CPB Netherlands Bureau for Economic
Policy Analysis

CPB Background Document | August 2016

Macro-economics of balance-sheet problems and the liquidity trap

Jasper Lukkezen
Bas Jacobs
Clemens Kool

Contents

Summary

Since 2010, nominal policy rates of central banks in most advanced economies have been close to zero. This is referred to as the zero lower bound on interest rates or as the liquidity trap. At the zero lower bound central banks can no longer lower nominal interest rates, which means that they cannot stabilise the business cycle and prevent deflationary pressures on prices by doing so. In addition, in many countries, homeowners, firms and banks have gotten into trouble due to bursts of real-estate bubbles, particularly in Ireland and Spain, but also in the Netherlands. This has caused balance-sheet problems. In response, firms and households in many economies are reducing private debts that have been built up in the past. This process of deleveraging involves reductions in aggregate demand and downward pressure on prices. Moreover, balance-sheet problems may have contributed to the emergence of the liquidity trap, since debt reduction increases the supply of savings and pushes real interest rates down.

Both balance-sheet problems and the zero lower bound have a major impact on macro-economic outcomes and on the macro-economic impacts of government policy. The CPB Policy Brief *Lessons learnt from seven years of stagnation in the Eurozone*, by Lukkezen and Kool, discusses these issues and presents policy recommendations. This background document supports that study and analyses the economic consequences of balance-sheet problems and the liquidity trap in an IS/MP–AD/AS model (IS/MP: Investment Savings/Monetary Policy; AD/AS: aggregate demand/aggregate supply). This is a simple business-cycle model based on the IS/LM model (investment savings/liquidity preference – money supply), which is expanded with a Taylor-rule for monetary policy and a Philips-curve for aggregate supply. Our model describes a large, relatively closed economy, such as that of the Eurozone. Our model generates seven main findings.

First, when the economy experiences larger balance-sheet problems or is in a liquidity trap, the negative impact of lower aggregate demand on total output is larger than under normal conditions. Under normal conditions, the central bank would lower nominal interest rates after a negative demand shock so as to boost aggregate demand and to avoid declining inflation rates. Lower interest rates boost consumption, investments and exports (via depreciation of the exchange rate), which accommodates the aggregate demand shock. When balance-sheet problems are present, negative demand shocks reduce inflation, just as they would under normal conditions. However, lower inflation now increases the real value of debts, which exacerbates balance-sheet problems and depresses aggregate demand further. In a liquidity trap, lower inflation will lead to *higher* instead of *lower* real interest rates, since the central bank cannot lower the nominal interest rate any further when interest rates are zero. Higher real interest rates, in turn, reduce consumption, investment and exports, thereby further exacerbating the shortfall in aggregate demand and strengthening the downward pressure on inflation.

Second, when balance-sheet problems are very severe or when the zero lower bound remains binding, the economy does not automatically revert to its long-run macro-economic equilibrium, but may slide down into a (debt-)deflation spiral with economic stagnation. Unresolved debt problems and an ongoing liquidity trap may even land the economy in *secular stagnation* (Summers, 2014). The economy can only fully recover, and stagnation scenarios can

only be avoided, when monetary policy is no longer constrained by the zero lower bound and balance-sheet problems have been sufficiently resolved.

Third, when balance-sheet problems are severe and the zero lower bound is binding, counter-cyclical fiscal policy is more desirable than under normal conditions. The reason is that fiscal policy multipliers are typically larger with balance-sheet problems and when the economy is in a liquidity trap. Expansionary fiscal policy will help to accelerate debt reduction via higher incomes and a more rapid increase (or less rapid decrease) in inflation, which erodes the real value of debts and lowers real interest rates. This will help to sustain aggregate demand. When the zero lower bound is binding, the central bank will not raise interest rates in response to expansionary fiscal policy. Furthermore, counter-cyclical fiscal policy is also more attractive under severe balance-sheet problems and a binding zero lower bound, because the risk of wrongly dosing or timing fiscal policy is smaller than under normal conditions. Under normal conditions, the economy will revert to its long-run equilibrium even without fiscal stimulus. Since it is difficult to determine the right amount of stimulus, and because it takes time to implement fiscal policy, there is a risk that fiscal policy becomes effective when it is no longer needed. These risks, however, are less relevant when balance-sheet problems are severe and when the economy reached the zero lower bound. The business cycle can be determined with less uncertainty, since the economy is typically in a slump as long as the interest rate is at the zero lower bound and the private sector is deleveraging. Since the economy does not automatically return to its long-run equilibrium, there is no real risk that fiscal stimulus comes to too late or causes unnecessary costs. Hence, the risk of excessive fiscal stimulus is small.

Fourth, monetary policy loses its power when the interest rate reaches the zero lower bound. Conventional monetary policy, here meaning lowering the nominal interest rate, is no longer feasible. Unconventional monetary policy may be useful to decrease nominal interest rates in the longer run or to raise inflation expectations. The resulting decrease the real interest rates, in turn, boosts consumption, investments and exports. However, central banks have difficulties making credible commitments to let future inflation rise. Furthermore, unconventional monetary policy may cause turbulence in financial markets.

Fifth, there is a 'timidity paradox': expansionary fiscal or monetary policy needs to be sufficiently aggressive to be effective when balance-sheet problems are severe and the economy is in a liquidity trap. Economic stagnation – caused by severe balance-sheet problems and an ongoing liquidity trap – can be avoided only when counter-cyclical policy is so powerful that all demand shortfalls are eliminated and the output gap is completely closed. Then, both inflation and aggregate demand will rise, balance-sheet problems will be alleviated, and the economy will automatically grow out of the zero lower bound. However, when policy stimulus is not large enough, the economic revival will only be temporary, and the economy will relapse again into a (debt-)deflation spiral.

Sixth, larger wage and price flexibility exacerbates short-term economic problems when balance-sheet problems are severe and the zero lower bound is binding. Under normal conditions, wage and price flexibility speed up the economic recovery after a reduction in aggregate demand. When wages and prices decline more quickly, the central bank will engage in more expansionary monetary policy, and thus lowers interest rates more aggressively. Hence, aggregate demand gets a stronger boost and the economy more quickly returns to its long-run equilibrium. However, with severe balance-sheet problems and a binding zero lower bound

larger wage and price flexibility results in a 'flexibility paradox': larger declines in prices amplify debt–deflation dynamics and raise real interest rates (which the central bank is no longer able to reduce using monetary policy). Wage and price flexibility then hinder the economic recovery.

Seventh, similar reasoning applies to structural reforms. Normally, structural reforms speed up the economic recovery, both in the short and in the long run. In the short run, larger aggregate supply puts downward pressure on prices, allowing the central bank to cut interest rates. This boosts aggregate demand and results in a more rapid economic recovery. In the long run, structural reforms increase future household incomes and firm profits. This implies that households and firms are also more willing to consume and invest today. However, if interest rates are stuck at the zero lower bound or when balance-sheet problems are severe, the 'paradox of toil' may apply: structural reforms may damage the economy in the short run. Larger aggregate supply causes the output gap to increase. When aggregate demand does not sufficiently increase – because households and firms will be richer in the future – net deflationary pressures will increase, causing stronger (debt-)deflation dynamics.

1 Introduction

Since 2010, policy interest rates of central banks in the Western world have been close to or at zero, also known as the *zero lower bound*. This situation changes the way the economy responds to economic shocks. At the zero lower bound, cash and short-run bonds have become perfect substitutes. Open-market operations by monetary policy authorities then fail to reduce the short-run interest rate. Since Keynes (1936) and Hicks (1937), this is also called the *liquidity trap*.

In a liquidity trap the supply of savings is much higher than demand for investments. This reduces nominal and real interest rates, and nominal interest rates may reach the zero lower bound. A liquidity trap emerges when a demand shock is large enough. Such a large negative demand shock can originate from people becoming more pessimistic and deciding to decrease their spending, which leads to lower future growth expectations (Krugman, 1998), can be the result of population ageing (Summers, 2014) or can occur when a large decline in asset prices forces people to pay of their debt (Eggertsson and Krugman, 2012). The later plays a large role in Europe. In many countries, homeowners, firms and banks have run into trouble due to bursts of real-estate bubbles, particularly in Ireland and Spain, but in the Netherlands as well. Due to negative wealth shocks, the private sector is faced with balance-sheet problems.

In many economies, households and firms are trying to bring down private debts at an increased pace. This may lead to Fisherian debt-deflation dynamics in which deleveraging leads to lower spending, which in turn reduce incomes and leads to a fall in prices (deflation). Deflation then increases the real value of debt, potentially leading to a vicious cycle and no escape from the liquidity trap.

This background document aims to provide insight into the macro-economic dynamics of economies that are suffering from balance-sheet problems and where the central bank faces a binding zero lower bound on nominal interest rates. To do so, we use an Investment-Savings/Monetary-Policy – Aggregate-Demand/Aggregate-Supply model (IS/MP–AD/AS model), based on Romer (2000, 2013), to analyse aggregate demand and aggregate supply. This model is a version of the standard IS/LM model, where a Taylor-rule for monetary policy replaces the LM-curve, and it is extended with a Philips-curve to describe short-run aggregate supply. The analysis demonstrates that economies may end up in a stagnation trap if their balance-sheet problems are large enough, or when a liquidity trap persists over a long period of time. This paper also analyses the macro-economic effects of fiscal and monetary policy. Finally, this article discusses the impact of structural reforms and measures that increase price and wage flexibility.

To improve of readability, we analyse a macro-economic model, which only contains the most essential economic mechanisms. The use of mathematics has been brought down to a minimum and all economic insights are derived graphically. The choices imply that our model lacks micro-economic foundations and we abstract from intertemporal optimising behaviour of households and firms.[1] Our findings are comparable to those of Eggertsson and Krugman (2012), who do

[1] Romer (2000) claims that the current generation of micro-founded models is arguably not more realistic than a simple IS/MP–AS/AD model, while the costs in terms of complexity are far greater.

employ a micro-founded New-Keynesian model, see the *Microfoundations* textbox for more details.

Microfoundations

Eggertsson and Krugman (2012) develop a micro-founded macro-model that gives qualitatively the same results as the IS/MP–AD/AS model employed in this Background document. In a micro-founded model, the behaviour of various actors and their interactions is modelled explicitly. Households maximise their utility, firms maximise their profits and the government maximises a social welfare function. Monetary authorities many follow simple rules, such as the Taylor-rule. Every agent faces constraints. For example, households cannot consume more than they earned, loans require collateral, and higher prices may decrease turnover, etc.

The main advantage of micro-founded macro-models is that they are internally consistent and able to handle expectations. This makes them resilient – if they describe economic behaviour correctly – to the Lucas critique (Lucas, 1976); all economic actors correctly internalise all policy changes. A disadvantage is that these models quickly tend to become complex and are therefore less well-suited as a didactical device. Also, calibration of such models is often difficult.

In the main body of their paper, Eggertsson and Krugman present a two-period model, short-run and long-run, and two types of households, those with debt and those without. Households without debt lend money to those with debt. Borrowing is restricted by an exogenous debt constraint. Under normal conditions, the economy returns to its long-run equilibrium after a deleveraging shock – an exogenous tightening of the debt constraint – through decreasing real interest rates. This model then has standard macro-economic properties: fiscal stimulus has an expansionary effect, monetary policy can stabilize the economy, a better economic structure increases output, and a more flexible economy accommodates economic shocks more easily.

However, if the deleveraging shock is large enough, the equilibrium nominal interest rate tends to become negative. This is not possible, since people can always hold money which is an asset with zero interest. The zero lower bound thus introduces a constraint, which reverses a number of standard macro-economic insights (Eggertsson and Krugman call this 'topsy-turvy economics'). Under normal conditions, the central bank lowers the nominal interest rate when inflation decreases. This causes real interest rates to go down. However, when the nominal interest rate is at the zero lower bound, lower inflation raises the real interest rate. This reduces aggregate demand and exacerbates the impact of a negative shock. When the zero lower bound is binding, the AD-curve thus shifts upwards and the effects of macro-economic policy change.

Fiscal stimulus creates additional aggregate demand, and by raising inflation, real interest rates are lowered. A central bank that can credibly commit to higher future inflation can also increase aggregate demand. Structural reforms that raise aggregate supply, also increase the output gap, and result in a reduction of output. Lower prices increase real interest rates and the real value of debts and thus lower aggregate demand (Eggertsson and Krugman call this the 'paradox of toil'). Policy that increases wage and price flexibility produces larger declines in incomes after a negative shock (Eggertsson and Krugman call this the 'paradox of flexibility').

In extensions of their base model, Eggertsson and Krugman demonstrate how their results remain robust when they relax various assumptions. For example, they show that a micro-founded model with more than two time periods produces the same qualitative results. In their analysis, balance-sheet problems cause the zero lower bound. We demonstrate that this link between balance-sheet problems and the zero lower bound is not a crucial one. In our analysis, the zero lower bound can be reached without balance-sheet problems as well, and balance-sheet problems can also arise without the zero lower bound being reached. And both can cause an upward-sloping AD-curve with important implications for macro-economic policy.

This Background document is organised as follows. In chapter 2 we introduce the baseline model. Subsequently, in Chapter 3 we analyse the macro-economic effects of economic shocks and the macro-economic adjustment process under normal conditions as well as under balance-sheet problems, and with a binding zero lower bound on the nominal interest rate. Then, in Chapter 4 we analyse fiscal policy, conventional and unconventional monetary policy. Also, we analyse structural reforms and measures to raise price and wage flexibility. Finally, in Chapter 5

we summarise our findings and discuss the implications of our analysis. The appendix contains the formal derivations of our findings.

2 The IS/MP–AD/AS model

The AD/AS model describes aggregate demand and aggregate supply as a function of the inflation rate. Aggregate demand will be derived from a variant of the IS/MP model by Romer (2000, 2013). Aggregate supply will be described by a standard, aggregate supply curve and is also known as a New Keynesian Philips curve. This is the simplest macro-economic general-equilibrium model in which output, interest rates and inflation rates are simultaneously determined by equilibrium in goods, capital and money markets. The IS/MP–AD/AS model can be used for analysing economic shocks and macro-economic policy on income, real interest rates and inflation in the short and medium run. Our model provides a reasonable description for a large, relatively closed economy, such as that of the Eurozone. For now, it suffices to note that our results are qualitatively the same in the closed and the open economy as long as capital is not infinitely mobile or the economy is not very small. Section 5.2 will discuss open-economy considerations formally.

