no effect on employment and, consequently, on output
- Classical/flex price aggregate supply curve is thus vertical (see next figure)
- Things are different once we assume that **money wages are fixed**
- For simplicity assume that there is a nominal contract between employers and employees that stipulate a fixed money wage for a specified period of time; furthermore employees agree to supply all the hours demanded by firms
- *Effective labour supply curve* is thus horizontal at the fixed money wage (W_0, say)
- Fluctuations in labour demand will be fully reflected in the amount of labour input into the production

Aggregate supply with fixed money wage

- If, e.g., the price level increases, the value of the marginal product of labour increases and firms will hire more workers up to the point were the value of the marginal product of labour once again is equal to the fixed wage (NB! Marginal product of labour is a decreasing function of the amount of labour)
- Hence, as employment increases, aggregate output increases so there is a *positive relationship between the price level and aggregate output*

Aggregate Supply: Flex Wage



Aggregate Supply: Fixed Wage

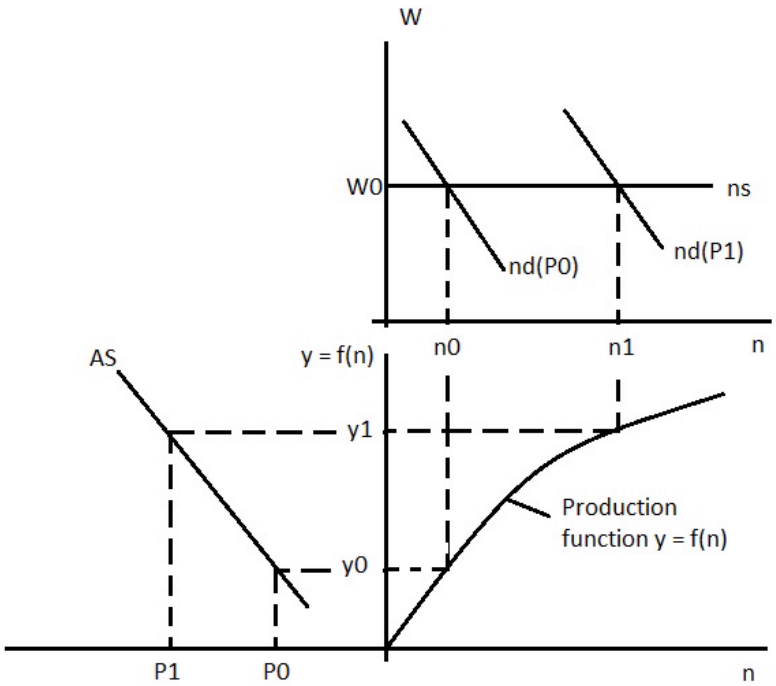


Figure: Aggregate supply under fixed wages.

AD = AS

- We can now represent the equality of aggregate demand and supply in (y, P) -space with the price level P on the vertical axis
- The nature and properties of the full goods mkt equilibrium - equality of aggregate demand and supply - depend critically on whether prices are fully flexible or not
- Under the classical assumptions, fluctuations in aggregate demand show up only as fluctuations in the price level
- Under Keynesian assumptions, on the other hand, aggregate demand fluctuations in general show up as fluctuations in the price level and output
- This is the underlying reason why we need, in these simple models, to drop the assumption of full price flexibility if we want aggregate demand management (through fiscal and monetary policy) to have non-trivial effects on aggregate activity, ie. output and employement

AD = AS