2. Keynes and the failure of self-correction

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2.1 Introduction

The term 'classical economists' reefers to a group of philosophers in the 18th and 19th centuries, such as Adam Smith, J. S. Mill, Thomas Malthus and David Ricardo, who advocated the laisser-faire. Among them, Adam Smith is considered "the father of Economics". Smith developed the theory of markets, where he stressed the powerful role of prices in coordinating economic activities[1]. Smith contended that the price mechanism entails the signals and the incentives enough for selfish agents to find it optimal to (re-)allocate the resources to where they are socially more valuable, without the need of government intervention. Smith echoed the Bernard Mandeville' idea that private vices can come along with public benefits[2]. In general, the Classical economists trusted the self-correction forces of the market economy ("The invisible hand").

The classical view was challenged by the advent of the Great Depression. The massive unemployment that marked the early 1930s in the United States defied the understanding that market economies are smoothly self-regulating. In alternative, John Maynard Keynes proposed a new theoretical framework, to contend that the government has a role in stabilizing the economy[3].

The key ingredient in the Keynesian doctrine is that certain prices, particularly wages, are not entirely flexible. Hence, they may not move fast enough to ensure the equality between demand and supply each moment in time. Under sticky prices, output is determined by the "effective demand", and the economy may find itself stuck in an "equilibrium" that falls short the "potential output" or "full employment". Even if the economy naturally gravitates to full employment in the long run, the process may be too slow, subjecting

[1] Smith, A. 1776. *The Wealth of Nations*, reprinted in Cannan, E. (ed.), 1961, London: Methuen.
[2] Bernard Mandeville, 1714). The Fable of the Bees, Private Vices, Public Benefits, Oxford.
[3] Keynes, J.M, 1936. *The General Theory of Employment, Interest and Money*. London: Macmillan.

citizens to unnecessary pain. Keynes defended that governments should do something to prevent or counteract economic downturns and to speed up economic recoveries.

This note briefly reviews the Keynesian attack to the classical doctrine. To make the explanation as simple as possible, we use a static model with the minimum structure to make the point. The basic setup is introduced in Section 2. In Section 3 we describe the classical view. In Section 4, we show how the assumption that prices are sticky reverts the principle that supply creates its own demand. In Section 5, we describe the Keynes' theory of the money market and the transmission of monetary disturbances to the real economy. In section 6, we focus on the Keynes' view of the Great Depression. Section 7 concludes.

2.2 Simple model

In the following, we use a static model with postulated behavioural consumption and investment functions, to confront the Keynes ideas with the classical view. The model is obviously limited, particularly because it abstracts from intertemporal decisions, but it contains the ingredients needed to explain the main ideas.

2.2.1 Market for goods and services

Consider a closed economy where production is a positive function of employment:

$$Q = zF(N) \quad , \; F_N > 0 \quad , \; F_{NN} \leq 0 \qquad (1)$$

In equation (1), z is a productivity parameter. You may interpret z as capturing the influence of other factors, such as capital, technology, public infrastructure, and the quality of institutions. Capital is pre-determined each moment in time, but is assumed to evolve along time as a function of investment.

A special case of (1) is when the marginal product of labour is constant, that is, $F_{NN} = 0$. In that case, the production function can be simply written as

$$Q = zN \qquad (1a)$$

This case is known and the *Ricardian production function*.

Since this economy is closed, the uses of income include private consumption (C), private investment (I) and government spending (G). The equilibrium in the market for goods and services implies:

$$Q = C + I + G \quad (2)$$

In this economy, households are the suppliers of inputs to production and the owners of firms, being therefore the recipients of the entire gross income generated, Q. The households' income is exhausted in taxes payments (T), consumption (C), and private savings[4]:

$$S_P = Q - T - C \quad (3)$$

The government savings are:

$$S_G = T - G \quad (4)$$

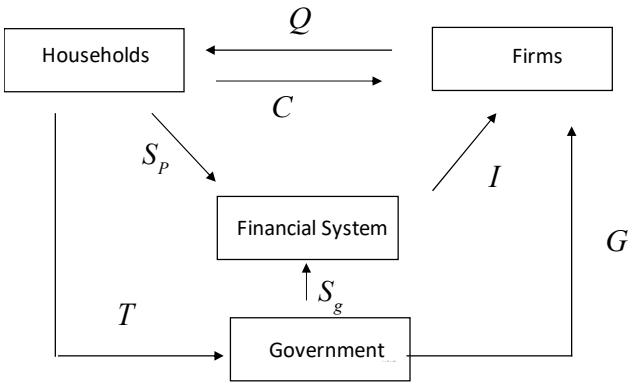
Combining (3), (4), and (2), one obtains an alternative equilibrium condition for the market for goods and services:

$$S = S_P + S_G = I \quad (5)$$

Figure 1 describes the flow income chart of this economy.

[4] The term T refers to taxes minus government' transfers. Interest on government bonds are accounted as transfers.

Figure 1 The flow income chart of the model economy



2.2.2 Savings and investment

In this note, we abstain from modelling intertemporal decisions. Instead, we postulate that private savings are a positive function of current disposable income and of the interest rate:

$$S_P = S_P\left(\overset{+}{r}, Q \overset{+}{-} T\right) \qquad (6)$$

For mathematical convenience, at some point we will refer to a particular functional form of (6):

$$S_P = s\left[Q - T\right] - a\left(r\right) \qquad \text{with} \qquad a_r < 0 \quad , 0<s<1 \qquad (6a)$$

Where s is the "marginal propensity to save" out of disposable income.

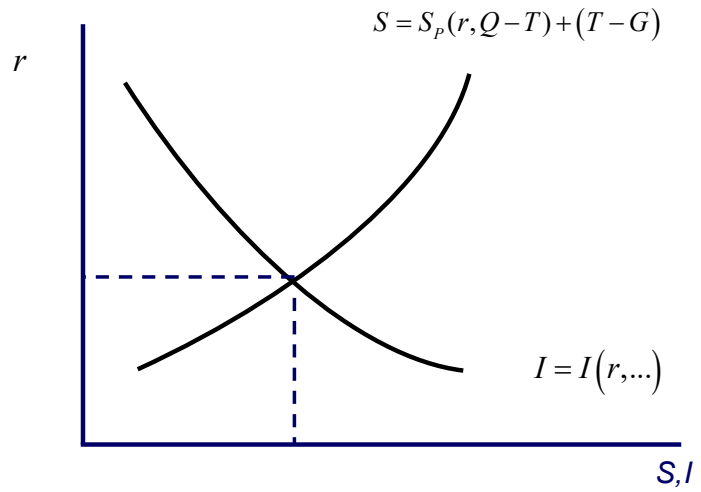
Investment is assumed to depend positively on future (expected) productivity and negatively on the interest rate:

$$I = I\left(\overset{-}{r}, \overset{+}{z^E}\right) \qquad (7)$$

Replacing (6) and (7) in (5), the equality between savings and investment becomes:

$$S_P\left(\overset{+}{r}, Q \overset{+}{-} T\right) + \left(T - G\right) = I\left(\overset{-}{r}, \overset{+}{z^E}\right) \qquad (8)$$

Figure 2 – Savings and investment



The equality between savings and investment is represented in figure 2, where the vertical axes displays the interest rate. A key feature of the saving schedule is that it is *parametric* on the level of output, Q: an increase in Q shifts the saving schedule to the right. The investment schedule shifts rightwards or leftwards depending on whether future productivity is expected to increase or to decline.

In light of (8), given the exogenous parameters T, G , z^E , and z, there are two possible candidates to balance the market for goods and services: income (Q), and the interest rate (r) As we will see next, the *variable that actually adjusts* to clear the market for goods and services is a matter of *fundamental disagreement* between the classical view and the Keynesian theory.

2.2.3 Labour market

For simplicity, we assume that the supply of labour is inelastic:

$$N^S = N^* \qquad (9)$$

Firms take current productivity (z), the output price (P), and the nominal wage rate (W) as given and choose the employment level to maximize profits. This problem delivers the well-known optimality condition stating that the demand for labour is such that the marginal product of labour is equal to the real wage:

$$zF_N(N) = \frac{W}{P} \qquad (10)$$

In case, $F_{NN} < 0$, equation (10) implicitly defines an optimal demand for labour as a function of productivity and of real wages:

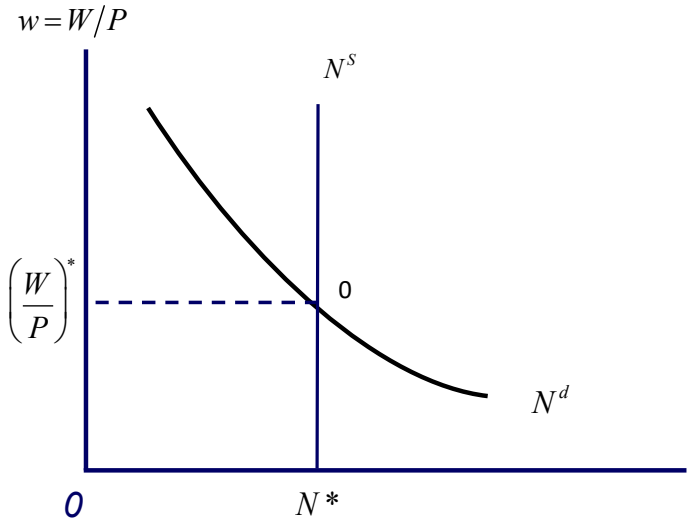
$$N^d = F_N^{-1}\left(\frac{W}{Pz}\right) \qquad (11)$$

In case the production function exhibits constant returns (equation 1a), the demand for labour is horizontal:

$$z = \frac{W}{P} \qquad (10a)$$

Figure 3 displays the supply and demand for labour. In the figure, the demand for labour is downward sloping, meaning that we are postulating diminishing returns ($F_{NN} < 0$). The case with constant returns is shown in figure 8.