2.1 The IS/MP model

Romer (2000, 2013) develops the IS/MP-model as a version of the standard IS/LM model. We largely follow Romer's model. The economy consists of households that consume, firms that invest, and a government that spends, imposes taxes and sets monetary policy. The IS/MP model describes the equilibrium in goods and money markets for a given inflation rate. In line with current practice in monetary policy, Romer assumes that central banks set the interest rate rather than the money supply, as in the traditional IS/LM model. The MP-curve thus replaces the more common LM-curve and is derived from the Taylor-rule that central banks use to set the interest rate.

2.1.1 Goods market equilibrium: the IS-curve

The IS-curve ('investment-savings') represents the combinations of income and the real interest rate at which the goods market is in equilibrium. In equilibrium, the supply equals the demand for of goods and services. Demand for consumption and investment goods increases when real interest rates are lower. Lower real interest rates make consumption more attractive vis-à-vis saving. And, demand for investment increases when the required return on investment is lower. The IS-curve is shown in the left-hand panel of Figure 2.1. In equilibrium, demand for goods and services equals supply:

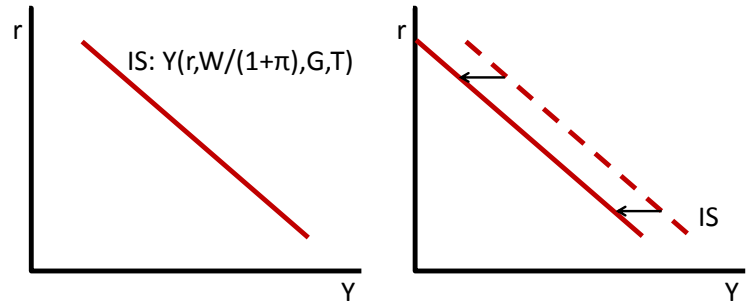
$$Y_t = C\big(Y_t - T_t, r_t, W_t/(1+\pi_t)\big) + I(Y_t, r_t) + G_t. \qquad (1)$$

Here, Y_t is total production/income/GDP in year t. Demand is the sum of household consumption C, firm investment I, and government investment and consumption G. Household consumption is designated as: $C(Y_t - T_t, r_t, W_t/(1+\pi_t))$. Consumption increases in net disposable income, which equals income minus taxes, $Y_t - T_t$. Consumption decreases when the real interest rate r_t is higher, where the real interest rate equals the nominal interest rate minus

the expected inflation rate: $r_t = i_t - \pi_t^e$. Furthermore, households increase their consumption when their real wealth is higher. Their real wealth is the nominal wealth W_t divided by the price level $1 + \pi_t$. Firms invest $I(Y_t, r_t)$. Investment increases with income Y_t and decrease when the costs of financing are higher, thus when the real interest rate r_t goes up. We abstract from wealth effects for firms. Government consumption and investment are denoted by G_t. The flow variables Y, C, I, G and T are real and the stock variable W is nominal.

The IS-curve represents the combinations of real interest rates r and incomes Y where the goods market is in equilibrium. The IS-curve is downward sloping in the real interest rate. The reason is that consumption and investment demand will be higher, see the left-hand panel of Figure 2.1. When autonomous demand – for a given real interest rate – decreases, the IS-curve shifts towards the left. Autonomous demand decreases when government spending G is lower, taxes T are higher and real wealth $W/(1 + \pi)$ is lower. The right-hand panel of Figure 2.1 shows the effect of a decrease in autonomous demand.

Figure 2.1 The IS-curve (left) and the IS-curve under lower autonomous demand (right).



2.1.2 Money market equilibrium: the MP-curve

The MP-curve ('monetary policy') gives all combinations of real interest rates r and incomes Y at which the money market is in equilibrium. In recent macro-economic literature, equilibrium in the money market is described by the policy rule for the nominal interest rate that is set by the central bank.[2] A central bank that follows conventional monetary policy determines the nominal money market interest rate i_t^T according to the Taylor-rule:

$$i_t^T = \alpha\pi_t^e + \beta(Y_t - Y^*), \qquad (2)$$

Where Y^* represents the potential output/income. $Y_t - Y^*$ is the so-called *output gap*, a measure for the business cycle indicating excess or lack of aggregate demand. Coefficients $\alpha > 1$ and $\beta > 0$ determine how strongly interest rates respond to inflation and to the output gap.[3]

When expected inflation is higher, or when the economy suffers from excess aggregate demand, i.e. $Y > Y^*$, the central bank tightens monetary policy by increasing the nominal interest rate. The central bank reduces the supply of short-run liquidity through refinancing operations up to the point where the desired, higher interest rate is reached in the money market. As a result, the

[2] Alternatively, the supply and the demand for money can be modelled via the LM curve, as in Blanchard (2005) and many others. This leads to a comparable description of equilibrium in the money market.
[3] The ECB has a single mandate of price stability, which can be interpreted as $\beta = 0$. However, in practice, also the ECB will take demand shortfalls into account, because demand shortfalls lead to lower expected inflation in the future. We assume $\alpha > 1$, which is a necessary condition for price stability in our model.

supply of money decreases. The reverse occurs when expected inflation is lower or when there is lack of aggregate demand. The central bank then lowers the interest rate. It does so by increasing the supply of short-run liquidity via refinancing operations, until the desired lower money market interest rate is reached. As a result, the money supply has increased.[4] Often, macro-economic models use the inflation rate instead of the expected inflation rate in the Taylor-rule. We have not used this simplification, because our formulation with inflation expectations is more in line with actual practice, see, for example, Martin and Milas (2004) and Asso et al. (2012). Moreover, our formulation allows for a simpler analysis of unconventional monetary policy.

The central bank can lower the nominal interest rate according to the Taylor-rule until the zero lower bound is reached. This bound puts a very important restriction on conventional monetary policy. In an economy with money, nominal interest rates cannot become (strongly) negative without inducing arbitrage. Wealth that is held in assets with a negative interest rate will then be replaced by money or investments in money market funds that offer a zero per cent interest rate.[5] The central bank is then no longer able to lower short-run nominal interest rates through refinancing operations. Thus, when the Taylor-rule prescribes an interest rate that is lower than zero, the central bank will set the interest rate to zero.

The MP-curve follows when we substitute the real interest rate, $r_t = i_t - \pi_t^e$, into the Taylor-rule (2):

$$\begin{array}{ll} i_t^T > 0: & r_t = (\alpha - 1)\pi_t^e + \beta(Y_t - Y^*), \\ i_t^T \leq 0: & r_t = -\pi_t^e. \end{array} \qquad (3)$$

The MP-curve will be upward-sloping as long as the zero lower bound is not binding, i.e. when $i_t^T > 0$. When GDP, Y_t, increases, the output gap will be larger, and the central bank will set a higher nominal interest rate. However, when the nominal interest rate is at the zero lower bound, i.e., $i_t^T \leq 0$, the real interest rate equals minus expected inflation. The MP-curve then no longer depends on the real interest rate and becomes horizontal; when GDP rises the central bank will not increase the nominal interest rate as long as the economy is in the liquidity trap. Then, it prefers to set a negative nominal interest rate, but cannot do better than to set it to zero. As long as the nominal interest rate does not change when incomes rise, the real interest rate will remain the same. The left-hand panel of Figure 2.2 shows the MP-curve.

Equation (3) shows that the MP-curve will only shift when inflation expectations change. Such expectations are a function of the realized inflation, π_t, and of the central bank's policy to manipulate inflation expectations via other means than a change in the nominal money market interest rate, also see Romer (2013). This is called unconventional monetary policy and is represented by parameter μ_t. We model inflation expectations as:

[4] In practice, the ECB focuses on the EONIA interest rate ('Euro Overnight Interest Average') that banks charge each other for short-run loans. Normally, the ECB auctions short-run bank liquidity against a minimum refinancing rate. During the crisis, however, the ECB switched to fixed-rate tenders with full allotment of bank's liquidity demands. Banks have to supply collateral with a haircut to qualify for these loans.

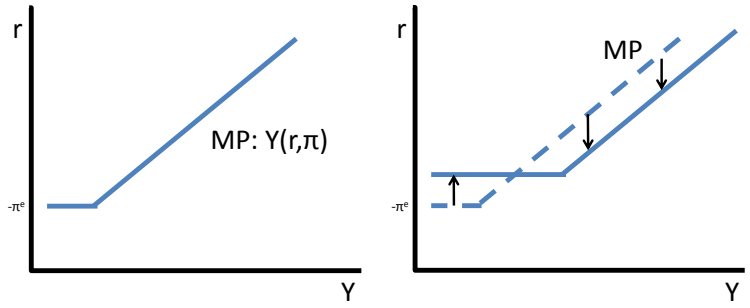
[5] In practice, the lower bound for the nominal interest rate is likely not zero, but slightly negative. This is because retaining large sums of cash involves costs of insurance and secure transportation and storage. Hall (2013) uses a lower bound of -1%. In our analysis we assumed the effective lower bound on nominal interest rates to be zero. This assumption has no qualitative consequences.

$$\pi_t^e = g(\pi_t, \mu_t). \tag{4}$$

We assume that expected inflation increases with realized inflation and unconventional monetary policy to raise inflation expectations. This means that $g_\pi > 0$ and $g_\mu > 0$.

The right-hand panel of Figure 2.2 illustrates the consequences of a negative shock to inflation expectations. A deflationary shock shifts the upward-sloping section of the MP-curve downwards or to the right[6] and the horizontal part of the MP-curve upwards. Under normal conditions, $i_t^T > 0$, lower inflation leads to a *lower* real interest rate, since the nominal interest rate decreases more than the inflation rate increases (since $\alpha > 1$) as the central bank decreases the nominal interest rate by more than the fall in inflation at any given level of income. When the nominal interest rate cannot respond, lower inflation leads to a *higher* real interest rate. Thus, the deflationary shock will lead to an upward shift of the horizontal part of the MP-curve.

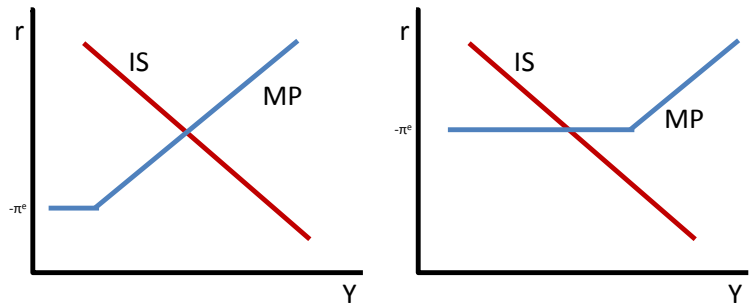
Figure 2.2 The MP-curve (left) and the MP-curve under a deflationary shock (right)



2.1.3 Simultaneous goods and money market equilibrium: IS/MP

The IS and MP-curves represent the combinations of real interest rates and incomes at which the goods and money markets are in equilibrium. In Figure 2.3 we combine both to simultaneously determine income and interest rates for a given level of inflation. The left-hand panel of Figure 2.3 gives a normal economic situation and the IS-curve intersects the MP-curve in the upward-sloping section. In the right-hand panel of Figure 2.3, the economy is in a liquidity trap and the IS-curve intersects the MP-curve in the horizontal section.

Figure 2.3 Equilibrium in the goods and money markets under normal conditions (left) and in a liquidity trap (right)



[6] We will use downward and to the right interchangeably throughout the paper.

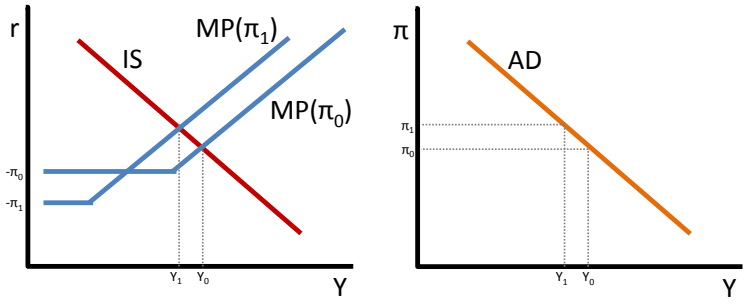
2.2 Aggregate demand: the AD-curve

The IS/MP model describes how national income and the real interest rate are determined for a given level of inflation. The IS/MP model can be used to derive a theory of aggregate demand. The aggregate demand curve, the AD-curve, describes GDP Y_t as a function of inflation π_t and presents the joint equilibrium in goods and money markets for different combinations of output and inflation. Since the AD-curve originates from the IS/MP model, it will be different when the IS or MP-curves are different. We analyse four scenarios, distinguishing between situations with and without wealth effects, and between situations with and without a zero lower bound for the nominal interest rate.

2.2.1 AD-curve without wealth effects under normal conditions

At first, we assume wealth effects do not play a role ($W = 0$) and the zero lower bound for the nominal interest rate is not binding ($i_t^T > 0$). The left panel of Figure 2.4 gives the equilibrium of the IS/MP model at two inflation rates.[7] Under normal conditions, the AD-curve is downward-sloping. When the inflation rate increases, the central bank will increase nominal interest rate more than proportionally. The MP-curve then shifts to the left, the real interest rate increases, and consumer demand and firm investment are lower in the new equilibrium. Higher inflation is thus associated with lower output, which results in a downward-sloping AD-curve, as shown in the right panel of Figure 2.4.

Figure 2.4 AD-curve, derived under normal conditions without wealth effects: higher inflation lowers aggregate demand



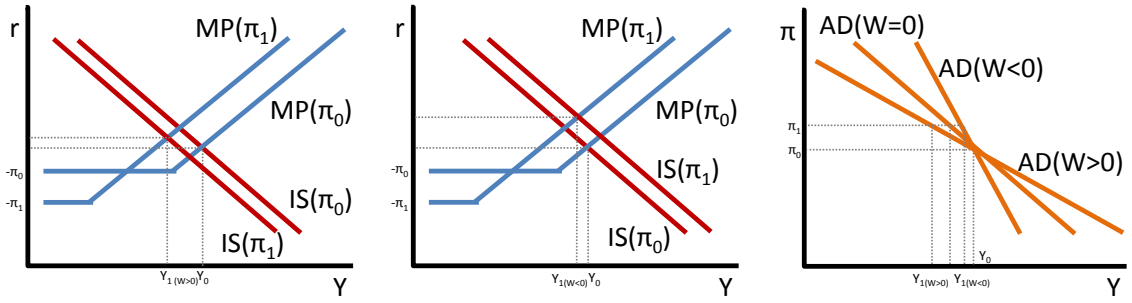
2.2.2 AD-curve with wealth effects under normal conditions

The AD-curve is qualitatively different when wealth effects are present, see Figure 2.5. With positive wealth, $W > 0$, higher inflation erodes the real net wealth of households, and a negative wealth effect lowers consumption.[8] As a result of this negative wealth effect, the IS-curve in Figure 2.5 shifts towards the left. Higher inflation thus shifts both the MP- and IS-curves towards the left. When wealth effects are present, incomes thus decrease more when inflation is higher. Compared to the situation without wealth effects, the AD-curve has become flatter (counter-clockwise rotation), see the right-hand panel of Figure 2.5.

