A diagramatic solution of the NK model with inflation (loosely based on Williamson's book)

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1   Introduction

Here we extend the analysis in Williamson's book by plotting the several figures simultaneously. The left half of below represents actual outcomes in the presence of sticky prices, while the right half shows the flexible-price equivalent values (these have the superscript n to denote natural values). We assume that expected inflation is equal to the inflation target in the analysis that follows.[1]

1.1   A nominal interest rate shock

The effects are shown in the first figure below. Before any shocks, the economy is at point a so that flexible and sticky price outcomes are the same (the output gap is zero). A sudden decrease in the nominal interest rate by the central bank (this is a nominal shock).

- lowers the real interest rate and as panel 2a shows, output increases (due to a rise in consumption and investment). To understand why the real interest rate falls, recall the Fisher equation: $r = R - \pi'$. With expected future inflation assumed exogenous, real and nominal rates move one-for-one;

- the increase in output leads to an increase in inflation (panel 1c, the NKPC);

- nothing has happened to the production function so the increase in output is obtained by increases in employment;

- the monetary policy action affected the real interest rate only because of the sticky-price assumption but the flexible-price version of the model (the natural values) remain unaffected. Hence, the right half of the figure is unchanged. As a result, Y^n remains at a but Y has risen: output is greater than its flexible price counterpart. In other words, monetary policy is non-neutral.

In summary, an unexpected temporary decrease in the nominal interest rate leads to an increase in output and inflation but leaves the flexible-price level of output unaffected. You can easily work out the effects on wages, employment, etc. In addition, as output is now above its flexible price level, $x = Y - Y^n$ is now positive (Williamson calls this a negative output gap).

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[1]I did not include the labour market under sticky prices but it is easy to see what is happening there.

(a) IS   (b) IS-RBC

(c) Phillips curve   (d) Rotation   (e) Prod. function

(f) Prod. function   (g) Rotation   (h) Output gap   (i) Labour market
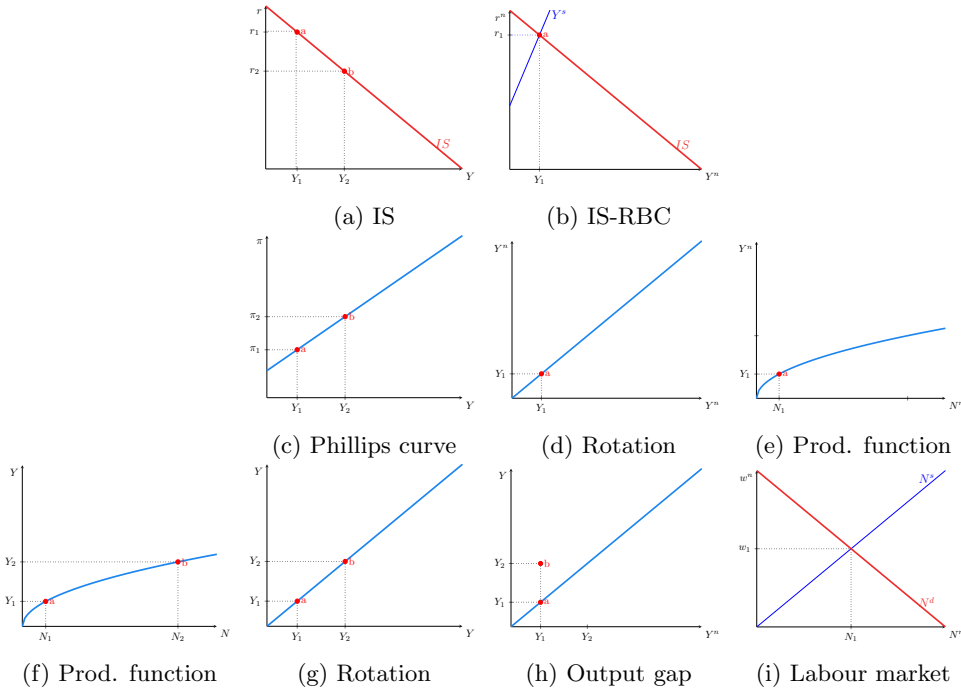
Figure 1: A shock to the nominal interest rate

2   A shock to the natural rate of interest

Consider a shock, such as an increase in current TFP, that shifts output supply downwards so that both the natural rate of interest falls and Y^n rises. The changes in the natural values/rates are presented by the move from a to b in the second figure.

- The flex-price side of the model shows that the increase in output and fall in the interest rate is accompanied by an increase in employment (both supply and demand increase, driven by the latter).

- While the shock represents a move along the IS, the Phillips curve shifts to PC_2 as the natural level of output has increased.

- The model is missing one equation: that representing the behaviour of the central bank regarding the setting of the nominal interest rate. Consequently, the analysis that follows is contingent on an 'if then' sequence.

- If the central bank does not change the nominal interest rate (and hence the real rate), equilibrium in the IS is given by (Y_1, r_1). In other words, output does not change (so that it is below its flex-price level; a recession).

- Given the above, we have the same level of output but the Phillips curve has shifted down: inflation is now below its target.

- From the production function, employment is below its natural level.

- Lastly, from panel h, $Y < Y^n$.

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(a) IS (b) IS-RBC

(c) Phillips curve (d) Rotation (e) Prod. function

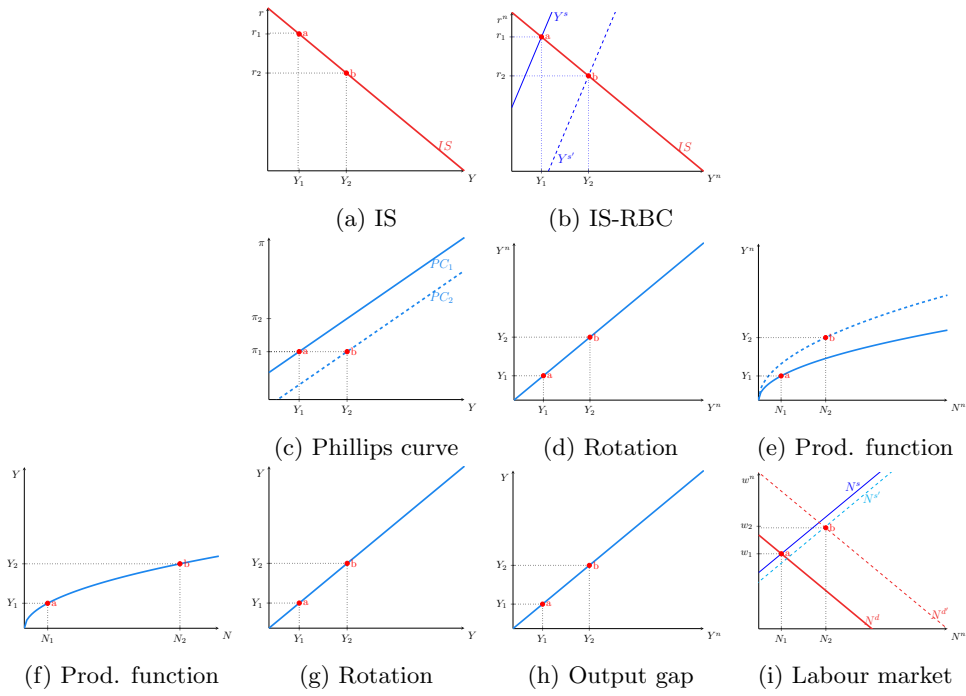(f) Prod. function (g) Rotation (h) Output gap (i) Labour market

Figure 2: A shock to the natural rate of interest (via TFP)