

The effect of monetary shocks



Outline

- Monetary policy decisions
- Money market
- Goods market
- Equilibrium
- Summary

■ Monetary policy decisions

■ Money market

■ Goods market

■ Equilibrium

■ Summary

Changes in money supply

Changes in money supply

- ▶ Monetary policy decisions by the central bank encompass decisions on **interest rates**

Changes in money supply

- ▶ Monetary policy decisions by the central bank encompass decisions on interest rates and **money supply**

Changes in money supply

- ▶ Monetary policy decisions by the central bank encompass decisions on interest rates and money supply
- ▶ If money supply is increased, the **price level** should increase

Changes in money supply

- ▶ Monetary policy decisions by the central bank encompass decisions on interest rates and money supply
- ▶ If money supply is increased, the price level should increase if the output is **given**

Changes in money supply

- ▶ Monetary policy decisions by the central bank encompass decisions on interest rates and money supply
- ▶ If money supply is increased, the price level should increase if the output is given
- ▶ From **purchasing power parity**, the exchange should adjust as well

Changes in money supply

- ▶ Monetary policy decisions by the central bank encompass decisions on interest rates and money supply
- ▶ If money supply is increased, the price level should increase if the output is given
- ▶ From purchasing power parity, the exchange should adjust as well
- ▶ However, prices will generally **not adjust quickly**

Changes in money supply

- ▶ Monetary policy decisions by the central bank encompass decisions on interest rates and money supply
- ▶ If money supply is increased, the price level should increase if the output is given
- ▶ From purchasing power parity, the exchange should adjust as well
- ▶ However, prices will generally not adjust quickly

Responses to changes in the money supply

Responses to changes in the money supply

- ▶ Changing the money supply changes **price levels** if there is full employment as output is given

Responses to changes in the money supply

- ▶ Changing the money supply changes price levels if there is full employment as output is given
- ▶ As prices only adjust slowly, the economy will **not be in equilibrium** immediately

Responses to changes in the money supply

- ▶ Changing the money supply changes price levels if there is full employment as output is given
- ▶ As prices only adjust slowly, the economy will not be in equilibrium immediately
- ▶ To ensure markets clear, **other adjustments** are needed

Responses to changes in the money supply

- ▶ Changing the money supply changes price levels if there is full employment as output is given
- ▶ As prices only adjust slowly, the economy will not be in equilibrium immediately
- ▶ To ensure markets clear, other adjustments are needed
- ▶ The **exchange rate** is a variable that can adjust quickly

Responses to changes in the money supply

- ▶ Changing the money supply changes price levels if there is full employment as output is given
- ▶ As prices only adjust slowly, the economy will not be in equilibrium immediately
- ▶ To ensure markets clear, other adjustments are needed
- ▶ The exchange rate is a variable that can adjust quickly

■ Monetary policy decisions

■ Money market

■ Goods market

■ Equilibrium

■ Summary

Money demand

Money demand

- ▶ Real money demand depends on the interest rate
- ▶ $\frac{M}{P} = (1 + r)$

Money demand

► Real money demand depends on the interest rate and output

► $\frac{M}{P} = (1 + r) Y$

Money demand

- ▶ Real money demand depends on the interest rate and output, with their respective elasticities
- ▶ $\frac{M}{P} = (1 + r)^{\varepsilon_r} Y^{\varepsilon_Y}$

Money demand

- ▶ Real money demand depends on the interest rate and output, with their respective elasticities
- ▶ $\frac{M}{P} = (1 + r)^{\varepsilon_r} Y^{\varepsilon_Y}$
- ▶ Interest rate parity holds and the exchange rate change is the difference between domestic and foreign interest rates: $\Delta e = r - r^*$

Money demand

- ▶ Real money demand depends on the interest rate and output, with their respective elasticities
- ▶ $\frac{M}{P} = (1 + r)^{\varepsilon_r} Y^{\varepsilon_Y}$
- ▶ Interest rate parity holds and the exchange rate change is the difference between domestic and foreign interest rates: $\Delta e = r - r^*$

$$\Rightarrow \ln M - \ln P = \varepsilon_r r + \varepsilon_Y \ln Y$$

Money demand

- ▶ Real money demand depends on the interest rate and output, with their respective elasticities
 - ▶ $\frac{M}{P} = (1 + r)^{\varepsilon_r} Y^{\varepsilon_Y}$
 - ▶ Interest rate parity holds and the exchange rate change is the difference between domestic and foreign interest rates: $\Delta e = r - r^*$
- $\Rightarrow \ln M - \ln P = \varepsilon_r r + \varepsilon_Y \ln Y$
- $\Rightarrow \ln P - \ln M = \varepsilon_r (\Delta e + r^*) - \varepsilon_Y \ln Y$