[7] The curves shown in Figure 2.4 only apply locally. If the decrease in aggregate demand is big enough, the economy under normal conditions will end up in a liquidity trap. That case is analysed in Figure 2.6.
[8] In practice, a decrease in real wealth also indirectly lowers aggregate demand. Lower wealth levels are associated with lower collateral values, which reduces the scope for financial intermediation and contracts credit supply.

However, if households are indebted and have negative wealth, $W < 0$, inflation reduces the real value of debt, which, in turn, boosts aggregate demand.[9] Wealth effects are then positive. As before, the MP-curve shifts to the left when inflation increases, since the central bank raises the interest rate for any level of income. However, the IS-curve now shifts to the right, as is depicted in the middle panel of Figure 2.5. With negative wealth holdings, positive wealth effects reduce the negative impact of inflation on income. Here, we assume wealth effects do not dominate; there is still a decline in aggregate demand, but this decline is smaller than in the absence of wealth effects. The AD-curve is now steeper than in the absence of wealth effects (clockwise rotation), see the right-hand panel of Figure 2.5.[10]

Figure 2.5 Derivation of the AD-curve (right) under normal conditions with positive wealth (left) and with negative wealth (middle)



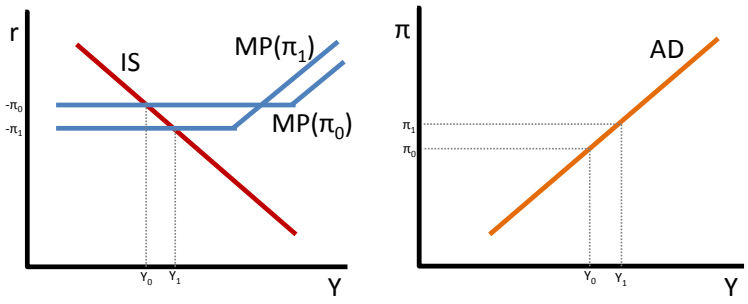
2.2.3 AD-curve without wealth effects in the liquidity trap

The left-hand panel of Figure 2.6 shows the equilibrium in the IS/MP model at two inflation levels in the liquidity trap where the zero lower bound is binding ($i = 0$). Here, we abstract from wealth effects ($W = 0$). Like above, we consider an increase in inflation. This shifts the horizontal part of the MP-curve downward. The reason is that, in a liquidity trap, the real interest rate is lower when inflation is higher. Lower real interest rates boost household consumption and firm investment. Hence, the MP- and IS-curves intersect at a higher level of output. Consequently, the AD-curve slopes upward in the liquidity trap. This will turn a number of conventional macro-economic insights upside down, as will become clear later on.

[9] There can be negative wealth effects even in an economy with positive net wealth if the wealth distribution is uneven. This is the case when a large group of households only holds a small amount or negative wealth for whom wealth shocks are important, and a small group owns a large amount of wealth for whom wealth shocks hardly matter. Hence, households with low net wealth (including highly leveraged households that have both high wealth and high debts) can be more sensitive to wealth shocks. This can be incorporated formally into our analysis by including two household types differing in their wealth holdings to which households respond differently. This would lead to qualitatively similar results. For the sake of simplicity, we abstracted from this extension.

[10] If debts become very large, debt-deflation dynamics can become dominant and may cause the AD-curve to slope upwards, even under normal conditions where nominal interest rates are positive. This possibility is not shown in Figure 2.5.

Figure 2.6 Derivation of the AD-curve in the liquidity trap without wealth effects: higher inflation boosts aggregate demand



2.2.4 AD-curve with wealth effects in a liquidity trap

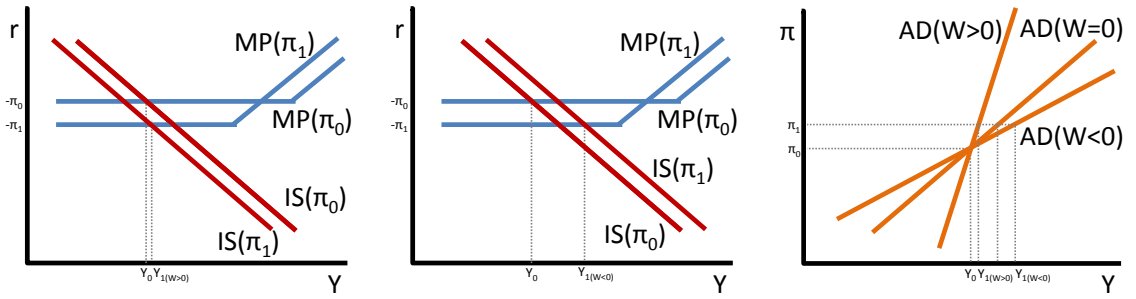
Finally, we discuss the situation in which both the zero lower bound is binding and wealth effects are present. Higher inflation shifts the flat part of the MP-curve downwards, so that real interest rates fall, and consumer spending and firm investment increase. However, when wealth is positive, $W > 0$, higher inflation also erodes the real value of wealth, which in turn reduces aggregate demand. Thus, the IS-curve will shift towards the left, see the left-hand panel of Figure 2.7. The AD-curve will continue to slope upwards as long as the wealth effect is not dominant, but it will become steeper and turn counter-clockwise compared to the case without wealth effects, see the right-hand panel of Figure 2.7.

When wealth effects are dominant and wealth levels are positive, the AD-curve rotates counter-clockwise so much that it becomes downward sloping again, even though the economy is in a liquidity trap. For this reason, Pigou (1943) thought that Keynes' (1936) liquidity trap would automatically disappear. With sufficiently large deflation, the real value of wealth would increase so much that the IS-curve would 'bounce back' and the economy escapes from the liquidity trap.[11] In response to Pigou (1943), Kalecki (1944) argued that wealth effects would make matters worse when net wealth is negative (as we show below). In Figure 2.7 we assume that the wealth effect is not dominant.

With negative wealth, $W < 0$, higher inflation reduces the real value of debts and boost the positive effects of lower real interest rates on aggregate demand. The IS-curve then shifts further to the right, as is shown in the middle panel of Figure 2.7. The right-hand panel of Figure 2.7 shows the upward-sloping AD-curve that results from the IS/MP model under a liquidity trap. A negative wealth effect reinforces the effect of the zero lower bound: the AD-curve becomes flatter (clockwise rotation). In the new equilibrium, the same increase in inflation produces higher income levels compared to the situation without wealth effects.

[11] The 'Pigou-effect' is controversial in the modern macro-economic literature. With perfect financial markets (no liquidity and borrowing constraints, no intertemporal frictions, etc.) the Pigou effect is not relevant, since inter-temporal models of consumption take into account (life-time) wealth via the Euler-equation for consumption. See for example Woodford (2003) and Buiter (2005). However, with imperfections and frictions in financial markets Pigou-effects may occur as Krugman and Eggertsson (2012) show. Alternatively, Michaillat and Saez (2015) assume that wealth enters the utility function, which yields the possibility of a permanent liquidity trap.

Figure 2.7 **Derivation of the AD-curve in a liquidity trap with positive wealth (left) and negative wealth (middle)**



2.3 Aggregate supply: the AS-curve

The model closed by the aggregate supply curve, the AS-curve. The AS-curve gives the supply of goods and services as a function of inflation in the short run. In the long run, income is determined by potential output Y^*. Potential output increases with a larger supply of production factors labour and capital and with a better production technology. In the long run, money is neutral, since all increases in the money supply will ultimately translate into higher prices. All nominal incomes and prices will then adjust, and only real factors determine long-run aggregate supply. The long-run aggregate supply curve (LRAS-curve), is independent from inflation rates and is vertical: $Y_{LR} = Y^*$.

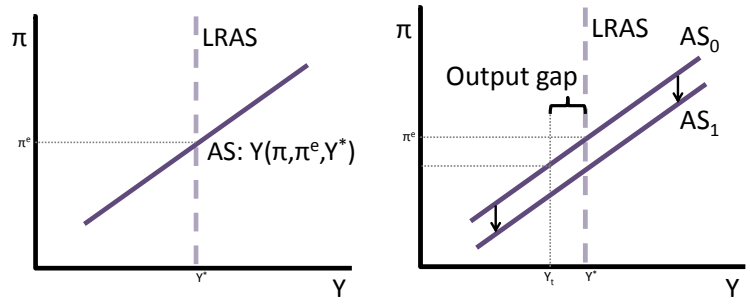
In the short run, supply of production factors and technology are given. Aggregate supply of goods and services can increase in the short run, but this will be accompanied by wage and price increases. The most common micro-foundation is that labour supply increases when wages are higher. Since a larger supply of goods and services raises labour demand wages will need to rise, accordingly. Firms will be prepared to meet higher demand for goods and services when they can demand higher prices. In the long run, wages are flexible and nominal wages increase at the same rate as prices. Labour demand is then only determined by real wage costs, see, for example, Blanchard (2005).

We assume a standard short-run supply or Philips curve, such the one employed by Gali (2015):

$$\pi_t = \pi_{t-1} + \gamma(Y_t - Y^*), \tag{5}$$

$Y_t - Y^*$ again denotes the output gap. When the output gap is negative (i.e., low aggregate demand), there will be less inflation than expected. γ measures the degree of price flexibility in the economy. The larger is γ, the quicker prices will respond to changes in aggregate demand and the steeper the AS-curve will be. The short-run AS-curve is indicated in the left-hand panel of Figure 2.8. The adjustment dynamics in our model take place through shifts in the AS-curve over time. If the economy suffers from lack of demand, and the output gap is negative, $Y_t < Y^*$, then inflation will decrease: $\pi_{t+1} < \pi_t$. This shifts the AS-curve downward over time, see the right-hand panel of Figure 2.8. This continues until the output gap has been closed, so that $Y_t = Y^*$. The reverse takes place with excess demand and a positive output gap, $Y_t > Y^*$. Then, inflation will increase, shifting the AS-curve upwards over time. Note that in the long-run equilibrium inflation equals $\pi = \pi^*$.

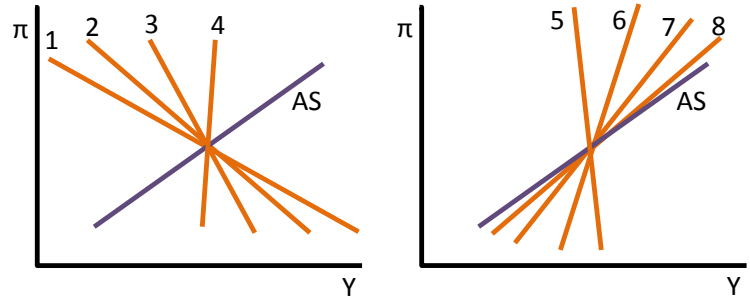
Figure 2.8 Supply curve in the long and short run (left) and with a downward shift (right)



2.4 The AD/AS model

The AD/AS model simultaneously determines income and inflation by combining the AD-curve from Figure 2.5 or 2.7 with the AS-curve from Figure 2.8. The left-hand panel of Figure 2.9 presents the model under normal conditions, with and without wealth effects. The right-hand panel of Figure 2.9 gives the model in a liquidity trap, with and without wealth effects. The numbers correspond to eight possible scenarios that are presented in Table 2.1.

Figure 2.9 Demand and supply curves under normal conditions (left) and in a liquidity trap (right)



The analysis in the remainder of this paper focusses on three scenarios that jointly describe the macro-economic dynamics that are possible in this model. The other scenarios can be understood from these three. Where necessary, we will indicate how in the remainder of this paper. The three scenarios are characterised as:

1. Positive interest rates, no wealth effects: downward-sloping AD-curve (Scenario 2).
2. Positive interest rates, negative wealth effects: downward-sloping AD-curve, steeper than without wealth effects (Scenario 3).
3. Zero lower bound on interest rate, negative wealth effects: upward-sloping AD-curve that is less steep than in the absence of wealth effects (Scenario 8).

Table 2.1 Possible scenarios

	Zero lower bound	Wealth effects	Slope of the AD-curve	
1	Not binding	Positive	Gradually downwards	Fig. 2.9 left
2	Not binding	None	Downwards	Fig. 2.9 left
3	Not binding	Negative	Steeply downwards	Fig. 2.9 left
4	Not binding	Strongly negative	Steeply upwards	Fig. 2.9 left
5	Binding	Strongly positive	Steeply downwards	Fig. 2.9 right
6	Binding	Positive	Steeply upwards	Fig. 2.9 right
7	Binding	None	Upwards	Fig. 2.9 right
8	Binding	Negative	Gradually upwards	Fig. 2.9 right

3 Economic recovery after a demand shock with balance-sheet problems and at the zero lower bound

This chapter analyses the consequences of a negative demand shock graphically in the previously described IS/MP–AD/AS model for the three scenarios: without the zero lower bound and no balance-sheet problems; without the zero lower bound, but with balance-sheet problems; and with a binding the zero lower bound and with balance-sheet problems. The analysis provides qualitative insights into the adjustment dynamics. How far does income decline below potential output due to a negative demand shock? Will the economy automatically (i.e. without policy intervention) return to its long-run equilibrium? And, if so, through which mechanism does this happen?

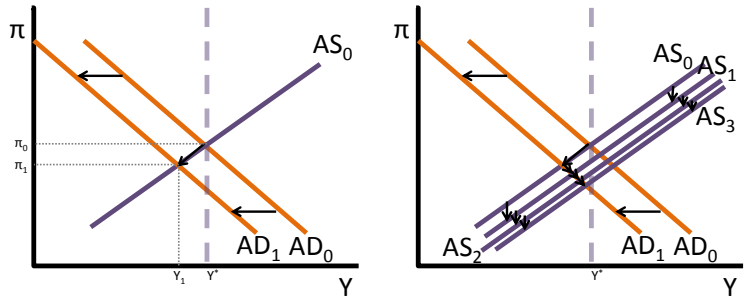
3.1 A demand shock under normal conditions without balance-sheet problems

Under normal conditions, the nominal interest rate is positive, $i > 0$. We abstract at this moment from balance-sheet problems ($W = 0$). In this case, the AD/AS model is described as in the left-hand panel of Figure 3.1. We assume the economy is initially (period 0) in a cyclically neutral situation, where the output gap is zero: $Y_0 = Y^*$. A negative demand shock shifts the AD-curve to the left (from AD_0 to AD_1). Lower aggregate demand, at given aggregate supply, will reduce inflation. This is shown in the left-hand panel of Figure 3.1. The economy will reach a new short-run equilibrium with lower incomes (from Y_0 to Y_1) and lower inflation (from π_0 to π_1). In the new short-run equilibrium, the economy operates below potential, $Y_1 < Y^*$, and the output gap is negative.