Figure 3: Labour demand and supply



2.3 The classical view

The classical interpretation of the economy emphasized the role of prices in regulating the demand and supply. Assuming competitive markets and price flexibility, the classical model delivers four main propositions: (i) The economy will always be at full employment;

(ii) Supply creates it's own demand; (iii) there is no role for stabilization policies; (iv) money only produces nominal effects, while real variables, such as output and employment, are determined on the real side of the economy (the "Classical Dichotomy").

2.3.1 Full employment

The key assumption in the classical model is that prices are flexible. For instance, in the labour market, the real wage $w = W/P$ is thought to adjust to balance the demand and supply of labour:

$$w^* : N^S = N^d \qquad (12)$$

The equilibrium in the labour market is identified in figure 3 by point 0. In this case there is full employment of labour.

More generally, under flexible prices there will be full employment in all markets. As a corollary, output will be the maximum feasible, given the technology and resource constraints:

$$Q^* = zF\left(N^*\right) \qquad (13)$$

This illustrates proposition (i): the economy will always be at full employment. In light of equation (13), output is entirely determined by the supply side of the economy.

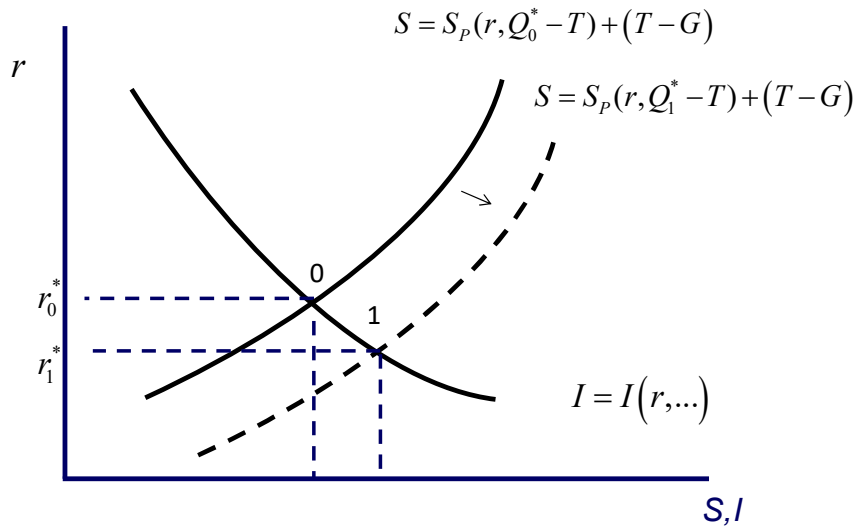
2.3.2 The equilibrium (or "natural") interest rate

Given the exogenous parameters, T and G, once the level of output is determined, the exact position of the saving-schedule in the diagram describing the market for loanable funds is determined. Given the investment schedule, there is a unique interest rate that balances the market for loanable funds:

$$r^* : S_P\left(Q^* - T, r\right) + T - G = I\left(z^E, r\right) \qquad (8a)$$

In the classical model all pries are flexible. This includes the interest rate. Thus, the later adjusts to ensure that savings and investment are equal. The equilibrium in the classical model is illustrated by point 0 in Figure 4.

Figure 4: Classical equilibrium and say's law



2.3.3 The Say's Law

To see the implications of a shift in supply, consider a case where population in this economy expands. In terms of Figure 3, that would imply an expansion of the labour supply schedule to the right, and a decline in the equilibrium real wage. The fall in wages ensures that all new population is absorbed by the labour market. Then, with a higher level of employment, output will expand.

In Figure 4, the fact that full employment output is now higher implies a shift of the savings curve to the right. At a constant interest rate, that would imply an excess of savings over investment (S>I) or, which the same, an excess supply over demand (Q>C+I+G). Because the interest rate is flexible, such situation will not last for long: the *excess supply of loanable funds* will cause the (natural) interest rate to decrease, inducing an expansion of consumption and of investment.

In the end, the extra output caused by the population expansion is totally absorbed by the increase in private spending, that is: $\Delta Q^* = zF_N \Delta N^* = \Delta I + \Delta C$.

This example illustrates the law of markets, or the Say's law: "aggregate production necessarily creates an equal quantity of aggregate demand" [5].

2.3.4 Crowding out

Since output is at its maximum possible level and aggregate demand is entirely determined by the supply side of the economy, in this framework the fiscal policy has no power to influence output. Still, the fiscal policy impacts on the composition of aggregate demand, crowding out private expenditures.

To see this, consider an increase in government expenditures. In terms of figure 4, the increase in government expenditures causes the schedule describing domestic savings to shift leftwards: in case G increases with T constant, there is a decline in government savings; in case the higher expenditures are financed with higher taxes, private savings decline. In any case, all else equal, there will be an excess of investment over savings (S<I) or, which is the same, an excess demand over income (C+I+G>Q). Thus, the interest rate must rise. This, in turn, causes private consumption and investment to decline.

The fall in private spending that results from an increase in government spending is labelled "crowding out". In the classical model, there is "full" crowding out, in the sense that the increase in government expenditures must be matched by an equal fall in private expenditures, that is: $\Delta G + \Delta I + \Delta C = 0$. In the end, only the composition of aggregate demand was impacted. This example illustrates the claim that there is no role for fiscal policy

[5] Say, Jean-Batiste, 1803. Traité d'economie politique.

in altering current output. Note however that future output will be impacted, because current investment is now lower[6].

Another example in which the composition of aggregate demand changes occurs when private savings increase – say, because households become more patient. In that case, the saving schedule shifts to the right. Since output is always at full employment, the equilibrium interest rate must decline. This, in turn, induces an increase in investment and thereby more output in the future. In the classical model, savings are expansionary, in the sense that they generate more output in the future. Current output, however, remains unchanged, at the level determined by the supply conditions.

2.3.5 The classical dichotomy

The classical economists did not explicitly formulate a theory of money demand. They however theorized the role of money as medium of exchange and the causal link between money and prices. These ideas were formulated in terms of the "Quantity Theory of Money"(Box 2.1).

To see how this theory works, assume that the demand for real money balances is proportional to real income:

$$m^d = kQ \qquad (14)$$

The rationale is that people need money to carry out transactions. Equation (14) postulates that, whenever the volume of desired transactions in the economy increases, the demand for money increases in a fixed proportion, k. The parameter k may be interpreted as the inverse of the "velocity of circulation of money" (see Box 2.1).

The nominal money supply M^S is determined by the central bank. The equilibrium in the money market then implies:

[6] This discussion abstracts from the impact of government expenditures on the supply side. For instance, more government services in terms of infrastructure and rule of law are likely to increase the productivity parameter, z. In this chapter we however abstract from this channel, to focus on the demand side.

$$\frac{M^S}{P} = kQ \qquad (15)$$

Given the nominal money supply, M^S , the equilibrium in the money market (15) implies a negative relationship between output and prices, $Q = M^S/Pk$. This negative relationship describes the classical Aggregate Demand curve (AD), depicted in Figure 5. In the figure, the Aggregate Supply (AS) is vertical, because output is always at full employment (13) irrespectively of the price level.

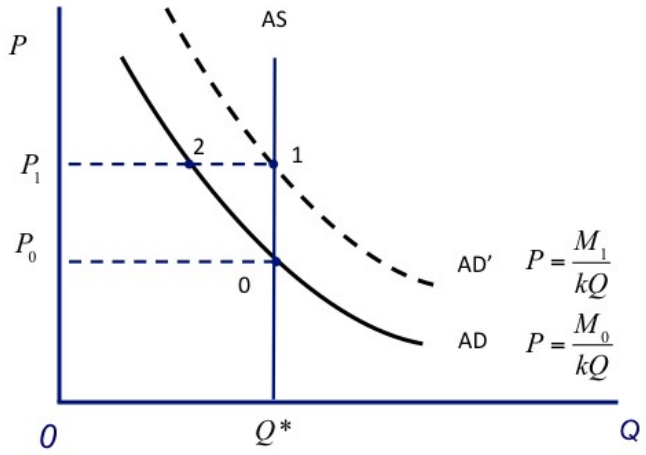
Setting the aggregate demand equal to aggregate supply, we obtain a solution for the price level: $P = M^S/kQ^*$. Since output is always at full employment, this equation implies that prices are proportional to money.

Referring to Figure 5, when the supply of money increases from $M^S = M_0$ to $M^S = M_1$, the aggregate demand schedule shifts to the right, and prices increase from P_0 to P_1 (from point 0 to point 1). What is the intuition? Since people desire a constant fraction of real income in the form of real money balances, when the nominal money supply increases, they will try to get rid of the excess money, buying more goods. Because the supply of goods is fixed (determined on the supply side), the purchasing power of money ($1/P$), must erode.

Money neutrality also holds in the labour market. In the labour market, the equilibrium is defined by a *real* wage rate that is determined by the demand for labour and the supply of labour, and these depend on real factors only, such as productivity and the size of the labour force. As long as these real factors remain unchanged, the equilibrium real wage rate will remain unchanged. Thus, whenever an increase in money supply causes an increase in the price level, nominal wages must increase accordingly (in our example, from $W_0 = P_0 w^*$ to $W_1 = P_1 w^*$). In terms of figure 3, changes in the price level do not tilt the labour market away from equilibrium.

This discussion illustrates the "classical dichotomy": In the classical model, the real variables, such as output, employment, consumption and the real interest rate are determined on the real side of the economy. Money is a mere veil, which generates nominal effects without any impact on real variables.

Figure 5 – Aggregate supply and the quantity theory in the classical model



Box 2.1. The Quantity theory

The quantity theory descends from philosophers of the 16th century, who observed a positive relationship between prices and the coinage of money. This view was first formalized by the Quantity Equation, stating a relationship between money and nominal GDP mediated by money velocity, MV=PQ. The quantity theory assumes that money velocity is constant. There is therefore a distinction between the quantity *theory* and the quantity *equation* of money. The quantity equation is an accounting identity: it basically defines "money velocity" as the ratio between nominal output and the quantity of money, that is, V=PQ/M. The quantity theory postulates that money velocity is constant over time

The quantity equation relating the supply of money to the value of transactions was first presented by John Stuart Mill while the Quantity Theory was stated by the astronomer Simon Newcomb (1885). It was however Fisher (1911) who popularised the quantity theory of money[7].