Money demand

- ▶ Real money demand depends on the interest rate and output, with their respective elasticities
 - ▶ $\frac{M}{P} = (1 + r)^{\varepsilon_r} Y^{\varepsilon_Y}$
 - ▶ Interest rate parity holds and the exchange rate change is the difference between domestic and foreign interest rates: $\Delta e = r - r^*$
- ⇒ $\ln M - \ln P = \varepsilon_r r + \varepsilon_Y \ln Y$
- ⇒ $\ln P - \ln M = \varepsilon_r (\Delta e + r^*) - \varepsilon_Y \ln Y$

Exchange rate change

Exchange rate change

- ▶ The equilibrium requires that exchange rates are stable, $\Delta e = 0$

Exchange rate change

- The equilibrium requires that exchange rates are stable, $\Delta e = 0$, at some **price level** \bar{P}

Exchange rate change

- ▶ The equilibrium requires that exchange rates are stable, $\Delta e = 0$, at some price level \bar{P}
- ▶ The output we assume to be **fixed** due to full employment

Exchange rate change

- ▶ The equilibrium requires that exchange rates are stable, $\Delta e = 0$, at some price level \bar{P}
- ▶ The output we assume to be fixed due to full employment
- ▶ Money demand: $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$

Exchange rate change

- ▶ The equilibrium requires that exchange rates are stable, $\Delta e = 0$, at some price level \bar{P}
 - ▶ The output we assume to be fixed due to full employment
 - ▶ Money demand: $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$
- $\Rightarrow \ln P - \ln \bar{P} = \varepsilon_r \Delta e$

Exchange rate change

- ▶ The equilibrium requires that exchange rates are stable, $\Delta e = 0$, at some price level \bar{P}
 - ▶ The output we assume to be fixed due to full employment
 - ▶ Money demand: $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$
- $\Rightarrow \ln P - \ln \bar{P} = \varepsilon_r \Delta e$
- $\Rightarrow \Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$

Exchange rate change

- ▶ The equilibrium requires that exchange rates are stable, $\Delta e = 0$, at some price level \bar{P}
- ▶ The output we assume to be fixed due to full employment
- ▶ Money demand: $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$
- $\Rightarrow \ln P - \ln \bar{P} = \varepsilon_r \Delta e$
- $\Rightarrow \Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$
- ▶ The exchange rate **decreases** if the current prices are below their equilibrium level

Exchange rate change

- ▶ The equilibrium requires that exchange rates are stable, $\Delta e = 0$, at some price level \bar{P}
- ▶ The output we assume to be fixed due to full employment
- ▶ Money demand: $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$
- $\Rightarrow \ln P - \ln \bar{P} = \varepsilon_r \Delta e$
- $\Rightarrow \Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$
- ▶ The exchange rate decreases if the current prices are below their equilibrium level

■ Monetary policy decisions

■ Money market

■ Goods market

■ Equilibrium

■ Summary

Demand in goods markets

Demand in goods markets

- ▶ Demand depends on the relative prices of goods
- ▶ $D = \left(\frac{eP^*}{P} \right)$

Demand in goods markets

► Demand depends on the relative prices of goods, output

► $D = \left(\frac{eP^*}{P} \right) Y$

Demand in goods markets

- ▶ Demand depends on the relative prices of goods, output, and interest rates

- ▶ $D = \left(\frac{eP^*}{P} \right) Y (1 + r)$

Demand in goods markets

- ▶ Demand depends on the relative prices of goods, output, and interest rates, with their respective elasticities
- ▶ $D = \left(\frac{eP^*}{P}\right)^{\hat{\epsilon}_P} Y^{\hat{\epsilon}_Y} (1+r)^{\hat{\epsilon}_r}$

Demand in goods markets

- ▶ Demand depends on the relative prices of goods, output, and interest rates, with their respective elasticities