When there is lack of demand and the output gap is negative, inflation will fall. Lower labour demand also puts downward pressure on wages. Therefore, the AS-curve will shift downward in the next period, from AS_0 to AS_1. This is shown in the right-hand panel of Figure 3.1. In the next period, inflation will be lower. Hence, the central bank lowers nominal interest rates – more than proportionally –, causing real interest rates to fall. The latter encourages consumption and investment, leading to an increase in aggregate demand. Larger aggregate demand brings the economy closer to its long-run equilibrium. The output gap is thus reduced, but is still negative and, therefore, the downward pressure on prices continues. In the subsequent period, the AS-curve again shifts downwards to AS_2. This causes lower inflation, which induces the central

bank to lower nominal interest rates. This results in higher demand, and leads the economy to move closer to its long-run equilibrium.

Figure 3.1 A negative demand shock (left) and adjustment to the equilibrium (right) under normal conditions



These adjustments will continue until the AS- and AD-curves again intersect at the long-run equilibrium value for potential output Y^*. The price level will be lower than it would have been without the shock since, inflation declined during several periods.[12] Following a recession, economic growth is temporarily higher than usual, since, in our simplified model potential economic growth has been normalised to zero. Therefore, if output increases (decreases), economic growth will be faster (slower) than normal. Note also that the degree of price flexibility γ determines the speed of adjustment. When prices are more flexible, the AS-curve is steeper and the output gap will be smaller after the demand shock. Moreover, the output gap will close more rapidly, since more of the economic adjustment occurs through price and wage changes and less through adjustments of quantities (volumes).

3.2 A demand shock under normal conditions, with balance-sheet problems

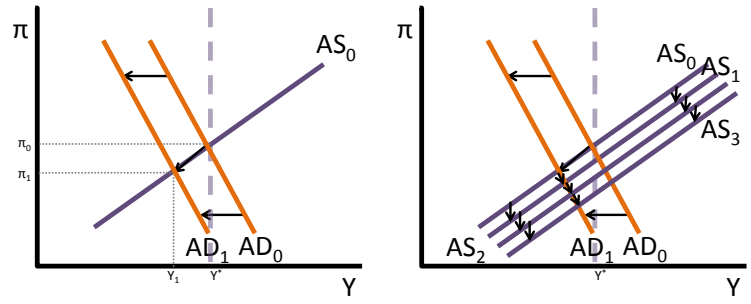
Now, we assume that the nominal interest rate is still positive, $i > 0$, yet we allow for balance-sheet problems and assume net wealth is negative, $W < 0$. The AD/AS model is then described as in Figure 3.2. Compared to a situation without wealth effects, the AD-curve slopes downward more sharply, since deflation exacerbates balance-sheet problems. The demand curve is steeper because deflation increases balance-sheet problems. As long as balance-sheet problems are not dominant however, the analysis of adjustment to the long-run equilibrium remains qualitatively the same.

The main difference with the situation without balance-sheet problems is that demand shortfalls are larger, because now debt-deflation dynamics also reduce aggregate demand. Households see the real value of their debts rise and are thus less willing to consume.[13] This effect is absent when there are no balance-sheet problems. For an equally sized negative demand shock, the decrease in both inflation and income is larger when balance-sheet problems are present.

[12] In the right-hand panel of Figure 3.2, inflation ultimately settles down at a level below the equilibrium inflation rate π^*. This difference indicates how much the price level falls due to the negative demand shock. Due to monetary policy, inflation will return to the equilibrium inflation π^* in the long run. The accompanying dynamics are complex and difficult to visualise in our graphical framework. Here we do not further elaborate on this, because the focus is on the way in which the real economy returns to potential output.

[13] The same mechanism applies to firms that reduce their investment level when they are heavily indebted. We do not model this explicitely.

Figure 3.2 **A negative shock in demand (left) and adjustment back to the equilibrium (right), under normal conditions and balance-sheet problems**



With balance-sheet problems, returning to the long-run equilibrium also requires a larger downward adjustment of inflation, since the output gap, $Y_1 - Y$, is bigger. The degree of price flexibility γ determines the adjustment speed of the AS-curve. For a given level of price flexibility, it will take more time to close a larger output gap via downward adjustments of the AS-curve. In addition, deflation raises the real value of debt, which depresses aggregate demand. Consequently, adjustment towards the long-run equilibrium takes longer than usual.

The qualitative analysis changes radically if balance-sheet problems become so large that the AD-curve is no longer downward-sloping, but becomes upward-sloping. In that case, the economy will not return to its original, long-run equilibrium. Fisherian debt-deflation dynamics then become dominant. They become dominant when following a fall in prices the positive impact on consumption and investment of a reduction in the nominal interest rate is smaller than the negative impact on consumption and investment of the increase in the real debt burden (deflation will raise real debts). When debt-defaltion dynamics are dominant, the AS-curve will shift further downwards and the economy will slide down into a destructive spiral with ongoing declines of incomes and prices.

Moreover, if balance-sheet problems become large enough, the economy may slide into a liquidity trap when the zero lower bound on nominal interest rates becomes binding. With the liquidity trap binding, deflation still increase the real debt burden, but the fall in prices is no longer accompagnied by a decrease in the nominal interest rate. This case is analysed in the next section.

3.3 A demand shock at the zero lower bound with balance-sheet problems

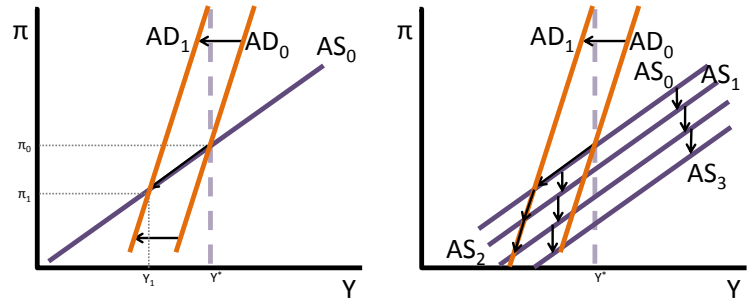
Now we analyse the consequences of a negative demand shock when the zero lower bound on nominal interest rates is binding ($i = 0$), and balance-sheet problems are present ($W < 0$). When interest rates are at the zero lower bound, the AD-curve will slope upwards unless wealth effects are strongly positive. The slope of the AD-curve will become less steep when balance-sheet problems are stronger.

In a liquidity trap, a reduction in aggregate demand leads to a fall in income and prices, as has been described above. Following the same negative demand shock, the output gap $Y_1 - Y^*$ will now be larger than under normal conditions, see the left-hand panel of Figure 3.3. Like in the case of severe negative wealth effects, when interest rates are at the zero lower bound the

economy does not automatically return to its initial equilibrium – whether it is the long-run or any other equilibrium. The right-hand panel of Figure 3.3 shows that, when the AS-curve shifts downwards, demand shortfalls are exacerbated as income and inflation decrease further. In a liquidity trap, the central bank can no longer reduce interest rates when inflation goes down. This means that lower inflation raises real interest rates when the nominal interest rate is zero. This, in turn, will further reduce consumption and investment, resulting in further reductions in income and stronger deflationary pressures. In the next period, the AS-curve shifts down further. The economy will end up in a deflationary spiral with continuing declines in incomes and prices. When the zero lower bound on interest rates is binding, the economy will therefore not return to its long-run equilibrium.

Balance-sheet problems exacerbate these adverse economic dynamics. The slope of the AD-curve is now less steep. Hence, the same negative demand shock leads to a stronger decline in income and inflation. Deflation not only increases real interest rates, resulting in lower consumption and investment, but it will also raise the real value of debts. As a result, consumption will decrease even further. As soon as the AS-curve shifts down, inflation decreases, and the real value of debts increases. This reduces consumption further and aggregate demand declines more. A negative demand shock in a liquidity trap with balance-sheet problems will therefore set a Fisherian debt-deflation-spiral in motion and this may cause long-run economic stagnation (*secular stagnation*).

Figure 3.3 **A negative demand shock (left) and adjustment back to the equilibrium (right) with balance-sheet problems and a binding zero lower bound**



3.4 Summary: effects of a negative demand shock

A decrease in aggregate demand causes a decline in income and puts downward pressure on wages and prices. Under normal conditions, the central bank will then intervene and lower the nominal interest rate. This encourages consumption demand as well as firm investment and, thus, partially offsets the fall in income. As long as the output gap has not been fully closed, inflation will continue to decrease. As a result, the central bank will continue to lower interest rates to stimulate aggregate demand more. The output gap will be closed over multiple periods, and ultimately the economy will return to its potential income.

When the economy faces balance-sheet problems or is in a liquidity trap, the decrease in income will be larger for the same negative demand shock. With balance-sheet problems, lower inflation increases the real value of debt. Debt-deflation dynamics thus cause a stronger reduction in consumption demand. In a liquidity trap, the central bank can no longer offset the decline in aggregate demand by lowering the nominal interest rate, since it is already at or close

to zero. In the liquidity trap, lower inflation raises real interest rates, which lowers consumption and investment and slows down economic growth.

When balance-sheet problems are moderate, the economy will ultimately revert to its long-run equilibrium. As long as the output gap remains negative, and inflation decreases, the central bank will continue to lower interest rates in order to boost both consumption and investment demand. Balance-sheet problems do require larger adjustments though, since the initial decrease in output is larger, and lower inflation diminishes aggregate demand as it raises the real value of debts.

However, when the economy suffers from severe balance-sheet problems and/or is in a liquidity trap, it will not automatically return to its long-run equilibrium. When balance-sheet problems are severe, debt-deflation dynamics become dominant, even when the central bank is aggressively cutting interest rates so as to boost aggregate demand. In a liquidity trap, interest-rate reductions are no longer feasible. Deflation then increases the real value of debts and raises real interest rates. Both reduce rather than increase aggregate demand. A demand shock may then send the economy into a downward economic spiral. In such a case, economic stagnation, deflation and rising real debts are looming. The economy may then get bogged down in a 'Japanese scenario' or in 'secular stagnation': a prolonged economic downturn caused by a chronic lack of demand.

4 Macro-economic policy

This chapter describes the consequences of macro-economic policy in the IS/MP–AD/AS-model. First, we analyse policy under normal conditions, then with severe balance-sheet problems, and finally in the liquidity trap with or without balance-sheet problems. In each case, we assume that a negative demand shock has hit the economy and we analyse the direct impacts of various policy interventions. We first focus on the demand side of the economy and analyse the effects of fiscal stimulus in the form of temporary, debt-financed increases in government spending or reductions in taxes, i.e. $dG > 0$ or $dT < 0$. We also analyse the effects of expansionary monetary policy in the form of interest-rate cuts or unconventional monetary policy. Then, we focus on the supply side and we analyse the role of structural reforms that raise potential GDP or raise the flexibility of labour and product markets.

Starting point of the analysis is a situation in which a negative demand shock has occurred. The IS- and AD-curves have both shifted towards the left. Output will thus be below its potential level and the output gap is negative.

4.1 Macro-economic policy impacts under normal conditions

4.1.1 Demand-side policies

Under normal conditions, the AD-curve slopes downwards (Scenario 2) and the economy will return to its long-run equilibrium even without government intervention. The most important contribution of fiscal and monetary policy is to raise the speed at with which the economy returns to its long-run equilibrium.

Adjustment towards to the long-run equilibrium takes place automatically through gradual wage and price decreases as long as the output gap remains negative. This is depicted by a downward shift of the AS-curve (see Figure 3.1 and the discussion there).

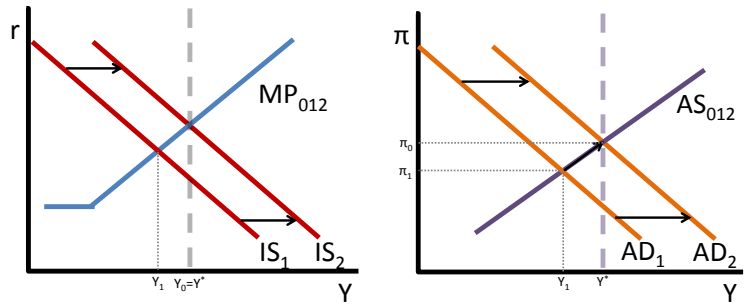
Discretionary fiscal policy entails risks of timing and dosage. The business cycle and the reason why it has changed are often difficult to determine. In addition, it takes time to implement macro-economic policy and this can have long and variable lags. As a result, stabilisation policy can be difficult to time. Moreover, determining the correct dosage for counter-cyclical stimulus is not easy, and a fiscal response can turn out to be pro-cyclical. Political-economy considerations also complicate conducting counter-cyclical fiscal policy. When discretionary fiscal policy to stabilize the business cycle is pursued asymmetrically – especially in bad times, but not enough in good times – government debt can increase over time. Asymmetric fiscal policy is then not necessarily socially optimal, since it affects the intergenerational distribution of welfare and it might raise distortionary taxes, since interest costs of financing the public debt increase. In the remainder of this analysis, we abstract from these concerns.

Expansionary fiscal policy under normal conditions

The left-hand panel of Figure 4.1 shows that fiscal expansion boosts aggregate demand. The IS-curve shifts back towards the right. Assuming that fiscal stimulus will offset the entire decline in aggregate demand, the economy will return to its original equilibrium. On the one hand, higher government spending raises aggregate demand, while, on the other hand, the central bank raises the interest rate to counter inflationary pressures caused by the increase in aggregate demand. Part of the demand increase is then offset by lower consumption and investment. This is also shown in the AS/AD panel on the right of Figure 4.1. Higher government spending shifts the AD-curve towards the right. In the long run, the composition of aggregate demand has changed; government spending is higher and private consumption and investment are both lower.

When the increase in aggregate demand is insufficient to close the output gap, inflation declines via lower prices in goods markets and lower wages in labour markets. This is depicted by a – limited – downward shift of the AS-curve and is referred to as 'undershooting'. The opposite case, 'overshooting', occurs when a large boost in aggregate demand raises output above its potential. Excess aggregate demand then results in a positive output gap, so that prices and wages increase. The central bank then raises the interest rate, which reduces consumption and investment. The output gap closes over time because the central bank raises interest rates when inflation rises. Hence, private demand crowds out higher government spending. Also in this case, the economy ultimately reaches the same real long-run equilibrium. Hence, the increase in government spending has no long-run effect on output, but enables the economy to converge to its long-run equilibrium more quickly.