[7] Mill, J.S., 1848. Principles of Political Economy. Fisher, I, 1911, The Purchasing Power of Money, New York: Macmillan.

2.4 When the price mechanism is too slow

2.4.1 Introduction

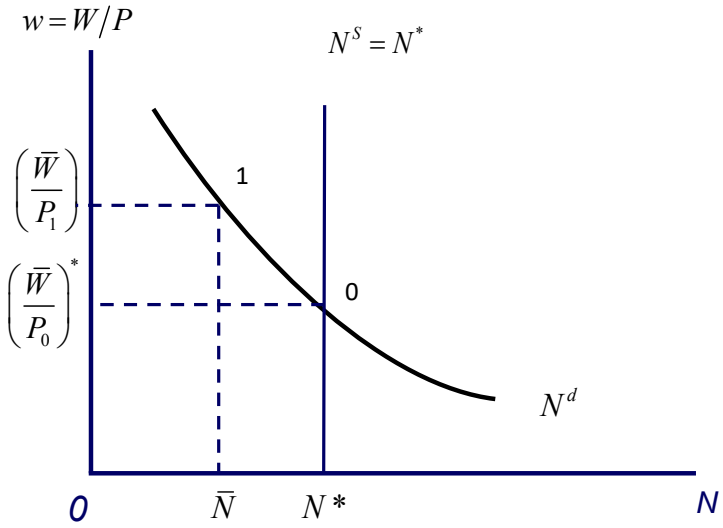
During the Great Depression, the high unemployment and the failure of self-correction challenged the classical doctrine. Keynes asked: if supply creates its own demand, why are we having a depression? Keynes argued that the price mechanism is not fast enough to ensure the self-correction of the economy in a reasonable time. When this is so, the economy may be stuck in an "equilibrium" that differs from full employment.

Keynes distinguished "full employment output", driven by technology and resources, from "equilibrium output", which is the quantity of goods that firms actually decide to produce. The later is driven by the firms' perception regarding what consumers, investors, and the government are planning to buy. Keynes reversed the Say's Law, contending that "effective demand determines output", not the other way around.

2.4.2 Sticky wages and aggregate supply

The main ingredient on the attack of Keynes to the classical doctrine is that wages are sticky: nominal wages do not adjust fast enough to clear the labour market each moment in time. When this is so, the economy may find itself stuck in an equilibrium that is different from full employment.

Figure 6 – Nominal wage stickiness in the Keynesian world



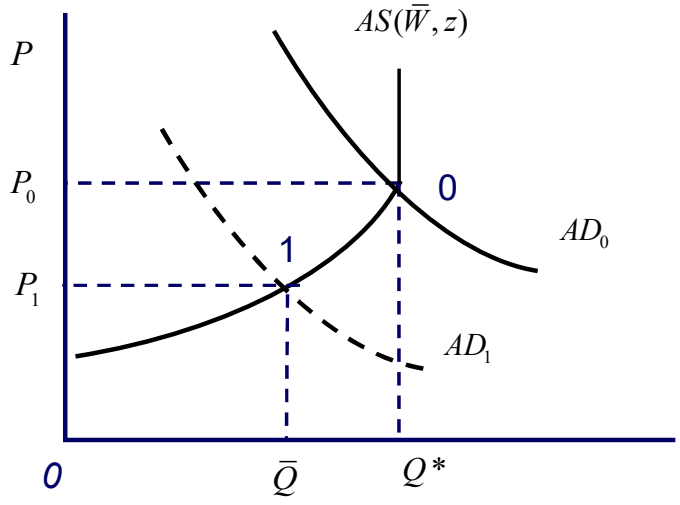
To illustrate this, we refer to Figure 6. The figure replicates the labour demand and supply described in Figure 3, with the difference that now nominal wages are fixed. Thus, if by chance prices are such that real wages are at the market-clearing level, full employment will be met (point 0). If however nominal wages are too high relative to prices, there will be unemployment. Under sticky wages, the equilibrium level of employment $\bar{N}$ is determined by the labour demand, (10) given the real wage rate, $\bar{W}/P_1$.

A corollary of nominal wage stickiness is that the aggregate supply becomes a positive function of the price level: holding constant the productivity parameter z, the negative relationship between real wages and employment in Figure 6 translates into a positive relationship between prices and output in Figure 7. Formally, the expression for the AS curve in Figure 7 is obtained by replacing the demand for labour (11) in the equation for output (1), assuming a constant nominal wage $\bar{W}$:

$$Q = zF\left[N^d\left(\bar{W}/P\right)\right] \qquad (16)$$

Note that the AS curve is parametric on nominal wages and on productivity. Since we are assuming that the labour supply is inelastic, the AS curve becomes vertical at the level corresponding to full employment.

Figure 7 – Aggregate supply and demand in the Keynesian world



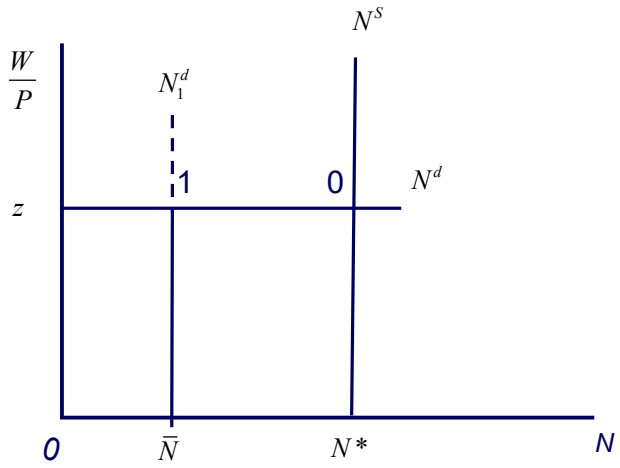
In this model with sticky prices, aggregate demand determines the level of output. For instance, when aggregate demand declines from 0 to 1 as depicted in Figure 7, the

equilibrium level of output declines bellow full employment. In terms of figure 6, the move from 0 to 1 in figure 7 corresponds to an increase in the real wage rate. Point 1 describes a situation of "involuntary unemployment": there are people willing to work at the prevailing wage rate, but firms do not hire because real wages are too high. Adjustment to full employment would require a decline in nominal wages, but such decline does not take place because wages are sticky. The situation described in Figure 6, whereby wages are too high, and workers are rationed in their choices is labelled "classical unemployment"

2.4.3 Keynesian unemployment

A particular specification of the Keynesian model consists in assuming that the production function is linear in labor, as describe by (1a). In that case, the labor demand is horizontal (eq. 10a). This is illustrated in figure 8.

Figure 8 – "Keynesian" unemployment and effective labour demand



Solving for the price level, we get:

$$P = \overline{W}/z\,. \qquad (16a)$$

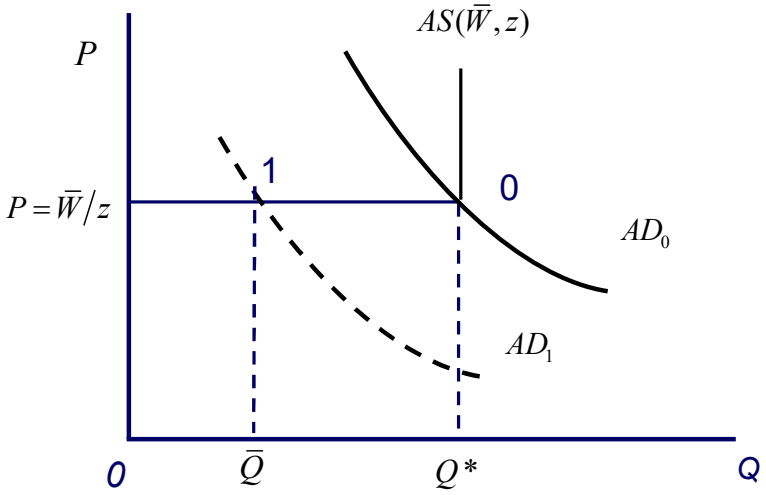
Equation (16a) implies a flat aggregate supply curve. In light of (16a), firms are willing to supply any amount of output at the given price. This curve is referred to as the "Keynesian supply function". Figure 9 shows a contraction in aggregate demand when the supply curve is "Keynesian". In point 1, firms would be willing to produce more units of

output at the given price, but they do not actually do so because there is no demand. The level of output is entirely determined by the demand side.

The corresponding equilibrium in the labor market is described by point 1 in figure 8. In this point, the quantity of labor demanded is exactly the needed to produce the quantity of output that firms are able to sell. The vertical quantity $N_1^d = \bar{Q}/z$ is labelled as the "effective demand for labour". Note that firms are willing to hire more workers at the given wage rate, but they prefer not to do so, because they are *rationed* in the output market.

In point 1, there is involuntary unemployment equal to the distance $N^* - N_1^d$. This case is labelled "Keynesian unemployment". The difference relative to "classical unemployment" is that real wages are not too high: firms would be willing to hire more workers at the prevailing real wage rate, but they fail to do so, because they are rationed in the output market.

Figure 9 – The "Keynesian" supply curve



2.5 The Keynes effect

A key ingredient in the Keynesian doctrine was a new theory of money demand. Keynes contended that the money demand depends on the interest rate, and that the later is determined in money market, rather than in the market for goods and services. In the Keynes world, *the interest rate is a monetary variable*, not a real variable.

But if the interest rate is determined in the money market, how will the equilibrium in the market for goods and services be ensured? Keynes argued that the variable that balances the markets for goods and services is real income. With this reasoning, Keynes opened a channel through which monetary policy influences the aggregate demand and by then the equilibrium level of output. This channel is labelled "the Keynes effect".