- ▶ $D = \left(\frac{eP^*}{P}\right)^{\hat{\varepsilon}_P} Y^{\hat{\varepsilon}_Y} (1+r)^{\hat{\varepsilon}_r}$

$$\Rightarrow \ln D = \hat{\varepsilon}_P (\ln e - \ln P + \ln P^*) + \hat{\varepsilon}_Y \ln Y + \hat{\varepsilon}_r r$$

Demand in goods markets

- ▶ Demand depends on the relative prices of goods, output, and interest rates, with their respective elasticities
- ▶ $D = \left(\frac{eP^*}{P}\right)^{\hat{\epsilon}_P} Y^{\hat{\epsilon}_Y} (1+r)^{\hat{\epsilon}_r}$
- ⇒ $\ln D = \hat{\epsilon}_P (\ln e - \ln P + \ln P^*) + \hat{\epsilon}_Y \ln Y + \hat{\epsilon}_r r$
- ▶ Prices adjust slowly to excess demand: $\Delta P = \lambda (\ln D - \ln Y)$

Demand in goods markets

- ▶ Demand depends on the relative prices of goods, output, and interest rates, with their respective elasticities
- ▶ $D = \left(\frac{eP^*}{P}\right)^{\hat{\epsilon}_P} Y^{\hat{\epsilon}_Y} (1+r)^{\hat{\epsilon}_r}$
- ⇒ $\ln D = \hat{\epsilon}_P (\ln e - \ln P + \ln P^*) + \hat{\epsilon}_Y \ln Y + \hat{\epsilon}_r r$
- ▶ Prices adjust slowly to excess demand: $\Delta P = \lambda (\ln D - \ln Y)$
- ▶ For simplicity we **normalise** the foreign price level such that $\ln P^* = 0$

Demand in goods markets

- ▶ Demand depends on the relative prices of goods, output, and interest rates, with their respective elasticities
- ▶ $D = \left(\frac{eP^*}{P}\right)^{\hat{\epsilon}_P} Y^{\hat{\epsilon}_Y} (1+r)^{\hat{\epsilon}_r}$
- ⇒ $\ln D = \hat{\epsilon}_P (\ln e - \ln P + \ln P^*) + \hat{\epsilon}_Y \ln Y + \hat{\epsilon}_r r$
- ▶ Prices adjust slowly to excess demand: $\Delta P = \lambda (\ln D - \ln Y)$
- ▶ For simplicity we normalise the foreign price level such that $\ln P^* = 0$

Inflation

Inflation

- From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$

Inflation

► From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$

$$\Rightarrow \Delta P = \lambda \left(\hat{\varepsilon}_P (\ln e - \ln P) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln P) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

Inflation

- ▶ From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$
- ⇒ $\Delta P = \lambda \left(\hat{\varepsilon}_P (\ln e - \ln P) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln P) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$
- ▶ The equilibrium requires that **prices are stable**, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}

Inflation

► From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$

$$\Rightarrow \Delta P = \lambda \left(\hat{\varepsilon}_P (\ln e - \ln P) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln P) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

► The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}

$$\Rightarrow 0 = \lambda \left(\hat{\varepsilon}_P (\ln \bar{e} - \ln \bar{P}) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln \bar{P}) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

Inflation

► From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$

$$\Rightarrow \Delta P = \lambda \left(\hat{\varepsilon}_P (\ln e - \ln P) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln P) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

► The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}

$$\Rightarrow 0 = \lambda \left(\hat{\varepsilon}_P (\ln \bar{e} - \ln \bar{P}) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln \bar{P}) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

$$\Rightarrow \Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

Inflation

► From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$

$$\Rightarrow \Delta P = \lambda \left(\hat{\varepsilon}_P (\ln e - \ln P) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln P) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

► The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}

$$\Rightarrow 0 = \lambda \left(\hat{\varepsilon}_P (\ln \bar{e} - \ln \bar{P}) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln \bar{P}) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

$$\Rightarrow \Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

► The price level increases if the current **exchange rate** is above the equilibrium

Inflation

► From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$

$$\Rightarrow \Delta P = \lambda \left(\hat{\varepsilon}_P (\ln e - \ln P) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln P) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