Figure 4.1 Fiscal expansion under normal conditions. The IS/MP-curve is shown on the left, the AS/AD adjustment dynamics are shown on the right



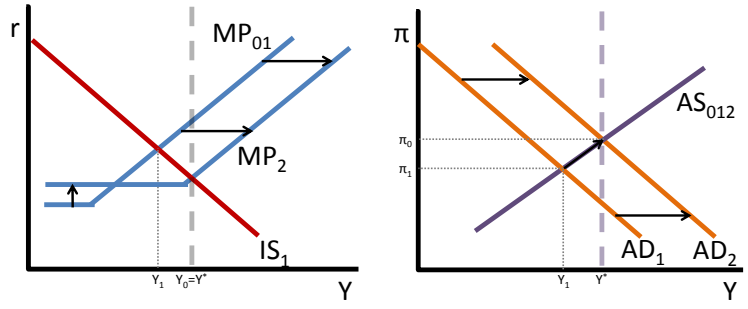
Note: The initial, negative demand shock from IS_0 to IS_1 is not shown in the figure. Monetary policy does not respond to fiscal policy. MP_0, MP_1, and MP_2 are identical and are represented by MP_{012}. This also applies to AS_0, AS_1 and AS_2.

Expansionary monetary policy under normal conditions

Monetary expansion can be described as the decision by the central bank to set a lower interest rate for each income and inflation level. This causes the downward-sloping part of the MP-curve to shift towards the right. The central bank implements the lower interest rate by carrying out refinancing operations until the money market interest rate reaches the policy rate. This will cause the money supply to increase.

Assuming that the initial situation is the same as above, i.e., the output gap is negative, the left panel of Figure 4.2 shows that monetary expansion shifts the MP-curve towards the right, from MP_0 to MP_1. Lower interest rates will raise consumption and investment, so that income increases. However, the shift of the MP-curve does not directly change inflation. The AD-curve shifts towards the right and the output gap becomes smaller, as shown in the right-hand panel of Figure 4.2. There, lower autonomous demand (the negative demand shock) is offset by lower interest rates that boost consumption investment. In the new equilibrium, the real interest rate is lower than before, but output (GDP) has returned to its long-run level. Again, if the monetary impulse is either too large or too small to completely eliminate the output gap, part of the macro-economic adjustment will take place via price declines on goods markets and wage declines in labour markets that will shift the AS-curve. Conventional monetary policy, therefore, will not have an impact on long-run output, but allows the economy to return to the long-run equilibrium more rapidly.[14]

Figure 4.2 Conventional monetary policy under normal conditions. The IS/MP-curve is shown on the left, the AS/AD adjustment dynamics are shown on the right.



Note: The initial shock from IS_0 to IS_1 is not presented by the figure. Monetary policy does not respond until after the shock, therefore MP_0 and MP_1 are identical and indicated by MP_{01}. This also applies to AS_0, AS_1 and AS_2.

[14] This is a version of the neoclassical synthesis of Samuelson (1955): in the short run the economy behaves in a Keynesian way, but in the long run in a neoclassical way. Therefore, monetary policy is effective to raise output in the short run, but not in the long run. In the long run, money is neutral.

4.1.2 Supply-side policies

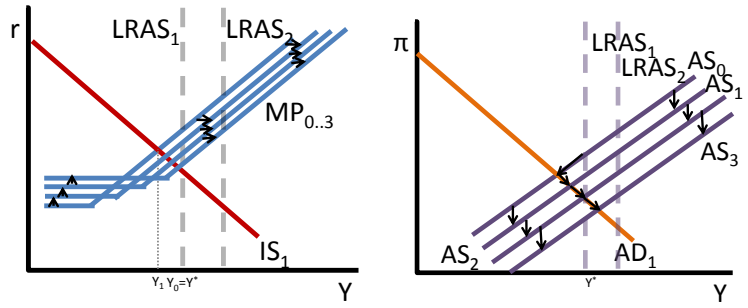
Supply-side policies are usually not associated with the business cycle. Supply-side policies are generally aimed at improving long-run economic performance. We discussed supply-side policies here for two reasons. First, countries that have been hit hardest by negative demand shocks in recent years, and for whom the return to long-run equilibrium of their economies is most difficult, are also the countries that would benefit from structural reforms and measures raising price and wage flexibility. Moreover, the question is what short-run effects reforms have in an economy that has been hit by negative demand shocks. Below, we analyse general structural reforms that raise long-run output and we analyse the consequences of larger wage and price flexibility.

Structural reform measures

Structural reforms are defined here as policy measures that increase potential output in the long run. Often, such policies aim to increase the supply of factors of production, for example, lower tax burdens on labour and capital, and reforms of labour markets, social-security systems, pension systems and the financial sector. Also public investments in, for example, education, infrastructure or research and development may increase potential output in the long run.

Once more, our analysis starts from an initial situation in which the economy has a negative output gap due to a negative demand shock. Structural reforms shift the short-run AS-curve to the right, as shown in the right-hand panel of Figure 4.3. Structural reforms also increase output in the long run, since the LRAS-curve shifts to the right as well, from $LRAS_1$ to $LRAS_2$. Hence, structural reforms will initially widen the already negative output gap.

Figure 4.3 Structural reforms with a declining AD-curve. The IS/MP-curve is shown on the left, and the effects on the AS/AD-curve are shown on the right



Note: The initial negative demand shock from IS_0 to IS_1 is not shown in the figure.

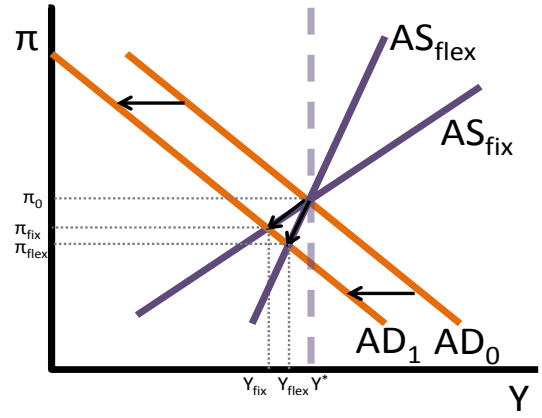
The adjustment towards the long-run equilibrium is not fundamentally different than the adjustment process after a negative demand shock. Inflation decreases because structural reforms raise aggregate supply, so that the output gap widens. Subsequently, the central bank lowers nominal interest rates, which boosts consumption and investment, see the left-hand panel of Figure 4.3. As long as the output gap remains negative, the central bank will continue to lower interest rates so as to boost aggregate demand, until the higher, potential GDP has been reached. This is described by the downward shift of the AS-curve. Following a negative demand shock, structural reforms do not lead to a more rapid recovery towards the new long-run equilibrium. Moreover, structural reforms raise the risk that the economy gets into a liquidity trap, because the central bank wants to lower the interest rate, and might thus more quickly reach the zero lower bound.

Higher wage and price flexibility

Measures that improve labour-market flexibility (e.g., reductions in employment protection legislation, allowing for or raising the attractiveness of flexible labour contracts, abolishing automatic wage indexation, reducing insider–outsider problems in trade unions) raise wage flexibility. Price flexibility can be enhanced by breaking up established cartels and monopolies, lowering entry barriers, stricter competition policy, and reducing privileges of protected professions. Some of these measures partially overlap with the structural reforms described above, and this lead raise in long-run aggregate supply as well (LRAS moves towards the right). For simplicity we abstract from the latter, and focus our analysis on the impact of larger wage and price flexibility on the slope of the short-run aggregate supply curve (AS-curve).

In the model we parameterize the degree of wage and price flexibility by γ. The higher is γ, the more flexible are wages and prices, and the steeper is the AS-curve. Therefore, a more flexible economy features a steeper AS-curve. In more flexible economies, a negative demand shock results in a smaller output gap, since a larger part of the macro-economic adjustment takes place via wage and price declines, see Figure 4.4.

Figure 4.4 Negative demand shock with high and low wage and price flexibility under normal conditions without balance-sheet problems



When a negative demand shock occurs, the degree of price and wage flexibility is given, and, therefore, also the resulting output gap. Raising flexibility can raise the speed at which the economy returns to its long-run equilibrium. As prices fall more strongly when the economy is more flexible, the central bank responds more aggressively by lowering nominal interest rates. Consumption and investment then increase more rapidly after the negative demand shock. Under normal conditions, wage and price flexibility is a good thing, since negative demand shocks can be absorbed more and the economy returns to its long-run equilibrium more rapidly.

4.2 Macro-economic policy impacts with balance-sheet problems

In an economy with only mild balance-sheet problems, the AD-curve is still downward-sloping (Scenario 3). Hence, the economy returns to its long-run equilibrium even without government intervention. However, wealth effects make the slope of the AD-curve much steeper. The steeper slope of the AD-curve implies that the negative demand shock leads to a larger output gap.

Moreover, the required downward adjustments to wages and prices are larger for the economy to return to its long-run equilibrium.

Counter-cyclical demand policy accelerates the speed at which the economy returns to its long-run equilibrium. Compared to the case without balance-sheet problems, fiscal stimulus is more effective to raise aggregate demand, i.e., fiscal multipliers are larger. Intuitively, higher incomes raise inflation, which reduces the real value of debts. The corresponding improvement in household's balance sheets allows for higher levels of private consumption, which contributes to the increase in aggregate demand. Since expansionary fiscal or monetary policy raises inflation, which reduces the real value of debts, the usual objections against counter-cyclical demand policy weigh less heavily when balance-sheet problems are present. In particular, it is easier to interpret the business cycle, hence counter-cyclical demand policy is less likely to be wrongly dosed. In addition, the risk of wrongly timing demand policy is lower, given that the macro-economic adjustment process after a negative demand shock takes more time.

The analysis is the qualitatively the same for supply-side policies as under normal conditions. Structural reforms widen the output gap. This forces the central bank to cut interest rates more aggressively, which in turn boosts consumption and investment. As a result of the steeper AD-curve, it takes more time for the economy close the output gap and reach the new long-run equilibrium output. Increasing wage and price flexibility increases the adjustment speed, which is more beneficial when the AD-curve is steeper.

4.3 Macro-economic policy impacts in the liquidity trap without and with balance-sheet problems

When the economy is in a liquidity trap, the AD-curve is upward-sloping. Our analysis shows that without government intervention the economy is not able to return to its long-run equilibrium, and could possibly become trapped in a deflationary spiral. This changes the nature and impact of counter-cyclical demand policy. Counter-cyclical demand policies not only allow the economy to reach its long-run equilibrium more quickly, but are also *necessary* to reach this equilibrium at all. Balance-sheet problems strengthen the case for demand management, since negative wealth effects reduce the slope of AD-curve. Consequently, balance-sheet problems strengthen the impact of counter-cyclical demand policy.

4.3.1 Demand-side policies

Expansionary fiscal policy

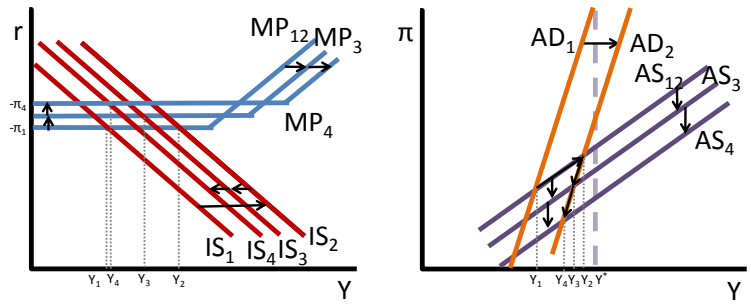
The analysis starts again in a situation in which a negative demand shock has occurred and with a negative output gap. The income level after the demand shock is indicated in Figure 4.5 by Y_0. Without expansionary fiscal policy, the economy will not return to its potential income. Instead, both income and prices continue to decline. This is represented by a downward shift of the AS-curve. The negative output gap grows, and in the next period more macro-economic adjustment is needed to return to the long-run equilibrium. A demand shock thus causes to a vicious economic spiral with declining output and deflation.

The effects of negative demand shocks are larger in a liquidity trap and with balance-sheet problems. Similarly, expansionary fiscal policy – a positive shock to aggregate demand – is more powerful, that is: multipliers are larger in the liquidity trap. This is shown in the left-hand panel

of Figure 4.5, where a fiscal expansion raises income from Y_1 to Y_2. The empirical literature provides evidence for more potent fiscal policy in the liquidity trap, see, for example, Auerbach and Gorodnichenko (2014), Jora and Taylor (2013) and Corsetti et al. (2012). Or, for an overview, see the meta-analysis in Gechert and Will (2012), and the literature surveys of Hebous (2011) and Lukkezen (2013).

The long-run consequences of counter-cyclical fiscal policy, depend nevertheless on the magnitude of the fiscal expansion. If stimulus is too weak, so that the output gap remains negative, deflationary pressures will remain. As long as the output gap is not closed, the AS-curve keeps on shifting downwards over time, from AS_1 to AS_2 to AS_3, and so on, see the right panel of Figure 4.5. The ongoing declines in inflation raise real interest rates. Hence, the horizontal part of the MP-curve keeps on shifting upwards, from MP(π_1), to MP(π_2) to MP(π_3), and so on, see the left panel in Figure 4.5. As are result, consumption and investment decline again, despite their initial increase due to a higher income. In addition, negative wealth effects shift the IS-curve to the left, since lower inflation raises the real value of debts. This scenario is similar to that of Japan in the 1990s, and suggests that, in a liquidity trap, a too weak fiscal expansion is not able to pull the economy out of deflation and stagnation. This finding is the 'timidity paradox'.

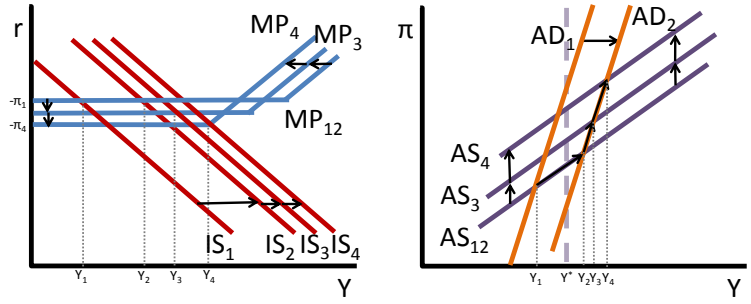
Figure 4.5 **Too weak fiscal expansion in a liquidity trap with balance-sheet problems where the output gap remains negative. The IS/MP-curve is shown on the left, the AS/AD-curve is shown on the right**



The adjustment dynamics will be different when the fiscal expansion is strong enough and (more than) closes the output gap. A sufficiently large fiscal expansion breaks the downward deflationary spiral, and sends the economy in a upward inflationary spiral, see the right-hand panel of Figure 4.6. The AD-curve will shift to the right, from AD_1 to AD_2. The output gap becomes positive, $Y_2 > Y^*$, and inflation increases. As long as the zero lower bound remains binding, higher inflation reduces the real interest rate and this will boost aggregate demand. As a result, the horizontal part of the MP-curve shifts downwards. Consumption and investment increase and income rises further, see the left-hand panel of Figure 4.6. As long as the zero lower bound on interest rates remains binding, higher inflation keeps on lowering real interest rates and boosting aggregate demand. The economy recovers more rapidly than in the absence of balance-sheet problems, because higher inflation reduces the real value of debts, which gives the economy an additional boost in aggregate demand. This is represented by shifts of the IS-curve to the right. Hence, both lower real interest rates and the reduction of real debts generate an 'inflationary spiral' with increasing incomes and rising inflation rates. Only when the zero lower bound on nominal interest rates is no longer binding, will the AD-curve become downward-sloping again. The central bank will then raise the interest rate to positive levels in order to choke off inflationary pressures. Then, the virtuous spiral stops and the economy

returns to its long-run equilibrium. In the right-hand panel of Figure 4.6, the AS-curve shifts up, from AS_1 to AS_2 and so on, until the zero lower bound is no longer binding and the AD-curve 'tips over' and becomes downward-sloping again.