2.5.1 The theory of liquidity preference

Keynes accepted the classical idea that the demand for money is driven by transaction purposes but contended that the ratio between money and transactions (money velocity) is not always constant: it can be destabilized by uncertainty (precautionary demand), or by changes in the opportunity cost of holding money (bond yields). The departure from a linear relationship between money and transactions presumes that any volume of transactions can be achieved with different quantities of money. If people hold more money, they will save more on transaction costs (money provides liquidity services). People may however prefer to carry out their transactions with less money – facing higher transaction costs – in case the opportunity cost of holding money (the interest rate on bonds) is high. Thus, for instance, when the nominal interest rate increases, people reduce the fraction of wealth they hold in the form of money, switching to bonds.

In light of the liquidity preference theory, people prefer to hold money than bonds, because money is more liquid than bonds. People are however induced to hold bonds because bonds pay an interest and money does not. Formally, Keynes allowed the velocity of money to be an increasing function of the *nominal* interest rate, introducing a "speculation motive" in the demand for money. This is summarized by the following equation[8]:

$$m^d = m(i, Q) \qquad (17)$$

[8] Keynes also argued that the demand for money increases in periods of high uncertainty, but in the model we ignore this extra term.

When the money demand takes the form (17), the equilibrium in the money market is as follows:

$$\frac{M^S}{P} = m(i, Q) \qquad (15a)$$

Comparing to equation (15), we see that there is now one more candidate to clear the money market, given the other variables: the nominal interest rate. Under this reasoning, Keynes created a mechanism to de-link the price level from the nominal money supply.

2.5.2 The interest rate as a monetary variable

The fact that money demand depends on the nominal interest rate does not challenge by itself the classical view of money neutrality: if prices were flexible and adjusted to clear the money market, the interest rate would still be free to clear the market for loanable funds (in Figure 3), being therefore exogenous in the money market[9]. In the Keynesian model, however, prices are sticky. If prices are sticky, they cannot adjust immediately to clear the money market. And if prices fail to clear the money market, the obvious candidate to take this job is the nominal interest rate.

[9] Note that the demand for money depends on the nominal interest rate, i, while savings and investment depend on the real interest rate, r. The nominal and the real interest rate differ by the inflation rate: $i = r + \pi$, where π is the inflation rate. In the discussion, we abstract from this distinction, assuming that the inflation rate is zero.

Figure 10 – Adjustment in the money market following a monetary contraction

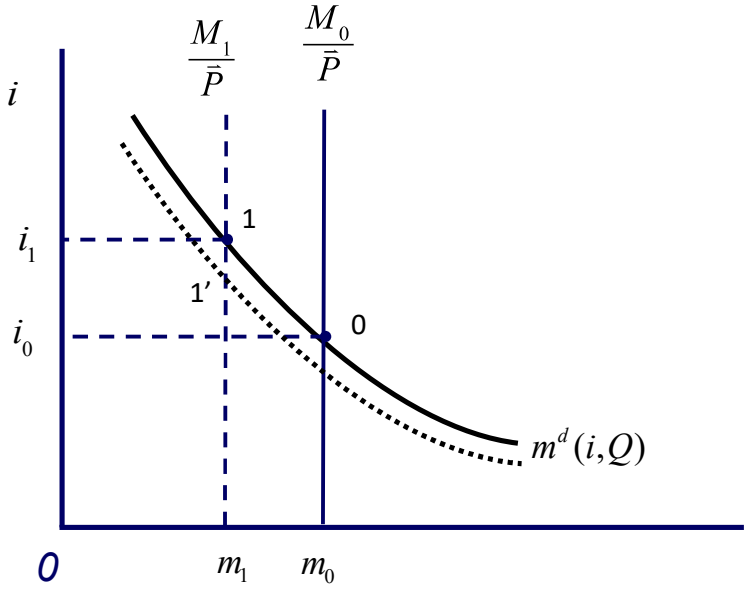


Figure 10 illustrates the adjustment in the money market when prices are sticky. Assume that the nominal money supply contracts from M_0 to M_1. Since prices are constant, the contraction of nominal money delivers a contraction in real money: the real money supply curve shifts leftwards (in contrast to the classical model, where changes in M do not cause the curve M/P to shift at all). At a constant interest rate, the monetary contraction implies an excess demand for money. In response, people will try to get cash, selling bonds. Since the economy is closed and the supply of bonds is given, the excess supply of bonds drives its secondary market price of bonds downwards and the corresponding yields (the interest rate) upwards. This is basically the adjustment underlying the move from 0 to 1 in Figure 10.

2.5.3 The transmission mechanism

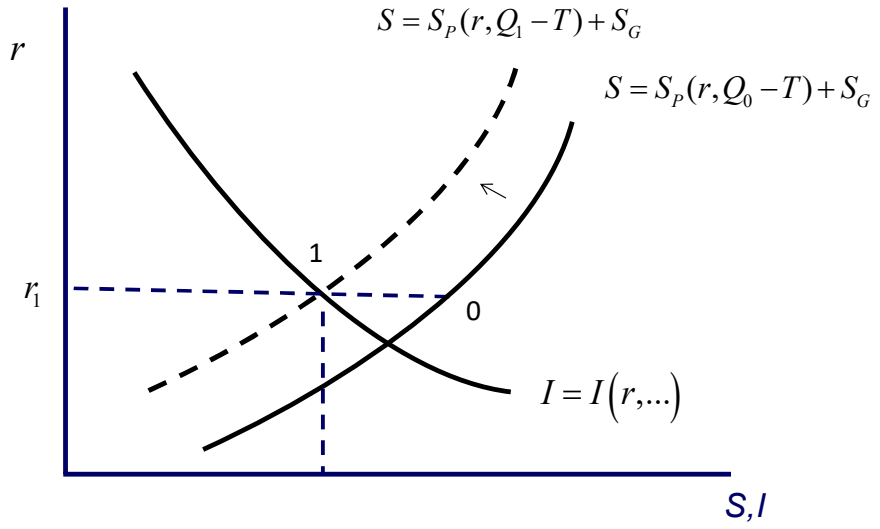
In light of the classical doctrine, the variable that clears the money market is the price level and the variable that clears the market for goods and services (as implied by the equality between savings and investment) is the interest rate. Keynes contended that prices are sticky and cannot adjust to clear the money market. He therefore argued that the variable that clears the money markets is the interest rate.

But if the interest rate is determined in the money market, how is the equilibrium in the goods market ensured? In equation (8), we see that the only remaining candidate to

balance savings and investment when the interest rate is exogenous is the level of income, Q. Thus, for instance, if the interest rate - determined in the money market - is too high, implying an excess of savings over investment, income will decline, to ensure the equality between savings and investment. What is the intuition? Remember that equation (5) is just another way of writing equation (2). Thus, an excess savings over investment means that aggregate demand falls short aggregate supply: the attempt of people to save depresses the demand for final goods. Keynes contented that in such a situation, firms will cut down production: if the supply of goods exceeds the demand for goods, inventories will start accumulating. Since firms do not profit with unsold production, they will reduce output until the flow supply equals the flow demand.

Figure 11 illustrates the adjustment process in the market for goods and services: suppose that the interest rate, determined in the money market, is too high, so that planned savings exceed investment when income is at its initial level, Q_0 (point 0). Because in this case there is an excess supply of goods and services, inventories will start accumulating and firms, in response, produce less. With the fall in production to Q_1 , the savings schedule shifts leftwards, until savings and investment are equal at the given interest rate.

Figure 11 – Adjustment in the market of goods and services under sticky prices



The link between the money market and market for goods and services via interest rate is known as the "transmission mechanism" or simply, the "Keynes effect". The Keynes

effect opens a channel through which the monetary policy can influence investment and savings, and by then equilibrium output.

2.5.4 Simultaneous determination

Analytically, the adjustment mechanism is a bit more complex, because output and the interest rate are determined simultaneously. When, at a given interest rate, there is an excess savings over investment causing the income level to fall like in figure 11, this feeds back in the money market, tilting the demand for money downwards. This is illustrated by the dashed money demand curve in Figure 10. Because of this "second round" effect, the equilibrium interest rate in the money market will decrease to the level 1', and this will impact again in the good markets, and so on.

Thus, the interest rate and output must be determined simultaneously. When the money supply is considered exogenous (policy variable) the model can be solved with two main equations: the one requiring the equality between savings and investment, (8) – known as the IS curve - and the one describing the equilibrium in the money market, (15a) – known as the LM curve. Solving together equations (8) and (15a), one obtains a negative relationship between output Q, and the price level, P, given the exogenous parameters G, T, and M. This is the "Keynesian AD curve".

2.5.5 The slope of aggregate demand

In the classical case, the aggregate demand is basically given by the money market equilibrium condition (15). In the Keynesian model the aggregate demand accounts for the fact that the interest rate and income are simultaneously determined by the equilibrium in the money market (15a) and the equilibrium in the market for goods and services (8).

In the general case, the AD schedule is downwards sloping, as described in figures 7 and 9. Underlying the slope of the aggregate demand is the Keynes effect: if, departing from an initial equilibrium, the price level falls, all else equal the real money supply will increase, causing the interest rate to decline and by then investment and consumption to increase. All in all, the fall in the price level is associated with a higher aggregate demand.

In a world with sticky wages, monetary authorities have the power to drive output towards full employment: by expanding the money supply and lowering the interest rate, the

central bank can induce higher levels of consumption and investment. In terms of figure 7, that would imply a shift of the aggregate demand to the right, at constant prices. Since the AS curve is positively sloped (or even horizontal, in the extreme case in which $F_{NN} = 0$), output will expand.