► The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}

$$\Rightarrow 0 = \lambda \left(\hat{\varepsilon}_P (\ln \bar{e} - \ln \bar{P}) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln \bar{P}) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

$$\Rightarrow \Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

► The price level increases if the current exchange rate is above the equilibrium and the **price level** is below its equilibrium

Inflation

► From the money demand we have $r = \frac{\ln P - \ln M + \varepsilon_Y \ln Y}{\varepsilon_r}$

$$\Rightarrow \Delta P = \lambda \left(\hat{\varepsilon}_P (\ln e - \ln P) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln P) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

► The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}

$$\Rightarrow 0 = \lambda \left(\hat{\varepsilon}_P (\ln \bar{e} - \ln \bar{P}) - \frac{\hat{\varepsilon}_r}{\varepsilon_r} (\ln M - \ln \bar{P}) + \left(\frac{\hat{\varepsilon}_r \varepsilon_Y}{\varepsilon_r} + \hat{\varepsilon}_Y - 1 \right) \ln Y \right)$$

$$\Rightarrow \Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

► The price level increases if the current exchange rate is above the equilibrium and the price level is below its equilibrium

■ Monetary policy decisions

■ Money market

■ Goods market

■ **Equilibrium**

■ Summary

Relationship between price level and exchange rate

Relationship between price level and exchange rate

- The equilibrium requires that **prices are stable**, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}

Relationship between price level and exchange rate

- ▶ The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}
- ▶ In equilibrium, **exchange rates are also stable**, $\Delta e = 0$, and from interest rate parity we then have $r = r^*$

Relationship between price level and exchange rate

- ▶ The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}
- ▶ In equilibrium, exchange rates are also stable, $\Delta e = 0$, and from interest rate parity we then have $r = r^*$

$$\Rightarrow \ln \bar{e} - \ln \bar{P} = \frac{-\hat{\epsilon}_r r^* + (1 - \hat{\epsilon}_Y) \ln Y}{\hat{\epsilon}_P}$$

Relationship between price level and exchange rate

- ▶ The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}
 - ▶ In equilibrium, exchange rates are also stable, $\Delta e = 0$, and from interest rate parity we then have $r = r^*$
- $$\Rightarrow \ln \bar{e} - \ln \bar{P} = \frac{-\hat{\varepsilon}_r r^* + (1 - \hat{\varepsilon}_Y) \ln Y}{\hat{\varepsilon}_P}$$
- ▶ In equilibrium, there is a **positive relationship** between the price level and exchange rate

Relationship between price level and exchange rate

- ▶ The equilibrium requires that prices are stable, $\Delta P = 0$, at some price level \bar{P} and exchange rate \bar{e}
 - ▶ In equilibrium, exchange rates are also stable, $\Delta e = 0$, and from interest rate parity we then have $r = r^*$
- $$\Rightarrow \ln \bar{e} - \ln \bar{P} = \frac{-\hat{\epsilon}_r r^* + (1 - \hat{\epsilon}_Y) \ln Y}{\hat{\epsilon}_P}$$
- ▶ In equilibrium, there is a positive relationship between the price level and exchange rate

Out-of equilibrium dynamics

Out-of equilibrium dynamics

- The **evolution** of the exchange rate and price level is given by

$$\Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$$

$$\Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

Out-of equilibrium dynamics

- ▶ The evolution of the exchange rate and price level is given by

$$\Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$$

$$\Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

- ▶ These equations characterise the relationship between price levels and exchange rates **outside of the equilibrium**

Out-of equilibrium dynamics

- ▶ The evolution of the exchange rate and price level is given by

$$\Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$$

$$\Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

- ▶ These equations characterise the relationship between price levels and exchange rates outside of the equilibrium
- ▶ The solution shows that the equilibrium is only reached if

$$\ln e - \ln \bar{e} = \frac{\xi + \lambda \left(\hat{\varepsilon}_P - \frac{\hat{\varepsilon}_r}{\varepsilon_r} \right)}{\hat{\varepsilon}_P} (\ln P - \ln \bar{P})$$