Figure 4.6 **Strong fiscal expansion in a liquidity trap with balance-sheet problems where the output gap becomes positive. The IS/MP-curve is shown on the left, the AS/AD-curve is shown on the right**



Expansionary monetary policy

When it is constrained by the zero lower bound, the central bank can no longer decrease the interest rate. Conventional monetary policy is then no longer effective. Therefore, central banks have resorted to unconventional monetary policy in recent years. Unconventional policy is generally aimed at decreasing real interest rates. We distinguish two types of unconventional monetary policy. First, the central bank can aim its policy to lower risk and term premiums and to improve the transmission of monetary policy such that real interest rates for households and firms, meaning the interest rates on other assets than short-run liquid assets, are reduced. Think of qualitative easing, for example Operation Twist, where the central bank buys commercial paper, consumer loans, or long-run government bonds, so as to reduce long-term interest rates.[15]

Second, the central bank can aim to raise inflation expectations, for example, through quantitative easing, forward guidance and forward commitment. Monetary financing also raises inflation expectations, for example through 'helicopter money'. Higher inflation expectations also reduce real interest rates. In practice, it is not easy to properly manage inflation expectations due to commitment and time-consistency problems in setting monetary policy.

Reduce real interest rates on assets other than liquid short-run loans

Lower risk and term premiums and a better transmission of monetary policy reduce effective real interest rates for households and firms. Lower real interest rates boost aggregate demand. It also provokes arbitrage among both international investors. Lower interest rates reduce the attractiveness of investments in local currency, which reduces the demand for the currency and thus leads to a depreciation of the currency. The latter improves competitiveness and stimulates net exports. Lower interest rates also result in higher share prices, and often also in higher commodity prices. Higher asset valuations improve balance sheets, which generates positive wealth effects on aggregate demand.

When such unconventional monetary policy is effective, the IS-curve will shift to the right (Romer, 2013). The economic effects are comparable to those of a fiscal expansion. Lower real

[15] The ECB has particularly focused on additional credit provision for the banks and has only since 2015 started to purchase long-run bonds on a large scale.

interest rates, other than short-run money market rates, boost consumption and investment, and a lower exchange rate raises net exports. The analysis of unconventional monetary policy is otherwise identical to what is described in the previous section on expansionary fiscal policy. As is the case for fiscal policy, monetary policy impulses should be sufficiently powerful to close the output gap and to lift the economy out of the vicious (debt-)deflation spiral. Otherwise, the recovery will be short-lived and, after a while, the economy will fall back into the (debt-)deflation spiral and economic stagnation results.

Increasing inflation expectations

A second channel whereby unconventional monetary policy can stimulate growth in a liquidity trap is to raise expected inflation. Krugman (1998) and Eggertsson and Woodford (2003) show that, when the zero lower bound is binding, higher expected inflation can lift the economy out of a liquidity trap. Higher expected inflation will reduce real interest rates, thus boosting aggregate demand, since consumption and investment increase. Central banks can only realise higher inflation expectations by committing to set low interest rates for a prolonged period when the liquidity trap is over. These commitments are often made conditional on macro-economic developments (growth, unemployment, inflation). This implies that, when monetary policy is considered credible, future money growth will be higher and inflation expectations will rise. For the same reason, central banks could also raise the long-run inflation target. This has been done recently by the Bank of Japan. Also, quantitative easing and 'helicopter money' could increase expected inflation.[16]

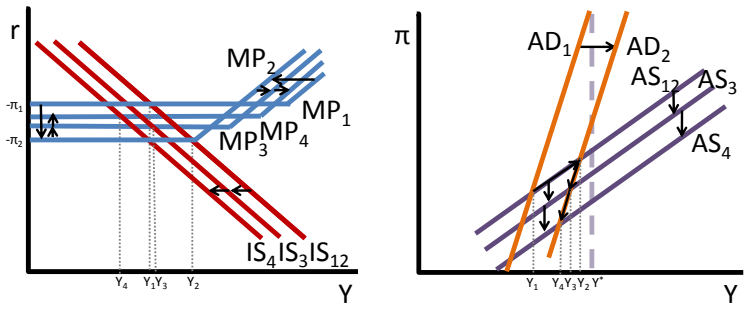
It is not guaranteed that the central bank's unconventional monetary policy will raise inflation expectations, since it suffers from a time-consistency problem. Central banks are responsible for keeping inflation rates low and predictable (i.e. it's their mandate). Therefore, when unconventional policy indeed generates inflation, the central bank may renege on its earlier announcements to let inflation rise, and tighten monetary policy by raising interest rates. When households, firms and banks anticipate this behaviour of the central bank, inflation expectations will not increase. Only when central banks can 'commit to be irresponsible', inflation expectations will rise (Krugman, 1998; Eggertsson, 2006). The key question is, therefore, to what extent monetary expansion can be regarded as permanent, or whether people expect the policy to be reversed again.

Figures 4.7 and 4.8 illustrate the adjustment dynamics of unconventional policy that raises inflation expectations, starting again from an initial position with a negative output gap ($Y_1 < Y^*$). In both figures, higher expected inflation shifts the horizontal part of the MP-curve downward and its upward-sloping part towards the left. The nominal interest rate remains at zero. Because the real interest rate decreases, consumption and investment increase. In the new short-run equilibrium income is higher. Again the effectiveness of unconventional monetary policy depends on whether the boost in output is large enough to close the output gap and to change deflation into inflation pressures. The right-hand panel of Figure 4.7 illustrates what happens when the monetary stimulus is too weak to close the output gap, $Y_2 < Y^*$. Then, downward pressures on prices will remain. The economy will experience a temporary recovery and will

[16] If the central bank makes quantitative easing permanent, and never reverses its bond purchases, inflation expectations increase (Woodford, 2012). When the central bank raises the money supply, and distributes it among the public or the government, it will be harder to reverse the operation in the future, and is therefore more credible than standard quantitative easing. This idea originates from Milton Friedman (1969) and is referred to as 'helicopter money'. It basically boils down to monetary financing of (government) debts, see also Buiter (2014) and Muellbauer (2014).

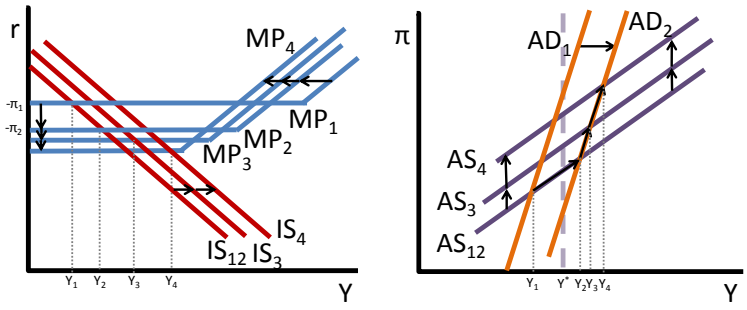
then slide back into deflation and recession, while real interest rates are rising. The MP-curve will then shift back up, see the left-hand panel of Figure 4.7. Lower rates of inflation increase the real value of real debts, causing the IS-curve to shift further towards the left.

Figure 4.7 **Higher expected inflation in a liquidity trap with balance-sheet problems, where the output gap remains negative. The IS/MP-curve is shown on the left, AS/AD-curve is shown on the right**



In Figure 4.8 the increase in expected inflation, and the corresponding boost in income, are large enough to close the output gap, $Y_2 > Y^*$. In that case, deflation turns into inflation. Higher inflation expectations result in a positive output gap, see the left-hand panel of Figure 4.8. This shifts the AS-curve upwards in the right-hand panel of Figure 4.8. Higher inflation will increase expected inflation, causing the horizontal part of the MP-curve to shift back down and the real interest rate falls further. This encourages consumption and investment (and exports via currency depreciation). Higher inflation also reduces the real value of debt, which shifts the IS-curve towards the right. The central bank will not increase the nominal interest rate while the economy is still in the liquidity trap. Income and prices will thus increase further and the economy escapes from the debt-deflation spiral.

Figure 4.8 **Higher expected inflation in a liquidity trap with balance-sheet problems, where the output gap becomes positive. The IS/MP-curve is shown on the left, AS/AD-curve is shown on the right**



4.3.2 Supply-side policies

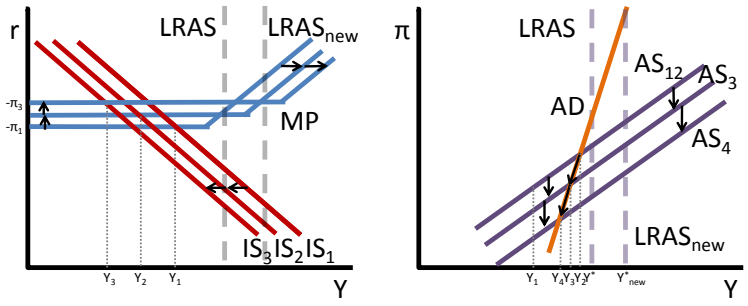
Structural reforms

In a liquidity trap, structural reforms can cause the 'paradox of toil' (Eggertsson and Krugman, 2012): structural reforms do not help the economic recovery in the short-run, but cause a deeper recession.

As described above, structural reforms shift the LRAS-curve from Y^* to Y^*_{new}, see the right-hand panel of Figure 4.9. The output gap becomes more negative, causing inflation to drop further. If

the nominal interest rate is at the zero lower bound, the central bank cannot lower it any further. The horizontal part of the MP-curve shifts up, as inflation goes down. The result is that real interest rates increase, consumption and investment decline, and income falls, as is shown in the left-hand panel of Figure 4.9. At the same time, lower inflation implies that the real value of debts increases so that the IS-curve shifts towards the left, see the left-hand panel of Figure 4.9. This also reduces incomes. Since the output gap will become even more negative, inflation only falls further. Consequently, the AS-curve shifts down, see the right-hand panel of Figure 4.9. As a result of structural reforms the economy gets into a (debt-)deflation spiral, with declining incomes, higher real interest rates and higher real debt burdens.

Figure 4.9 **Effects of structural reforms with a rising AD-curve in a liquidity trap. The IS/MP-curve is shown on the left, the AS/AD-curve is shown on the right**



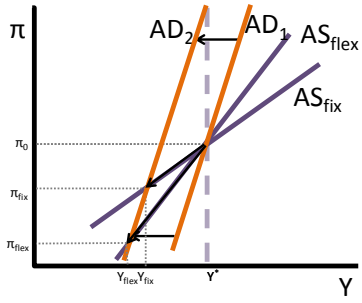
The paradox of toil occurs when the AD-curve is upward-sloping. In a liquidity trap, structural reforms therefore have an important downside. When structural reforms are effective, they strengthen (debt-)deflation dynamics, which may lead to economic stagnation, rather than economic recovery. Fiscal policy that boosts aggregate supply, such as tax cuts, could also have these negative short-run side effects. Multipliers for fiscal policy that raises aggregate supply can thus be smaller than those for policies that raise aggregate demand.

Higher wage and price flexibility

Stronger wage and price flexibility may be counter-productive in an economy with severe balance-sheet problems or in a liquidity trap. This is known as the 'paradox of flexibility' of Eggertsson (2010), which has been popularized by Eggertsson and Krugman (2012).

Figure 4.10 shows the consequences of a negative demand shock when wage and price flexibility is larger in a liquidity trap (with or without balance-sheet problems). A negative demand shock shifts the IS-curve towards the left and the AD-curve thus to shifts to the left. The output gap turns negative and inflation falls. With larger wage and price flexibility, a larger part of the macro-economic adjustment takes place via price declines. At the zero lower bound, lower inflation raises the real interest rate, which depresses consumption and investment further. Also, the reduction in inflation raises the real value of debts, which reduces aggregate demand further. As the output gap remains negative, equilibrium shifts downward along the AS-curve, and inflation falls further. An economy with larger wage and price flexibility, thus experiences a stronger (debt-)deflation spiral. This is the paradox of flexibility: larger wage and price flexibility is economically costly in the liquidity trap. The risk of a debt-deflation spiral is smaller if wages and prices are more rigid.

Figure 4.10 Negative demand shock with high and low wage and price flexibility in a liquidity trap without and with balance-sheet problems.



5 Summary, extensions and limitations

In this chapter we first summarise the findings from the IS/LM–AD/AS model of the two previous chapters. Then, we show that these results do not qualitatively change in an open economy that is not too small or does not have perfect capital mobility. Subsequently, we discuss how similar results are obtained in more advanced macro-models. Finally, we reflect on the implications of the model outcomes.

5.1 Summary of economic dynamics and policy effects

Table 5.1 summarises the results from the IS/MP–AD/AS model of this paper. Starting from a situation with aggregate demand shortfalls (i.e., a negative output gap), the economy returns to its long-run equilibrium under normal conditions via lower inflation (downward adjustment of the AS-curve). The central bank then conducts a more expansionary monetary policy by lowering interest rates. This boosts consumption and investment and the economy starts to return to its long-run equilibrium. As long as the output gap remains negative, and the downward pressure on inflation persists, the central bank will continue its expansionary monetary policy, until the long-run equilibrium has been reached. When balance-sheet problems are mild, the same adjustment process takes place, although takes longer to return to potential output. The reason is that lower inflation exacerbates balance-sheet problems and, thus, reduces consumer spending.

Expansionary monetary and fiscal policy can speed up the macro-economic adjustment towards long-run equilibrium by raising aggregate demand. However, one also encounters the standard problems to correctly time and dose stabilisation policy. Structural reforms and larger wage and price flexibility will also speed up the macro-economic adjustment. Larger price declines will induce the central bank to more aggressively cut interest rates or to keep them low for a longer time.