2.6 The Great Depression

The "Keynes effect" is what makes the Aggregate Demand sloping negatively. Ironically, however, Keynes argued that this effect was absent during the Great Depression. For two reasons: (a) consumption and investment were not responding to the interest rate; (b) even if they did, the interest rate could not be lowered, because the money market was caught in a liquidity trap. In that case, monetary policy becomes impotent and the only way to drive the economy back to full employment is with fiscal policy.

2.6.1 Expectations and unresponsive investment

According to Keynes, one reason why monetary policy failed to stimulate aggregate demand during the Great Depression is that the interest rate played little role in influencing consumption and investment. Keynes contended that private savings are primarily a function of income, rather than of the interest rate. Keynes is often quoted saying that "People don't change their standard of living simply because the interest rate changes a few points". More formally, Keynes appealed to the distinction between individual decisions and aggregate outcomes: at the micro level, he argued, relative prices matter. Hence, the interest rate may have a role in determining the saving behaviour of borrowers and lenders. However, much of relative price effects cancel out in the aggregate, delivering a prominent role for income as determinant of savings[10].

[10] The presumption that what is true for individual agents is true for the aggregate is known as the *fallacy of composition.* The fallacy of composition implies that using representative agents to characterize the entire economy may sometimes be misleading.

Similarly, Keynes argued that investment is much more influenced by the state of business expectations, than by the interest rate. Economic agents are human beings, and hence driven by "animal spirits" (changes in the collective mood that have little to do with rationality). Thus, whenever people become pessimistic regarding the future, investment will decline. When, in contrast, people become more optimistic, even if tilted by some "irrational exuberance" they will consume and invest more, regardless the interest rate.

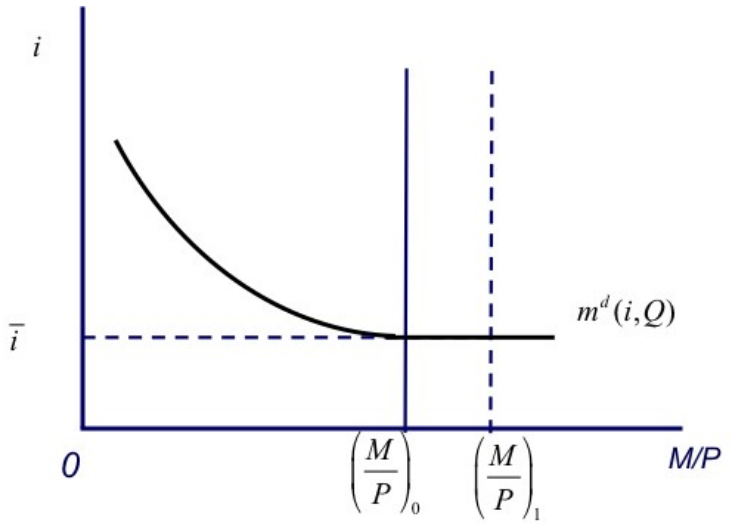
If investment and consumption do not respond to the interest rate, then a monetary policy that successfully lowers the interest rate will not be capable of shifting the aggregate demand to the right. Moreover, any fall in the price level, even if causing the real money supply to increase and the nominal interest rate to decline, will not impact on consumption and investment. In that case, the transmission mechanism fails, and the AD curve becomes vertical.

2.6.2 Liquidity trap

A second reason for the aggregate demand to become vertical (and for monetary policy to be impotent) during a depression is the "liquidity trap".

Keynes argued that, during the Great Depression, the interest rate was already so low that people were not willing to buy bonds instead of money. First, when the interest rate is close to zero, there is no reason for people to accumulate wealth in the form of bonds instead of money, because money is liquid whereas bonds are not. Second. when bond yields are very low, the prices of bonds are very high, subjecting bondholders to the (asymmetric) risk of a capital loss in case interest rates start increasing again.

Figure 12 – Monetary expansion in a Liquidity Trap



When the economy is in the liquidity trap, any further expansion of the money supply by the central bank will not be successful in inducing people to buy more bonds: people will simply hoard the extra money, implying that the price of bonds will not increase, and the interest rate will not fall. This is illustrated in Figure 12.

The liquidity trap implies that the central bank is impotent to expand aggregate demand: if printing money does not deliver a lower interest rate, the central bank becomes incapable of influencing consumption and investment. The liquidity trap also implies that a decline in the price level (leading to an increase in real money balance) does not come along with a higher demand for goods and services: the Keynes effect fails, and the aggregate demand curve becomes vertical[11].

[11] Keynes went even further, suggesting that the fall in the price level could depress the aggregate demand. First, when prices decline (deflation), people may expect further decreases in the price level, and will respond postponing consumption (the "expectations effect"); second, a fall in the price level causes the *real* value of bonds to increase, leading to a "redistributive effect" from debtors to creditors. Since debtors tend to spend more on extra income than creditors, this redistributive effect translates into a positive relation between the price level and aggregate demand. The evidence for the Great Recession is that, between 1929 and 1933, the cumulative fall in prices was about 24%.

2.6.3 The multiplier

An essential claim in the Keynesian doctrine is that the failure of the monetary transmission mechanism implies that shocks to the economy are amplified, through a "multiplier" effect.

To find out the multiplier in our model, assume that the economy is in the liquidity trap, so that the interest rate becomes independent of real money. Formally, the equation that describes the equilibrium in the money market is replaced by:

$$i = \overline{i} \qquad (15b)$$

Using (4), (6a) and $r = \overline{r}$, the savings investment equality (8) becomes:

$$sQ + (1-s)T - a(\overline{r}) - G = I(\overline{r}, z^E)$$

Solving for income, one obtains:

$$\overline{Q} = \frac{1}{s}\left[a(\overline{r}) - (1-s)T + G + I(\overline{r}, z^E) \right] \qquad (18)$$

This equation describes an aggregate demand that is independent of money and of the price level, due to the liquidity trap (the same if investment and savings do not depend on the interest rate). The AD schedule is vertical.

Equation (18) shows that a unitary change in one component of aggregate demand – say investment - as an impact on income of the magnitude 1/s. For instance, with a saving rate equal to 20%, the multiplier will be equal to 5. Thus, if investment falls by one unit of output, output will contract by five units. This happens because the initial decrease in income gives rise to successive rounds of decrease in consumption, which then impact negatively on income.

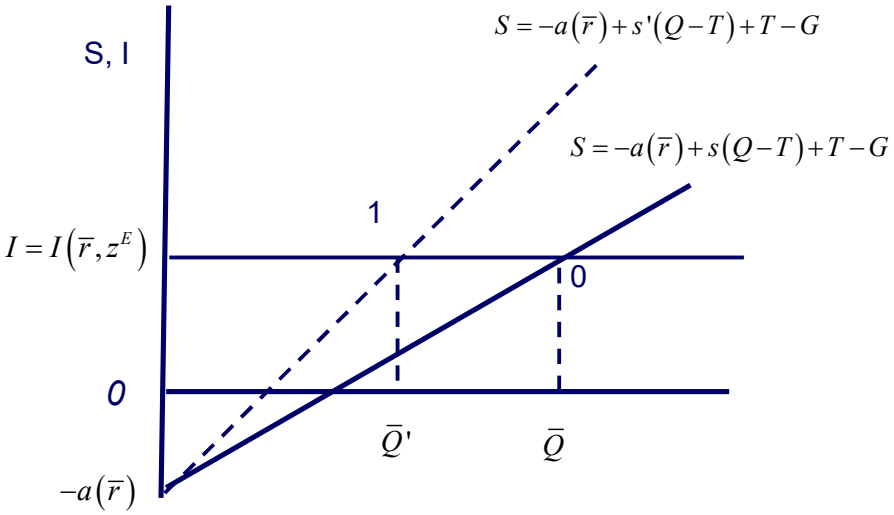
The equilibrium in the Keynesian model is described in the alternative diagram represented in figure 13. In this diagram, savings are represented as a function of income, because the interest rate plays no role. In the figure, the investment schedule is horizontal, because we are assuming that investment does not depend on the level of economic activity. The equilibrium level of output, (18), corresponds to the intersection between aggregate savings and investment.

2.6.4 The Paradox of thrift

Referring to figure 13, we now examine the implication of an increase in the saving rate. The initial equilibrium corresponds to point 0, with the marginal propensity to save equal to *s*.

Suppose that in this economy people decided to save more per unit of output. One possible reason could be excess leveraging: households, being too indebted, decided to save a larger proportion on their income, to start repaying their debts. Hence, the marginal propensity to save, *s*, increases.

Figure 13 – The Paradox of Thrift



In the figure the increase in the marginal propensity to save causes the saving schedule to rotate upwards. Given the investment level and the initial level of output, the change in the slope of the savings curve creates a situation of excess savings over investment – or which is the same, an excess supply of goods relative to demand. In response, inventories will start accumulating and firms cut down production. In the new equilibrium, described by point 1, the level of output is lower. The new level of income is the required to make aggregate savings equal to exogenous investment.

In the end, the attempt of households to save more resulted in a situation where aggregate savings did not increase at all. This is the "paradox of thrift": irrespectively of the desire for savings by individuals in the society considered in isolation, it will be impossible for the level of aggregate savings to increase, because aggregate saving is ultimately determined by investment, and the later does not increase because it doesn't respond to the interest rate[12]. The only implication of a thriftier society will be a depressed economy.

Note how different this result is from what we saw in the classical mode: under flexible prices, savings are a good thing, because they come along with more investment and by then higher output in the future. In the Keynesian formulation, a higher saving rate depresses demand and output, resulting in a lower income today. Thus, while individual thrift may be a good thing from the individual point of view, collective thrift may be bad for the society as a whole. The Paradox of Thrift is an example of the *Fallacy of Composition*.

2.6.5 The accelerator principle

In figure 13, it was assumed that the contraction of economic activity did not impact on investment. A darker case would occur if investment responded to changes in current demand.