Out-of equilibrium dynamics

- ▶ The evolution of the exchange rate and price level is given by

$$\Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$$

$$\Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

- ▶ These equations characterise the relationship between price levels and exchange rates outside of the equilibrium
- ▶ The solution shows that the equilibrium is only reached if

$$\ln e - \ln \bar{e} = \underbrace{\frac{\xi + \lambda \left(\hat{\varepsilon}_P - \frac{\hat{\varepsilon}_r}{\varepsilon_r} \right)}{\hat{\varepsilon}_P}}_{<0} (\ln P - \ln \bar{P})$$

Out-of equilibrium dynamics

- ▶ The evolution of the exchange rate and price level is given by

$$\Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$$

$$\Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

- ▶ These equations characterise the relationship between price levels and exchange rates outside of the equilibrium
- ▶ The solution shows that the equilibrium is only reached if

$$\ln e - \ln \bar{e} = \underbrace{\frac{\xi + \lambda \left(\hat{\varepsilon}_P - \frac{\hat{\varepsilon}_r}{\varepsilon_r} \right)}{\hat{\varepsilon}_P}}_{<0} (\ln P - \ln \bar{P})$$

- ▶ The adjustment towards the equilibrium has a **negative slope**

Out-of equilibrium dynamics

- ▶ The evolution of the exchange rate and price level is given by

$$\Delta e = \frac{\ln P - \ln \bar{P}}{\varepsilon_r}$$

$$\Delta P = \lambda \hat{\varepsilon}_P (\ln e - \ln \bar{e}) + \lambda \left(\frac{\hat{\varepsilon}_r}{\varepsilon_r} - \hat{\varepsilon}_P \right) (\ln P - \ln \bar{P})$$

- ▶ These equations characterise the relationship between price levels and exchange rates outside of the equilibrium
- ▶ The solution shows that the equilibrium is only reached if

$$\ln e - \ln \bar{e} = \underbrace{\frac{\xi + \lambda \left(\hat{\varepsilon}_P - \frac{\hat{\varepsilon}_r}{\varepsilon_r} \right)}{\hat{\varepsilon}_P}}_{<0} (\ln P - \ln \bar{P})$$

- ▶ The adjustment towards the equilibrium has a negative slope

Impact of monetary policy

Impact of monetary policy

- ▶ From the money demand we had $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$

Impact of monetary policy

- ▶ From the money demand we had $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$
- ▶ An increase in the money supply will **increase the price** level due to the output being given

Impact of monetary policy

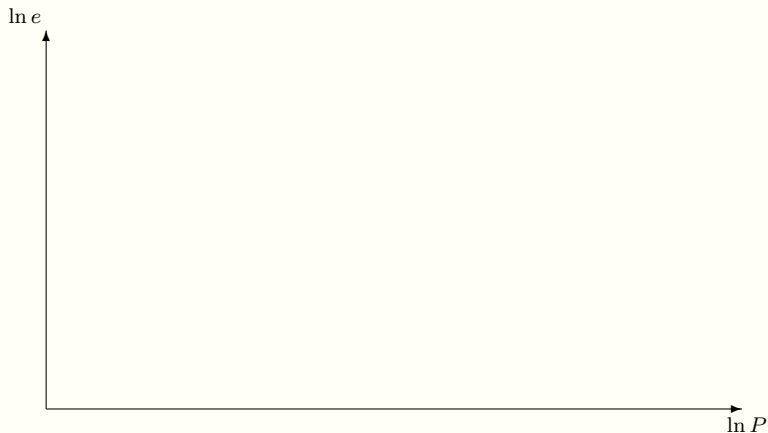
- ▶ From the money demand we had $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$
- ▶ An increase in the money supply will increase the price level due to the output being given
- ▶ From the relationship of exchange rates and price levels in equilibrium, this implies a **higher exchange** rate