However, when balance-sheet problems are severe, or when the economy has entered a liquidity trap, the economy does not automatically recover. The reason is that standard monetary policy can no longer remove the downward pressures on inflation. As long as the zero lower bound on the nominal interest rate binds, real interest rates increase, causing consumption and investment to fall. Balance-sheet problems also worsen because decreasing inflation raises the real value of debts, which depresses consumer spending even more. As a result, the output gap widens and downward pressures on inflation becomes stronger. The

economy may then get into long-run economic stagnation caused by ongoing deflation and debt-deflation dynamics. Monetary and fiscal policy may prevent these stagnation scenarios, but only if stimulus is powerful enough to fully close the output gap, deflation stops and inflation is created. Insufficiently powerful policy responses that do not fully close the output gap only result in a temporary economic revival, after which the economy slides back into stagnation. Structural reforms and larger wage and price flexibility do not always have desirable short-run impacts. Both strengthen deflation, which raises both real interest rates and debt-deflation dynamics, causing the downward spiral to continue.

Under normal conditions the economy recovers automatically from a negative demand shock. Hence, it is possible that expansionary fiscal or monetary policy are incorrectly timed or their dosage is wrong. However, when there are balance-sheet problems, the economic recovery will be slower and the risk of incorrectly timing or dosing stimulus is smaller. With severe balance-sheet problems or in a liquidity trap, the economy does not automatically recover from a negative demand shock. Stimulus then needs to be strong enough to (more than) close the output gap. This is the timidity paradox; with insufficiently large stimulus, the economy will only experience a temporary revival, but slides back down into (debt-)deflation and recession.

Table 5.1 Summary of adjustment dynamics and policy impacts

	Effect	Policy impacts		
		Normal conditions	Mild balance-sheet problems	Severe balance-sheet problems and/or liquidity trap
Return to long-run equilibrium	Downward adjustment AS-curve	Yes	Yes, but slowly	No
Fiscal stimulus	IS-curve to the right, AD-curve to the right	Quicker return to long-run equilibrium, risk of wrong timing and/or dosage	Quicker return to long-run equilibrium, more potent than usual, lower risk of wrong timing and/or dosage	More potent than usual. Return to long-run equilibrium only if fiscal stimulus is large enough to fully close the output gap (timidity paradox), no risk of wrong timing or dosage
Expansionary conventional monetary policy	IS-curve to the right, AD-curve to the right	Quicker return to long-run equilibrium, risk of wrong timing and/or dosage	Quicker return to long-run equilibrium, more potent than usual, lower risk of wrong timing and/or dosage	n/a
Expansionary unconventional monetary policy	Horizontal part MP-curve upwards, IS-curve to the right, AD-curve to the right	n/a	n/a	Return to long-run equilibrium only if fiscal stimulus is large enough to fully close the output gap (timidity paradox), no risk of wrong timing or dosage
Structural reforms	MP-curve downwards, LRAS to the right	Larger output gap, recovery to new higher long-run equilibrium	Larger output gap, recovery to new higher long-run equilibrium	Larger output gap, more deflation/stagnation in short run, stronger debt-deflation spiral (paradox of toil)
More flexibility	Steeper AS-curve	Quicker recovery to equilibrium	Quicker recovery to equilibrium	Larger output gap, more deflation/stagnation in short run, stronger debt-deflation spiral (flexibility paradox)

Supply-side policies, such as structural reforms and larger wage and price flexibility, contribute little to economic recovery in the short run, but do raise economic potential in the longer term and increase the ability to absorb economic shocks. However, with balance-sheet problems or in a liquidity trap, however, supply-side policies harm economic recovery. Structural reforms and larger wage and price flexibility only strengthen (debt-)deflation dynamics and can cause economic stagnation. These phenomena are called the 'paradox of toil' and the 'paradox of flexibility'.

5.2 Extension: the open economy

Until now, we assumed that the economy is closed. For the Eurozone as a whole, this seems a reasonable assumption. Nevertheless, it is important to verify whether our findings are robust when allowing for an open economy that can trade with the rest of the world. In order to do so, we analyse an open-economy version of our model, which is again based on Romer (2013). We assume that exchange rates are flexible, otherwise the central bank is not able to conduct an independent monetary policy. The main conclusion of this extension is that our analysis remains qualitatively the same as long as capital is not fully mobile or the economy is not very small.

We extend our model to an open-economy setting in the following way. Let X_t denote net exports and e the (flexible) real exchange rate. Net exports increase when the exchange rate decreases ($X_e < 0$). According to the balance of payments, net exports X_t are equal to net capital outflow F_t. We assume that the net capital outflow is a decreasing function of the real interest rate r_t: $F_t(r_t)$. The higher is the real interest rate, the larger is the capital outflow. Intuitively, domestic investments are more attractive to foreign investors when real interest rates are high. This assumption implies that there is either imperfect capital mobility or the economy is large and affects world interest rates. The model can thus be best thought of as describing a large open economy, such as the European economy, or an open economy with imperfect capital mobility.[17] Hence, the IS-curve for our open economy is given by:

$$Y_t = C\left(Y_t - T_t, r_t, \frac{W_t}{1+\pi_t}\right) + I(Y_t, r_t) + G_t + F_t(r_t). \qquad (6)$$

This IS-curve has qualitatively similar properties as the IS-curve of the closed economy analysed before. However, the IS-curve will have a steeper downward slope, since a larger share of total demand now depends on the domestic real interest rate. When the interest rate declines, not only consumption and investment will increase, but also net exports. The latter occurs via a depreciation of the real exchange rate. Foreign investors reduce their domestic investments when domestic interest rates are lower, and move their investments abroad. As a result, the demand for the domestic currency falls and it depreciates. The depreciation of the exchange rate stimulates net exports. The exchange rate depreciates until capital outflows equal net exports $F_t(r_t) = X_t(e_t)$. When we replace the closed-economy IS-curve with open-economy IS-curve all our previous analyses remain qualitatively the same. Note, however, that the real exchange rate

[17] Hence, we do not assume that the domestic interest rate r_t is by definition equal to the world interest rate ρ_t in global asset markets. Equality of interest rates across countries may be a reasonable assumption for the long run, but in the short run there are many factors that cause interest rates to differ substantially across countries.

changes along the IS-curve. A lower interest rate implies that the exchange rate will fall and thus exports increase. Although the AD-curve does not change qualitatively, its slope will become steeper since aggregate demand responds stronger to the real interest rate. The entire structure of the IS/MP–AD/AS model, therefore, will remain the same when we extend it to the open economy as long as the economy is large or there is imperfect capital mobility.

What is the effect of a negative demand shock in the open economy? Under normal conditions, lower aggregate demand shifts the AD-curve towards the left. This reduces incomes and lowers inflation. The central bank will then lower interest rates. This will not only boost consumption and investment, but also net exports, since the currency will depreciate. The remainder of the analysis is analogous to the analysis of previous sections for the closed economy.

When the economy is in a liquidity trap or suffers from severe balance-sheet problems, a negative demand shock increases the output gap and reduces inflation. However, since the central bank is constrained by the zero lower bound, it cannot lower nominal interest rates any further. Lower inflation raises real interest rates and net exports decrease. The reason is that higher real interest rates render domestic investments more attractive, which raises demand for the domestic currency. The real exchange rate appreciates and this lowers net exports. In a closed economy a higher real interest rate reduces consumption and investment, but in the open economy it also reduces net exports. Thus, the analysis of a negative demand shock remains qualitatively the same. And, this is also the case for the analysis of fiscal and monetary policy.

What happens in the open economy when it is in a liquidity trap and the nominal interest rate is at the zero lower bound? Net capital outflow is then only determined by inflation expectations, i.e., $F_t(r_t) = F_t(-\pi_t^e)$. Moreover, the real exchange rate is only determined by inflation expectations. When inflation expectations increase, real interest rates go down, and the exchange rate depreciates. Consequently, net exports increase. The reverse reasoning holds when inflation expectations decline. Hence, in a liquidity trap, higher inflation expectations not only raise consumption and investment, but also net exports.

Finally, one may ask the question how it is possible than an open economy gets stuck in a liquidity trap in the first place. How can nominal interest rates become zero if it is possible to invest abroad at positive interest rates? Krugman (1998) provides two answers to this question. First, goods and services are only partially mobile and the non-tradable sector dominates the tradable sector. For both reasons net capital outflows may be insufficiently strong to escape the liquidity trap. Second, when monetary policy is constrained by the zero lower bound, and the exchange gradually reverts back to its long-run equilibrium, a zero nominal interest rate can bring about only a limited amount of depreciation of the currency. Hence, the resulting capital outflows may be insufficient to eliminate the zero lower bound on interest rates. Both these arguments are valid even when capital mobility is perfect.

5.3 Modelling assumptions

The biggest shortcoming of our static model is that it does not explicitly take into account long-run consequences of policy on short-run economic behaviour. In more advanced, micro-founded

models, forward-looking households and firms do take into account future policies and adjust their behaviour accordingly in the short run. Therefore, this section analyses whether our findings are sensitive to such forward-looking behavioural responses, and discusses the policy implications.

5.3.1 Fiscal and monetary policy

Until now we always assumed that a fiscal expansion is financed with government debt. However, higher government debt today is equivalent to tax increases or spending cuts tomorrow. Our model does not include this intertemporal dimension. However, fiscal policy – higher government spending or lower taxes – boosts aggregate demand also in models with intertemporal optimisation that take the intertemporal government budget constraint explicitly into account (see, e.g., Ramey, 2011; Christiano, Eichenbaum and Rebelo, 2011; Woodford, 2012; Eggertsson and Krugman, 2012). The effects of fiscal policy derived in micro-founded models with rational expectations are qualitatively the same as those derived from our simplified IS/MP–AS/AD model. Fiscal multipliers are generally smaller than in the simple IS/MP–AD/AS-model.[18] However, fiscal multipliers can also be larger, especially when balance-sheet problems are severe or the zero lower bound on multipliers is binding. Balance-sheet problems are often modelled by tighter liquidity and borrowing/credit constraints. See, for example, Corsetti et al. (2013) and Roeger and In 't Veld (2013). Moreover, larger fiscal policy multipliers during financial crises are found as well empirically, see Lukkezen (2013) for an overview of the literature.

Our analysis of unconventional monetary policy has a limitation. We did not explicitly model how inflation expectations relate to unconventional monetary policy. We simply assumed that unconventional monetary policy can raise inflation expectations. Krugman (1998) and Woodford (2012) argue that the critical question is whether a monetary expansion would become permanent. If not, then inflation expectations will not increase and unconventional monetary policy will not be effective. For example, temporary quantitative easing that is only implemented in the short run, while the economy remains in a liquidity trap, is impotent. Financial parties are indifferent to quantitative easing, since it merely swaps short-run bonds – an asset with a zero interest rate – for money – another asset with a zero interest rate. Therefore, as long as the economy remains in a liquidity trap, temporary quantitative easing has no effect on interest rates, inflation expectations and, thus, on the output. The strength of unconventional policy, therefore, lies in the credible commitment of the central bank to pursue expansionary monetary policy in the future, when the zero lower bound on interest rates is no longer binding. The weaker is this commitment, the weaker will be the relation between inflation expectations and unconventional monetary policy.

5.3.2 Supply-side policies

An important caveat should be made regarding the analysis of structural reforms in our model. We assume that structural reforms do not impact the IS-curve (other than via debt-deflation dynamics). However, when households and firms base their decisions also on future incomes, structural reforms are not necessarily harmful in the short run when balance-sheet problems

[18] Ricardian equivalence occurs if a debt-financed fiscal expansion today is equivalent to a future tax increase. Under Ricardian equivalence fiscal stimulus has no macro-economic impact, since forward-looking households anticipate future tax increases and start saving today. The fiscal expansion is then exactly offset by decrease in private consumption. However, in practice Ricardian equivalence fails, because households have finite lives, taxation is distortionary, capital and insurance markets fail, and households may be subject to behavioural biases (e.g., hyperbolic discounting). When Ricardian equivalence fails, a fiscal expansion boosts aggregate demand in the short run.

are severe or when the economy is in a liquidity trap. The reason is that households and firms already increase consumption and investment today when they anticipate higher future incomes (Fernández-Villaverde et al., 2011; Eggertsson, Ferrero and Raffo, 2014). As a result, the IS-curve may shift towards the right when structural reforms are very powerful to raise incomes. Hence, when intertemporal effects are strong enough, structural reforms can also boost aggregate demand in the short run. The paradox of toil does not necessarily occur, hence the economy does not need to stagnate.

Moreover, income may be structurally higher in a more flexible economy. As with structural reforms, forward-looking households and firms then increase their consumption and investment level today. And, the IS-curve shifts to the right. If this positive impact on the IS-curve is strong enough, more flexibility can boost aggregate demand, also in the short run. Accordingly, the paradox of flexibility need not occur, see also Bhattarai, Eggertsson and Schoenle (2014). The empirical question, however, is how strong this positive effect can be in the short run. The structural benefits of greater flexibility in wages and prices may generally manifest themselves in the long run only. It can therefore be assumed that larger wage and price flexibility adversely effects the economy in the short run for economies in the liquidity trap or with severe balance-sheet problems.

5.3.3 Return to the long-run equilibrium

Most studies assume that the liquidity trap ends at some time in the future and that balance-sheet problems will ultimately be resolved, see, for example, Krugman (1998), Eggertsson and Woodford (2003) and Eggertsson and Krugman (2012). However, these assumptions may not be warranted. The most far-reaching conclusion from our IS/LM–AD/AS framework is that the economy does not return to its long-run equilibrium at all when it is in a liquidity trap and/or faces severe balance-sheet problems, but gets stuck in a (debt-)deflation scenario with economic stagnation. This result is also found in recent theoretical macro-economic models. In a fully micro-founded New Keynesian model, Werning (2012) shows that an economy in a liquidity trap can indeed become trapped into a stagnation scenario with ongoing recession and deflation, exactly as in our model. Eggertsson and Mehrotra (2014) develop a micro-founded model of how a deleveraging shock may cause secular stagnation from which the economy cannot escape without government intervention. Indeed, without government intervention, the economy will continue to contract, year after year.

Werning (2012) demonstrates that the economy can escape from a deflationary stagnation trap, only when households and firms expect a future economic boom. This is completely in line with our analysis. Indeed, the economy only escapes the liquidity trap and destructive (debt-)dynamics if the output gap becomes positive. Werning (2012) also shows that a destructive scenario with ongoing depression and deflation can be avoided if the central bank is able to commit to an expansionary monetary policy in the future, during periods after which the economy escaped from the liquidity trap. In our model we find as well that the stagnation trap can be avoided by a long-run commitment to expansionary monetary policy in the future via unconventional monetary policy μ.