For instance, suppose that:

$$I = \bar{I} + v\Delta Q^e \qquad (19)$$

This specification is known as the Theory of Accelerator (Box 2.2). This theory states that net investment depends on the expected change in output. If, in plus, expectations regarding future economic activity are influenced by what firms observe today, then an initial fall in output has the potential to tilt the economy to a vicious cycle, of declining investment,

[12] The Paradox of Thrift was already appearing in 1714, in the Fable of Bees, by Bernard Mandeville. It was later stated more explicitly by John M. Robertson in 1892: "Had the whole population been alike bent on saving, the total saved would positively have been much less" (pp 131). [Mandeville, B., 1714. The Fable of Bees: or private vices, public benefits. J. Roberts, London. Robertson, 1892. The Fallacy of Saving: a study in economics. Swan Sonenshein. London).

output and consumption. The "accelerator theory" fits well with the idea of "animal spirits" and has been part of the Keynesian business cycle theory.

Note that with the accelerator model, the Paradox of Thrift becomes even stronger: any attempt of individuals to save more (through a higher saving rate, *s*) will cause aggregate savings to actually decrease.

Box 2.2 The theory of accelerator

The Theory of the Accelerator was first put forward by Clark (1917) [13]. In terms of our model, suppose that the production function (1) is a Cob-Douglas, $Q = AK^{\beta}N^{1-\beta}$, that is, $z = AK^{\beta}$, and that capital depreciates at the rate δ each year. In this case, profit maximization implies the following demand for capital $\beta(Q/K) = \delta + r$, where r is the real interest rate. Assuming that the right-hand side is constant (a natural assumption in a liquidity trap), the change in capital stock each year (net investment) will be equal to $\Delta K = [\beta/(\delta + r)]\Delta Q$, implying a gross investment equal to $I = [\beta/(\delta + r)]\Delta Q + \delta K$. The interaction between the investment multiplier and the accelerator was explored by John Hicks (1939). The accelerator principle is still alive as an important explanation of the business cycle [14].

2.6.6 The effective labour demand

We now turn to the implications of a negative demand shock. The adjustment in the output market is described in figure 14. In the figure, the AD curve is vertical. As we already know, this may be reflecting a liquidity trap (horizontal LM) or, in alternative, that consumption and investment do not respond to the interest rate (vertical IS). In the figure, the AS curve is positively sloped, implicitly assuming diminishing returns, but the same argument could be illustrated using a "Keynesian" supply function.

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[13] Clark, 1917, Business acceleration and the law of demand, *Journal of Political Economy*, March.

[14] Hicks, J,. 1939, "Interactions between the multiplier analysis and the principle of acceleration, *Review of Economics and Statistics*, May. Blanchard, O., 1981. What is left of the multiplier accelerator?, *American Economic Review*, May.

The initial equilibrium corresponds to point 0, where the vertical aggregate demand meets the full employment level of output. Departing from 0, suppose that some anxiety about the future causes investment to decline. In light of (18), this causes aggregate demand to contract, and the more the marginal propensity to save, that determines the income multiplier. The depressed demand causes a fall in output and involuntary unemployment amounting to the distance $N^* - \bar{N}$. The vertical curve at the quantity $\bar{N}$ is the "effective labour demand".

Figure 14 – Demand contraction

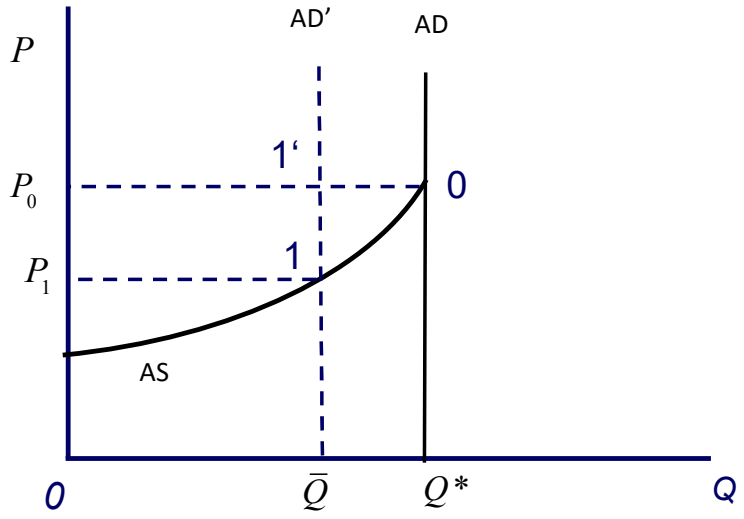
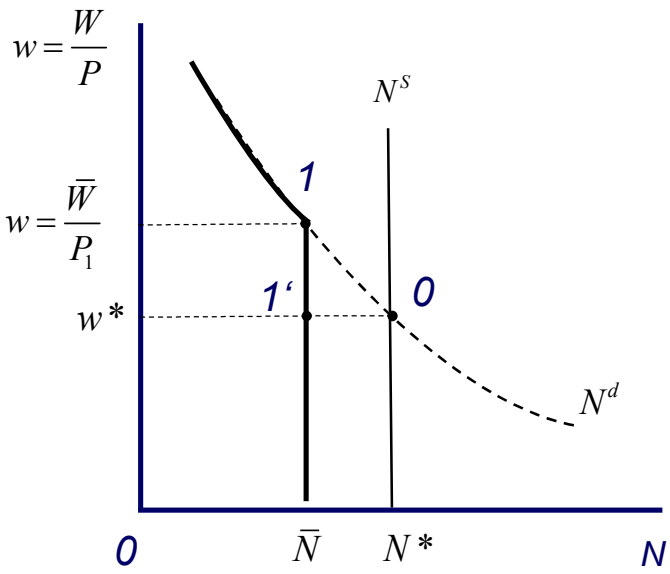


Figure 15- Effective labour demand in a depressed economy



Since nominal wages are sticky, what happens to real wages depends on the price level. In case prices are flexible but wages are not, the new equilibrium will be at point 1 (figures 14 and 15). If the price level is also sticky, the economy moves from point 0 to point 1' (figures 14 and 15): in point 1', firms would be willing to hire more workers at the existing wage rate, but they refuse to do so because there is no demand for final output.

2.6.7 Fiscal policy

The main normative implication of the Keynesian model is that, if the private sector demand falls, the government can step in to drive the aggregate demand back to full employment. An expansionary fiscal policy may include increasing government purchases, increasing transfer payments or decreasing taxes. In terms of figure 14, a fiscal expansion will shift the AD curve to the right. In figure 15, the "effective labour demand" will move rightwards as well.

When the AD curve is vertical, the multiplier of government spending is:

$$\frac{\Delta\overline{Q}}{\Delta\overline{G}} = \frac{1}{s} \qquad (20)$$

When government expenditures increase, there is an increase in the government deficit. However, the output expansion induces an increase in private savings the enough to finance the government deficit. Total savings will remain equal to investment, only the composition of savings between the government sector and the private sector has changed.

If the increase in government spending is fully financed with an increase in taxes, then the multiplier of the incrementally balanced budgetary expansion becomes:[15]

$$\frac{\partial Q}{\partial G}\Big|_{dG=dT} = 1 \qquad (21)$$

[15] T. Haavelmo, 1945 .Multiplier Effects of a Balanced Budget, Econometrica 13, 311-318.

Thus, even with a balanced budget, the government has the power to drive the economy to full employment. Note however that in this second case (21), the output expansion is just the enough to feed the higher government expenditures: the household sector will not be consuming more.

2.7 Keynes' legacy

In this note, we confronted two opposing views regarding the functioning of a market economy. The classical economists believed in the self-correcting role of the price mechanism. In the classical economy, output is determined on the supply side of the economy and the economy will always operate at full employment, so there is no role for stabilization policies. In the classical framework, real variables are determined independently of the price level. Money only produces nominal effects without altering the fundamental relative prices.

The Keynesian attack to the classical doctrine was launched in two fronts: first, problems in aggregate supply: if wages are sticky, a fall in the price level during a depression will cause real wages to increase, generating involuntary unemployment. Second, problems in aggregate demand: at the liquidity trap, or if consumption and investment fail to respond to the interest rate, the transmission mechanism fails and the aggregate demand curve become vertical. In that case, the equilibrium in the goods markets is achieved by changes in income, rather than by adjustments in the interest rate. When aggregate demand decreased, inventories start accumulating, and firms decide to produce less. In the Keynesian model, effective demand determines supply, reverting the Say's Law. When demand is insufficient, there will be involuntary unemployment.

The contributions of Keynes changed the curse of macroeconomics. Many of his basic ideas, such and the aggregate demand and supply and the distinction between equilibrium output and full employment output are still at the centre of the macroeconomics debate. But even if his thinking was path-breaking, there were many missing issues. First, the post-war economic conditions, with full employment and rising inflation, urged economists to adapt the Keynesian ideas to contexts other than the Great Depression. Second, a follow up work was needed to formalize the theory and make it consistent with the other pieces of economic thinking. The attempt to merge the Keynesian ideas with those of the earlier economists, and the refinements that this effort allowed gave rise to a new consensus that was labelled the "neo-classical synthesis".

The original Keynes' theory was developed for the Great Depression, where the transmission mechanism failed. In normal times, however, the AD curve is negatively sloped. Monetary expansions succeed in driving the interest rate down, inducing expansions in aggregate demand that feed-back in the money market, via the transactions' demand for money. This interaction was worked out by John Hicks and Alvin Hansen, who launched the IS-LM mode [16] . Other important extensions include the theories of consumption, independently developed by Franco Modigliani and Milton Friedman (drawing on a previous work by Irwin Fisher), the theories of money and of investment by James Tobin[17].

In 1958, the neo-Zealand economist William Phillips reported an empirical regularity in the UK, consisting in a negative relationship between changes in nominal wages and unemployment. Two years later, Paul Samuelson and Robert Solow popularized the negative inflation-unemployment correlation and coined it as the "Phillips curve"[18]. Based on these findings, there was a period in which policymakers believed they could exploit the "trade-off between inflation and unemployment", expanding the economy at the cost of a small additional inflation. This Phillips curve was also integrated in the neo-classical synthesis, and included in official macroeconomic simulation and forecasting models, such as those developed by Lawrence Klein for the US, in the early 1960s.