Finally, sufficiently strong positive demand shocks in the future could generate the economic boom that is necessary to close the output gap, so that the zero lower bound is no longer binding. This could be driven by external shocks in aggregate demand, such as an increase in

world trade or positive shocks to consumer and business confidence. A similar argument applies to balance-sheet problems. It is conceivable that they sufficiently resolve themselves without further government intervention. However, macro-economic adjustment then takes longer, which raises the risk of semi-permanent stagnation with large associated economic costs. The most important lesson for policymakers is, therefore, that not intervening in an economy in a liquidity trap or when balance-sheet problems are severe, is not only economically damaging, but also runs risk of landing the economy in secular stagnation.

References

Asso, P., G. Kahn and R. Leeson, 2012. The Taylor-rule and the Practice of Central Banking, in: E. Koenig, R. Leeson and G. Kahn, *The Taylor-rule and the Transformation of Monetary Policy*, chapter 3, Hoover Institution, Stanford University. [link]

Auerbach, A. and Y. Gorodnichenko, 2012, Measuring the Output Responses to Fiscal Policy, *American Economic Journal: Economic Policy,* vol. 4(2): pp. 1-27. [Link]

Bhattarai, S., G. Eggertsson and R. Schoenle, 2014, Is increased price flexibility stabilizing? Redux, NBER Working Paper 19886. [link]

Blanchard, O, 2005, *Macro-economics (4th Edition)*, Prentice Hall, Upper Saddle River, NJ.

Buiter, W., 2005, New Developments in Monetary Economics: Two Ghosts, Two Eccentricities, A Fallacy, a Mirage and a Mythos, *Economic Journal*, 'vol. 115: C1-C31. [link]

Buiter, W., 2014, The Simple Analytics of Helicopter Money: Why It Works — Always, *Economics: The Open-Access, Open-Assessment E-Journal*, vol. 8: 1-51. [link]

Christiano, L., M. Eichenbaum and S. Rebelo, 2011, When Is the Government Spending Multiplier Large?, *Journal of Political Economy*, vol. 119(1): 78-121. [link]

Corsetti, G., A. Meier and G.J. Müller, 2012, What determines government spending multipliers?, Economic Policy, vol. 27(72): pp. 521-565. [Link]

Corsetti, G., K. Kuester, A. Meier and G.J. Müller, 2013, Sovereign Risk, Fiscal Policy, and Macro-economic Stability, *The Economic Journal*, vol. 121(566): pp. F99-F132. [Link]

Eggertsson, G., 2006, The Deflation Bias and Committing to Being Irresponsible, *Journal of Money, Credit and Banking*, vol. 38(2): 283-321. [link]

Eggertsson, G., 2010, The Paradox of Toil, Federal Reserve Bank of New York Staff Report No. 433. [link]

Eggertsson, G., A. Ferrero and A. Raffo, 2014, Can structural reforms help Europe?, *Journal of Monetary Economics*, vol. 61(C): 2-22. [link]

Eggertsson, G. and P. Krugman, 2012, Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach, *Quarterly Journal of Economics*, vol. 127(3): 1469-1513. [link]

Eggertsson, G. and N. Mehrotra, 2014, A Model of Secular Stagnation, NBER Working Paper 20574. [link]

Fernández-Villaverde, J., P. Guerrón-Quintana, K. Kuester and J. Rubio-Ramírez, 2011, Fiscal Volatility Shocks and Economic Activity, NBER Working Paper 17317. [link]

Friedman, M., 1969, The Optimum Quantity of Money, in: *The Optimum Quantity of Money and Other Essays*, Chicago: Aldine Publishing Company.

Gali, J., 2015, *Monetary Policy, Inflation and the Business Cycle: An Introduction to the New Keynesian Framework*, Princeton University Press.

Gechert, S. and H. Will, 2012, Fiscal Multipliers: A Meta Regression Analysis, IMK Working Paper 97, [Link]

Hall, R., 2013, The routes into and out of the zero lower bound, Presented at the 2013 Jackson Hole conference. [link]

Hebous, S., 2011, The Effects of Discretionary Fiscal Policy on Macro-economic Aggregates: A Reappraisal, Journal of Economic Surveys, vol. 25(4): pp. 674-707, [Link]

Hicks, J., 1937, Mr. Keynes and the Classics: A Suggested Interpretation, *Econometrica*, vol. 5(2): 147-159.

Jorda, O. and M.A. Taylor, 2013, The Time for Austerity: Estimating the Average Treatment Effect of Fiscal Policy, mimeo, [Link]

Kalecki, M., 1944, Professor Pigou on "The Classical Stationary State" A Comment, *Economic Journal*, vol. 54 (213): 131-132. [link]
Keynes, J., 1936, *A general theory of employment, interest and money*, Macmillan, London.

Krugman, P., 1998, It's Baaack: Japan's Slump and the Return of the Liquidity Trap, Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, vol. 29(2): 137-206. [link]

Lucas, R., 1976, Econometric Policy Evaluation: A Critique, Carnegie-Rochester, *Conference Series on Public Policy*, vol. 1(1): 19–46. [link]

Lukkezen, J. and C. Kool, 2015, Lessons learnt from seven years of stagnation in the Eurozone, CPB Policy Brief 2015/9. [link]

Lukkezen, J., 2013, Vraag en antwoord over de begrotingsmultiplier, CPB Achtergronddocument 15 september 2013. [link] (in Dutch)

Martin, C. and C. Milas, 2004, Modelling Monetary Policy: Inflation Targeting in Practice, *Economica*, vol. 71(282): 209-221. [link]

Michaillat, P. and E. Saez, 2015, An Economical Business-Cycle Model, mimeo: London School of Economics/University of California, Berkeley. [link]

Muellbauer, J., 2014, Combatting Eurozone deflation: QE for the people, VoxEU blog 23 december 2014. [link]

Neuteboom, N. and J. Lukkezen, 2015, Structurele determinanten van de groei in Europa, CPB Achtergronddocument, 5 juni 2015. [link] (in Dutch)

Pigou, A. C. 1943, The Classical Stationary State, *Economic Journal*, vol. 53 (212): 343-351. [link]

Ramey, V., 2011, Identifying Government Spending Shocks: It's all in the Timing, *Quarterly Journal of Economics*, vol. 126(1): 1-50. [link]

Roeger, W. and J. in 't Veld, 2013. Expected sovereign defaults and fiscal consolidations, European Economy - Economic Papers 479, [Link]

Romer, D., 2000, Keynesian Macro-economics without the LM-curve, *Journal of Economic Perspectives*, 14 (2): vol. 149-169. [link]

Romer D., 2013, Short-Run Fluctuations, mimeo: University of California, Berkeley. [link]

Samuelson, P., 1955, *Economics (3rd ed.),* McGraw-Hill, New York, NY.

Summers, L., 2014, US Economic Prospects: Secular Stagnation, Hysteresis and the Zero Lower Bound, speech delivered to the National Association for Business Economics' Economic Policy Conference, 24 February 2014. [link]

Werning, I., 2012, Managing a Liquidity Trap: Monetary and Fiscal Policy, mimeo: MIT. [link]

Woodford, M., 2003, *Interest and Prices*, Princeton: Princeton University Press.

Woodford, M., 2012, Methods of Policy Accommodation at the Interest-Rate Lower Bound, mimeo, Columbia University. [link]

Appendix: Analytical solution open economy IS/MP–AD/AS model

The IS/MP model is described as:

$$Y_t = C(Y_t - T_t, r_t, W_t/(1+\pi_t)) + I(Y_t, r_t) + G_t + F_t(r_t) = f(Y_t, r_t, W_t/(1+\pi_t), G_t, T_t)$$

and

$$\begin{aligned} i_t^T > 0: \quad & r_t = (\alpha - 1)\pi_t^e + \beta(Y_t - Y^*), \\ i_t^T < 0: \quad & r_t = -\pi_t^e, \end{aligned}$$

with $1 > f_Y > 0$, $f_r < 0$, $f_W > 0$, $f_G > 0$ and $f_T < 0$, $i_t^T = \alpha\pi_t^e + \beta(Y_t - Y^*)$, $\alpha > 1$, $\beta > 0$, and $\pi_t^e = g(\pi_t, \mu_t)$, with $g_\pi > 0$ and $g_\mu > 0$. Note that f_r is smaller in an open economy than in a closed one, and in both cases it is smaller than zero.

Totally differentiating the IS-curve yields (time subscripts are omitted):

$$dY = \frac{1}{1 - f_Y}\left[f_r dr - \frac{f_W W}{(1+\pi)^2}d\pi + \frac{f_W}{1+\pi}dW + f_G dG + f_T dT\right].$$

Totally differentiating the MP-curve gives:

$$\begin{aligned} i_t^T > 0: \quad & dr = (\alpha - 1)g_\pi d\pi + (\alpha - 1)g_\mu d\mu + \beta \mathrm{dY}, \\ i_t^T < 0: \quad & dr = -g_\pi d\pi - g_\mu d\mu. \end{aligned}$$

When the zero lower bound is not binding (normal situation), we have $i_t^T > 0$. We obtain the AD-curve by eliminating dr in the differentiated IS-curve:

$$i_t^T > 0: \quad dY = \frac{1}{1 - f_Y - f_r\beta}\left[\left(f_r(\alpha - 1)g_\pi - \frac{f_W W}{(1+\pi)^2}\right)d\pi + f_r(\alpha - 1)g_\mu d\mu + \frac{f_W}{1+\pi}dW + f_G dG + f_T dT\right],$$

where $1 - f_Y - f_r\beta > 0$. The AD-curve shifts outwards when government spending increases or taxation decreases, i.e., $dG > 0$ or $dT < 0$. Note also that a negative wealth shock, $dW < 0$, shifts the AD-curve inwards. The slope of the AD-curve is given by:

$$\left.\frac{d\pi}{dY}\right]_{i_t^T > 0} = \frac{1 - f_Y - f_r\beta}{f_r(\alpha - 1)g_\pi - \frac{f_W W}{(1+\pi)^2}}.$$

Note that the downward slope of the AD-curve will become smaller (less strongly declining) when net wealth is positive, $W > 0$. However, the slope of the AD-curve will become steeper when net wealth is negative, $W < 0$. The AD-curve may slope upwards, if negative wealth effects are strong enough, i.e., when $f_W W < f_r(\alpha - 1)g_\pi(1+\pi)^2$.

When the zero lower bound is binding we have $i_t^T < 0$. The AD-curve is found analogously by eliminating $dr = -g_\pi d\pi - g_\mu d\mu$ from the differentiated IS-curve:

$$i_t^T < 0: \quad dY = \frac{1}{1 - f_Y}\left[\left(-f_r g_\pi - \frac{f_W W}{(1+\pi)^2}\right)d\pi - f_r g_\mu d\mu + \frac{f_W}{1+\pi}dW + f_G dG + f_T dT\right].$$

Here, we derive an important difference compared to the normal situation where $i_t^T > 0$. The impacts of government spending *dG,* taxes *dT*, and net wealth *dW* on output *dY* are larger because the denominators are smaller (i.e., 'multipliers' are larger) than normal: $1 - f_Y - f_r\beta > 1 - f_Y$. The reason is that there are no crowding-out effects when aggregate demand rises, since the central bank does not increase nominal interest rate. The slope of the AD-curve now equals:

$$\left.\frac{d\pi}{dY}\right]_{i_t^T<0} = \frac{1 - f_Y}{-\left[f_r g_\pi + \frac{f_W W}{(1+\pi)^2}\right]}.$$

In the absence of wealth effects, $f_W = 0$, the AD-curve slopes upwards, $f_r < 0$, instead of downwards. When wealth effects are present and net wealth is positive, $W > 0$, the AD-curve is still upward sloping, but becomes steeper. Very strong positive wealth effects can thus make the the AD-curve downward sloping, as under normal conditions. This is the case when $-f_r g_\pi < \frac{f_W W}{(1+\pi)^2}$. However, if net wealth is negative, $W < 0$, the slope of the AD-curve is still upward sloping, but less steeply. Lower inflation then leads to a larger decrease in income.

The AS-curve is given by:

$$\pi_t = \pi_{t-1} + \gamma(Y_t - Y^*).$$

The totally differentiated AS-curve at time *t* (note that π_{t-1} is given at time *t* and does not change – and that time subscripts have been omitted) is then:

$$d\pi = d\pi_{-1} + \gamma dY$$

When solve for the change in inflation and income, in the normal situation, then we find:

$$i_t^T > 0: \quad dY = \frac{1}{1 - f_Y - f_r\beta - \gamma g_\pi\left(f_r(\alpha - 1)g_\pi - \frac{f_W W}{(1+\pi)^2}\right)} \times \left[\frac{f_W}{1+\pi}dW + f_G dG + f_T dT + \left(f_r(\alpha - 1)g_\pi - \frac{f_W W}{(1+\pi)^2}\right)d\pi_{-1} + f_r(\alpha - 1)g_\mu d\mu\right]$$

And, in a liquidity trap, we find:

$$i_t^T < 0: \quad dY = \frac{1}{1 - f_Y - \gamma g_\pi\left(-f_r - \frac{f_W W}{(1+\pi)^2}\right)} \times \left[\frac{f_W}{1+\pi}dW + f_G dG + f_T dT + \left(-f_r g_\pi - \frac{f_W W}{(1+\pi)^2}\right)d\pi_{-1} - f_r g_\mu d\mu\right].$$

We excluded the theoretical possibility that the denominator in the fraction is zero or negative. In that case, the AD-curve would become steeper than the AS-curve. This case would occur if the interest-rate sensitivity of demand would be very high (f_r very negative) and wealth would become very negative ($W << 0$). See also Eggertsson and Krugman (2012), who also excluded this case.

Note also that, when wealth effects are negative, the effects of spending, *dG, dT*, and wealth, *dW*, on output, *dY*, are larger because the denominators are smaller ('multipliers' are larger) than in the normal case: $-f_W W/(1+\pi)^2 > 0$.

The downward adjustment of the AS-curve follows immediately. If inflation is lower in the previous period, the AS-curve will shift downwards by $d\pi_{-1}$. Under normal conditions, this raises output in the next period, because $\left(f_r(\alpha - 1)g_\pi - \frac{f_W W}{(1+\pi)^2}\right)$ is negative. In a liquidity trap or with severe balance-sheet problems, this expression is positive and output will decrease when the AS-curve shifts downwards.

Publisher:

CPB Netherlands Bureau for Economic Policy Analysis
P.O. Box 80510 | 2508 GM The Hague
T +31 70 3383 380

info@cpb.nl | www.cpb.nl

August 2016