For three decades, Keynesian economics dominated the macroeconomic thinking. During the 1950s and the 1960s, economists and policymakers believed that stabilization policies (specially the fiscal policy) were a powerful tool to mitigate business cycles. But in

[16] Hicks, J. R. (1937). "Mr. Keynes and the 'Classics': A Suggested Interpretation". Econometrica 5 (2): 147–159. Hansen, A. H. (1953). A Guide to Keynes. New York: McGraw Hill

[17] Fisher, I., (1930), "The Theory of Interest", McMillan. Modigliani, Franco, 'The Life Cycle Hypothesis of Saving, the Demand for Wealth and the Supply of Capital, Social Research, (1966: summer). Extracted from PCI Full Text, published by ProQuest Information and Learning Company. Friedman, M. (1956). "A Theory of the Consumption Function" (PDF). Princeton, NJ: Princeton University Press. Tobin, James (1956). "The Interest-Elasticity of Transactions Demand for Cash," Review of Economics and Statistics, 38(3). Tobin, James (1969). "A General Equilibrium Approach to Monetary Theory". Journal of Money, Credit, and Banking 1.1 (1): 15–29

[18] Phillips, A. W. (1958). "The Relationship between Unemployment and the Rate of Change of Money Wages in the United Kingdom 1861-1957". Economica 25 (100): 283–299. Samuelson, Paul A., and Robert M. Solow. 1960. "Analytical Aspects of Anti - Inflation Policy," American Economic Review Papers and Proceedings 50: May, no. 2, 177 - 94.

the 1970s, after two oil shocks, the world met a new phenomenon that became known as "stagflation", that is, a combination of inflation and unemployment. This particular combination of symptoms was not accounted for in the Keynesian model. Being purely static, the IS-LM model is not suitable to model inflation. On the other hand, the conventional prescription of counteracting downturns expanding fiscal and monetary policies did not succeed so well in this period: in the 1970s, employment was low and inflation became even higher. The established view that government intervention could be used to influence employment and minimize the amplitude of the business cycle was challenged by the events.

Further reading

Robert Gordon, Macroeconomics, 9th edition: Chapter 7.8-7.10.

Mankiw, G., Macroeconomics, 10th ed., chapter 3, 9-11.

Review questions and exercises

Review questions

2.1. Keynes attacked the classical view of self-correction in two fronts: failure of the "transmission mechanism" and nominal wage rigidity. Explain the arguments.

2.2. According to Keynes, in a depressed and leveraged economy, price deflation should be stabilizing or destabilizing? Why?

2.3. Referring to the article from Paul Krugman ("How did economists..."), explain how the Great Capitol Hill Baby-sitting Co-op entered into crises. How does this example relate to monetary theory? Is this a general case?

Problems

2.4. (**The Classical model**) Consider a closed (Classical) economy with no government, where the representative production function takes the following form $Q = zN$. Further assume that the labour supply is constant at $N^S = 100$, and that prices and wages are fully flexible. Workers are the only consumers in this economy.

a) Assuming that firms maximize profits, find out the labour demand in this economy. Display the equilibrium in the labour market in a graph, assuming that $z = 10$. What will be the equilibrium output in this case?

b) Now assume that the demand for real money was given by $m^d = Q$, and the supply of nominal money was $M^S = 1000$. (b1) Describe the equilibrium in the money market; (b2) Which theory underlies this specification?

c) Represent in a graph the aggregate demand and the aggregate supply in this economy and find out the equilibrium prices and nominal wages. Explain what will happen to prices and wages if the supply of money increased to $M^S = 2000$. Which proposition is being illustrated here?

d) Finally, assume that productivity increased to $z = 20$. What would be the impact on production, income and consumption? Which proposition is being illustrated here?

2.5. (**Classical model**) Consider a closed economy where the labour supply is inelastic at $N^S = 100$ and the production function of the representative firm is given by $Q = zN^{0.5}$. In this economy, the market for goods and services is described by: private savings $S^P = s(Q - T) - 1/r$, where s is the marginal propensity to save; government savings, $S^G = T - G$; and investment, $I = 4/r$. The money demand obeys to the quantity theory, with money velocity equal to 0.5. In the baseline case, consider z=10, G=T=20, s=0.25, and M=300.

a) From profit maximization, find out the demand for labour in this economy.

b) Display the labour market equilibrium in a graph, assuming that real wages are flexible [0.5].

c) Describe graphically the market for loanable funds (S, I). Find out the equilibrium rea interest rate in this economy [0.25].

d) Describe in a graph the aggregate demand and aggregate supply and find out the corresponding price level. How much will be nominal wage in that case? [1.5].

e) Examine the implications of a monetary expansion from M=300 to M=500 for the different variables of the model (r, W/P, Q, C, I, W, P, etc). Use graphical analysis. Which proposition is being illustrated here? [2.5].

f) Examine the implications of a productivity shift from z=10 to z=12 in the different variables of the model. Use graphical analysis. Which proposition is being illustrated here? [0.2].

g) Examine the implications of an increase in government expenditures from G=T=20 to G=T=50. In particular, explain what will happen in the (S,I) locus and to the interest rate. Use graphical analysis [0.4].

h) Examine the implications of an increase in the saving rate from s=0.25 to s= 0.3125. In particular, explain what will happen in the (S,I) locus and to the interest rate. [0.2].

2.6. (**Paradox of Thrift**) Consider a closed economy in a liquidity trap, where P=1 and natural output is $Q^* = 100$. In this economy, the consumption function is given by

$C = (1-s)[Q-T]$, and the government budget is always balanced, that is $T = G$. Initially, G=0.

a) Assume that Investment is equal to $I = 20$. Explain how this economy will adjust to an increase in the saving rate from s=0.2 to s=0.25. In particular, find out: (a1) The level of output before and after the shock; (a2) aggregate savings before and after the shock. (a3) Represent in a graph. (a4) Explain what could have driven the increase in the saving rate. (a4) Explain what this exercise trying to capture [A: Q=100, Q=80].

b) Assume now that investment, instead of exogenous, was determined according to $I = 20 + 0.125(Q - Q^*)$. (b1) Explain this theory. In that case, how would the economy adjust to the increase in the saving rate from s=0.2 to s=0.25? In particular, find out: (b1) the level of output before and after the shock; (b2) aggregate savings before and after the shock [A: Q=60].

c) Finally, assume that the government in this economy wanted the economy to operate in full employment permanently. Departing from (b), what would be the optimal policy rule, for G as a function of s? Exemplify when s=0.2 and s=0.25.

2.7. (**Keynesian model**) Consider a Keynesian economy in a liquidity trap. In this economy, the production function of the representative firm is given by $Q = 10N^{0.5}$, the size of the labour force is $N^S = 100$, and nominal wages are sticky at $\overline{W} = 1$. Investment is exogenous and the consumption function is given by $C = (1-s)[Q-T]$, with s=0.2. Initially, there are neither taxes nor government spending.

a) (Demand shock) Assume that, due to a confidence shock, investment falls from $I = 20$ to $I = 15$. Compute the equilibrium level of output before and after the shock. Explain how the aggregate demand shifts, in the (Q,P) locus.

b) (Supply side) Assuming that firm are price takers, find out the labour demand and the output supply curve.

c) (Classical unemployment) Describe what happens in the labour market and in the output market following the confidence crises described in (a). In particular, explain the change in prices, real wages, employment and output. Use graphic analysis.

d) (Fiscal expansion) Finally, consider the possibility of the government intervening in this economy, with a balanced budget, that is, with T=G>0. Could such policy bring the economy back to full employment?

2.8.(**Keynes effect**) Consider a closed economy with no government, where the production function of the representative firm takes the following form: $Q = 10N$. Further assume that the labour force is constant at $N^S = 10$. The output price is flexible, but the wage rate is sticky at $\overline{W} = 10$. Further assume that the money demand is given by $m^d = Q/10i$, the consumption function is $C = (20/10r) + 0.75Q$, and planned investment responds to the interest rate according to $I = (5/10r)$. In this economy, there is no inflation.

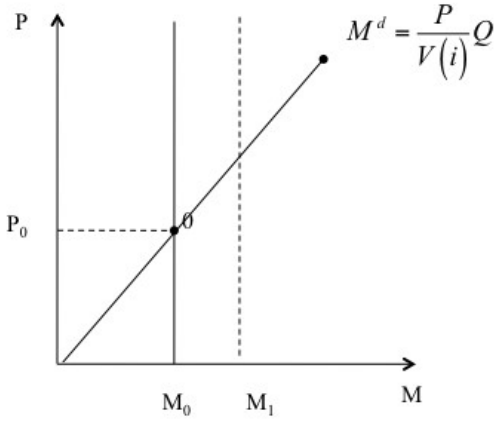
a) (Keynesian supply curve) Assuming that firms maximize profits, find out the aggregate supply function in this economy.

b) (AD curve) Using the equilibrium in the money market and the equality between savings and investment, find out the expression of aggregate demand in this economy. Explain its slope in the (P,Q) locus.

c) (Keynesian unemployment) Suppose that the money supply was equal to M=81. Would the economy be at full employment in that case? How much would be investment and consumption? Describe the labour market in a graph.

d) (Policy shift) Could monetary policy be used to drive the economy to full employment? Describe the effect of the policy in the savings-investment diagram.

2.9.(**Money Market equilibrium**) Point 0 in the following figure describes the initial situation in a money market. Assuming that the nominal money supply increases from M0 to M1, how will the new equilibrium look like, in light of the: (i)The classical model; (ii) The Keynesian model with liquidity trap ; (iii) The conventional IS-LM model. Explain the adjustment process in each case.



2.10. Consider a closed economy where the labour supply is inelastic at $N^S = 100$. In this economy, the production function and aggregate demand are given, respectively, by $Q = zN$ with z=1, and $Q^d = (M/P)^2$.

a) (**Well-functioning**) Assume perfect competition. (a1) Find out the equilibrium real wage, W/P, and full employment output. (a2) Describe this economy in the AS-AD diagram, assuming that prices and wages are both flexible. Analyse the effects of a monetary contraction from M=10 to M=8, on prices, output and wages.

b) (**Keynesian model**) Describe this economy in the AS-AD diagram assuming that nominal wages are sticky at $\overline{W} = 1$. In particular, analyse the effects of a monetary contraction from M=10 to M=8, on output and employment. Show in a graph the adjustment in the labour market. What is the name of the curve describing the demand for labour in this case?

c) (**Keynes effect**) In this economy, the market for goods and services is described by: private savings $S^P = 0.25(Q-T) - 1/10r$, government savings, $S^G = T - G$, and investment, $I = 3/20r$. The money market equilibrium condition is

$M/P = (Q/r)^{0.25}$. In the baseline case, consider G=T=0. (c1) Show that aggregate demand is indeed $Q^d = (M/P)^2$. In light of this model, find out the solutions for the interest rate and investment when: (c2) M=10 and P=1; (c3) M=8 with P=1. (c4) Describe the changing equilibrium in the savings-investment locus. (c5) Explain the intuition for the change in investment. (d6) Could the government use a balanced budget T=G>0 to reach full employment? Discuss.

d) (**Flexible prices**) Referring to (c), compare now the cases with M=10, P=1 with that with M=8, P=0.8. How do savings and investment adjust in this case? Does the Say Law hold in reverse?

2.11. Consider an economy in a liquidity trap, where the size of the labour force is $N^S = 100$. In this economy prices are flexible, but nominal wages are stuck in W=1. Investment is exogenous and the consumption function is given by $C = (1-s)[Q-T]$, with s=0.25. Firms operate under perfect competition, being the production function of the representative firm given by $Q = 20N^{0.5}$.

a) Assume that, due to a confidence crisis, investment was initially $I = 50$ and then fell to $I = 40$. (a1) Compute the equilibrium output before and after the shock. (a2) Explain why production declines; (a3) Describe the aggregate demand shift in the (Q, P) locus.

b) Describe the supply side of this economy. In particular, find out the expressions for: (b1) labour demand; (b2) aggregate supply.

c) Describe what happens in the labour market and in the output market following the confidence crises. In particular, explain the change in prices, real wages, employment, unemployment, and output. Use numerical and graphical analysis

d) If nominal wages were instead flexible, the nature of the equilibrium would have changed? Describe what would happen in the labour market.

2.12. Consider a closed economy where the labour supply is inelastic at $N^S = 100$. In this economy, the production function and aggregate demand are given, respectively, by $Q = zN^{0.5}$ with z=10, and $Q^d = (M/P)$.

a) **(Perfect competition)** Assume perfect competition. Find out the demand for labour as a function of real wage, W/P.

b) (**Well-functioning case**) Assume that prices and wages are flexible. (b1) Find out the equilibrium in the labour market and represent it in a graph. (b2) Describe this economy in the AS-AD diagram. In particular, examine the effects of a monetary contraction from M=200 to M=128, on prices, output and nominal wages. Which proposition is illustrated here? Explain the intuition.

c) **(Keynesian model)** Describe this economy in the AS-AD diagram assuming that nominal wages are sticky at $\overline{W} = 1$. In particular: (c1) Find out the expression of the aggregate supply; (c2) analyse in the AD-AS diagram the effects of a monetary contraction from M=200 to M=128, and quantify the impacts on output, prices, and employment;(c3) describe with the help of a graph the adjustment in the labour market. How would you classify the unemployment thereby generated? Explain.

d) (**Transmission mechanism**) In this economy, the market for goods and services is described by: private savings $S^P = 0.25(Q-T) - 1/10r$, government savings, $S^G = T - G$, and investment, $I = 3/20r$. The money market equilibrium condition is $M/P = (Q/r)^{0.5}$. In the baseline case, consider G=T=0. (d1) Show that aggregate demand is indeed $Q^d = (M/P)$. Examine again the implications of a monetary contraction from M=200 to M=128, assuming that nominal wages are sticky at $\overline{W} = 1$. In particular: (d2) Find out the interest rate before and after the policy change. (d3) Describe the changing equilibrium in the money market. Depict graphically and explain what happened to the demand for money. (d4) Describe the changing equilibrium in the savings-investment locus. Depict graphically and explain the intuition for the change in savings and in investment.

e) (**Fiscal policy**) Departing from the equilibrium under M=128 in d), suppose that the government uses a balanced budget T=G to reach full employment. (e1) Find out the new AD curve, as a function of G; (e2) compute the required G and represent the new equilibrium in the AD-AS graph; (e3) describe graphically the adjustment in the money market and quantify the new interest rate. Explain. (e4) Describe the adjustment in the I-S diagram and compute the new investment level. Explain what happened to investment. (e5) Describe with the help of a graph the adjustment in the labour market.

f) (**Increase in the savings rate**) Departing from full employment (say, with M=200), use the 4 diagrams to examine the effects of an increase in the marginal propensity to save assuming that: (f1) wages are flexible. (f2) wages are sticky at $\overline{W} = 1$. Use only graphical analysis. Explain carefully why the different variables adjust differently in the two models. Does the paradox of thrift hold in any of these cases? Why?

2.13. (**Classical Model vs sticky wages**) Consider an economy with a fixed number of identical households, each of which maximizes the utility function $U = v\ln C + \ln m$, subject to $C + M/P = M_0/P + Q - T$, where $m = M/P$ denotes for real money balances, and M_0 for the initial nominal money holdings. In this economy, there is perfect competition, and the production function of the representative firm is given by $Q = zN$, with z=1, and the money supply is inelastic at N=100. In this economy, the government deficit is financed by seigniorage revenues: $G - T = (M - M_0)/P$.

a) (setup) From the household optimization problem, (a1) find out the demand for money and optimal consumption, as functions of M_0, P, Q. (a2) Using the results above and the government budget constraint, find out the equation for aggregate demand, as function of M, P, G.

b) (Classical case). Consider the case with perfect competition and flexible prices. (b1) Assuming that v=1/4 and M=320, and G=20, find out the equilibrium levels of output, consumption, employment, money demand wages and prices [A: C=80]. (b2) Examine the implications of a helicopter–driven expansion in money supply to M=640. Describe the change in the AD-AS diagram [A: W=2]. (b3) Departing from (b1), examine the implications of a productivity change to z=1.8. Does the Say' Law hold in this case? [A: W=0.9]. (b4) Departing from (b1), examine the implication of an increase in government expenditures to G=50,

financed with taxes. How much is the fiscal multiplier? [A: W=1.6, full crowding out, the fiscal multiplier is zero].

c) (Sticky wages). Assume now that wages were stuck at W=2. (c1) Describe the aggregate supply in this case; (c2) Describe the equilibrium when M=320 and G=20. Examine the possibility of reaching full employment with (c3): Helicopter money; (c4) an increase in government expenditures financed with taxes. (c5) an increase in government expenditures financed with money printing (M=384).

2.14. Consider a closed economy with no inflation. In this economy, the labour supply is inelastic at $N^S = 100$, and the production function is given by $Q = zN$, with z=1 initially. The market for goods and services is described by: private savings $S^P = 0.1(Q - T)$, government savings, $S^G = T - G$, and investment, $I = \overline{I} - 100r$, where initially G=T=0, and $\overline{I} = 20$. The money demand equation is given by $m^d = Q - 500r$ and the nominal money supply is initially M=50. The government budget is always balanced.

a) **(Baseline)**: (a1) Assume perfect competition. Find out the demand for labour. (a2) Assume that prices and wages are flexible. Find out: Full employment output, interest rate, investment, private consumption, price level, nominal wages. (a3) Show graphically the initial equilibrium in: the market for loanable funds, in the money market and in the labour market.

b) **(Well-functioning economy):** Assume that prices and wages are flexible. (b1) (Fiscal policy): Examine, quantifying, the implications of an increase in government expenditures from G=T=0 to G=T=20. Show graphically the adjustment in the market for loanable funds, in the money market and in the labour market. Which idea is being illustrated here? (b2) (Productivity shift): Returning to the case with G=0, examine, quantifying, the impacts of a productivity increase from Z=1 to Z=1.2. Show graphically the change in the market for loanable funds, in the money market, and in the labour market. Which proposition is being illustrated here?

c) **(Liquidity trap):** Departing from a), suppose that the autonomous component of investment declined to $\overline{I} = 8$. (c1) Find out what would be the full employment (or natural) interest rate. (c2) Assuming that the interest rate cannot fall below zero, describe, quantifying, the implied equilibrium in this economy. Show graphically the adjustments in the market for loanable funds, in the money market, and in the labour market. (c3) (Monetary policy) Departing from the equilibrium described in (c2), discuss the effectiveness of monetary policy in driving the economy to full employment. (c4) (Fiscal Policy) Departing from the equilibrium described in (c2), assume that the government used the budget to meet full employment. Show graphically and quantify the adjustments in the market for loanable funds, in the money market, and in the labour market (departing from c2). Is there crowding out in this case? Why?

d) **(Sticky wages):** Returning to a), assume from now on that nominal wages were sticky at $\overline{W} = 1$. (d1) Describe the aggregate supply in this case and display it in a graph. How would you label this case? (d2) (Productivity shift) Departing from (a), examine the implications of a productivity increase from Z=1 to Z=1.25. Show graphically and quantify the impacts in the market or loanable funds, in the money market, and in the labour market. How you would label the labour demand

curve? (d3) (Monetary policy) Departing from (d2), assume that the monetary authorities adjusted the quantity of money to meet full employment. Show graphically what happens in the market or loanable funds, in the money market, and in the labour market (departing from d2). Explain the intuition regarding the change in the interest rate.