Impact of monetary policy

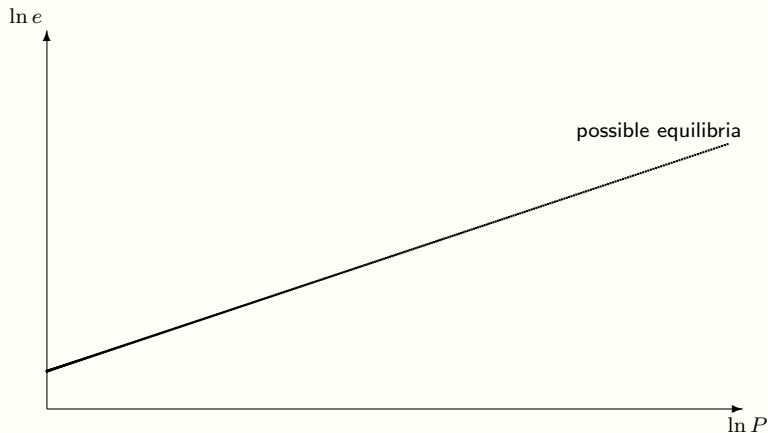
- ▶ From the money demand we had $\ln \bar{P} - \ln M = \varepsilon_r r^* - \varepsilon_Y \ln Y$
- ▶ An increase in the money supply will increase the price level due to the output being given
- ▶ From the relationship of exchange rates and price levels in equilibrium, this implies a higher exchange rate

Reaction to an increase in money supply

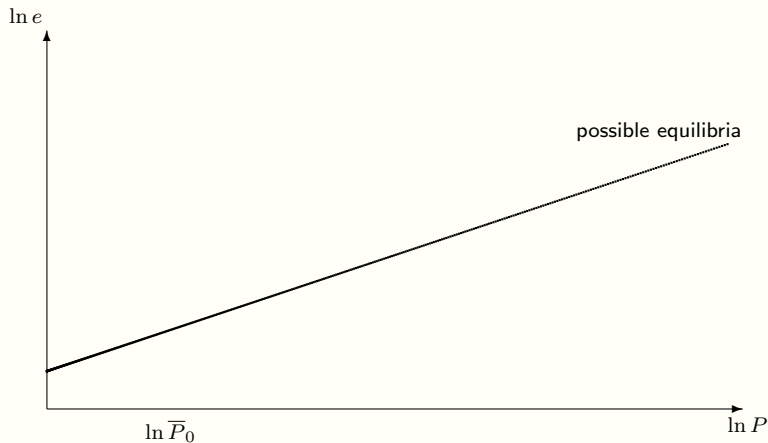
Reaction to an increase in money supply



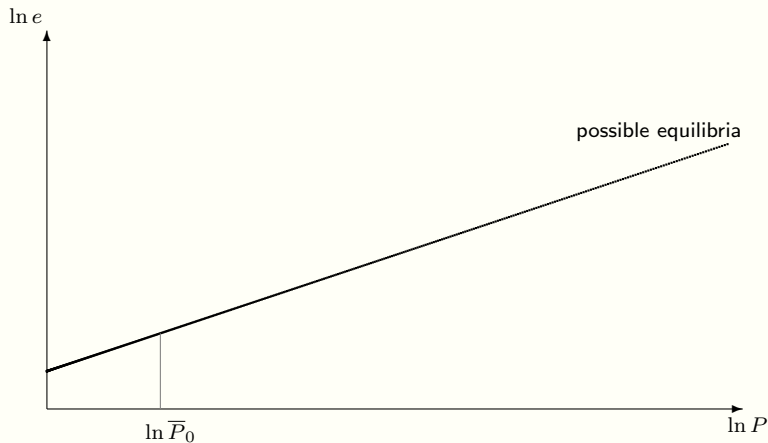
Reaction to an increase in money supply



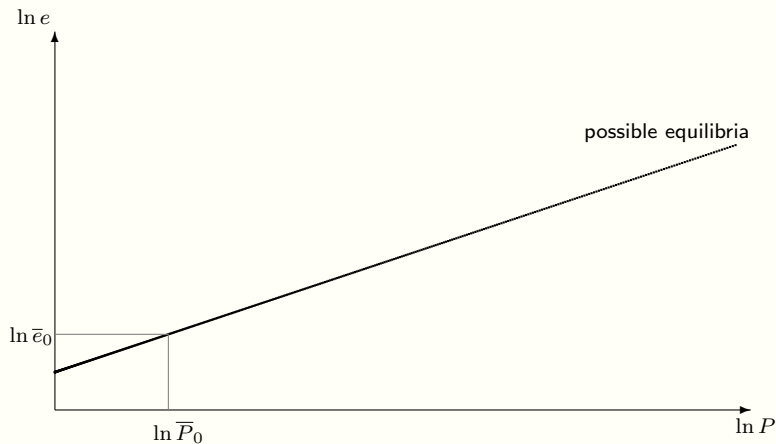
Reaction to an increase in money supply



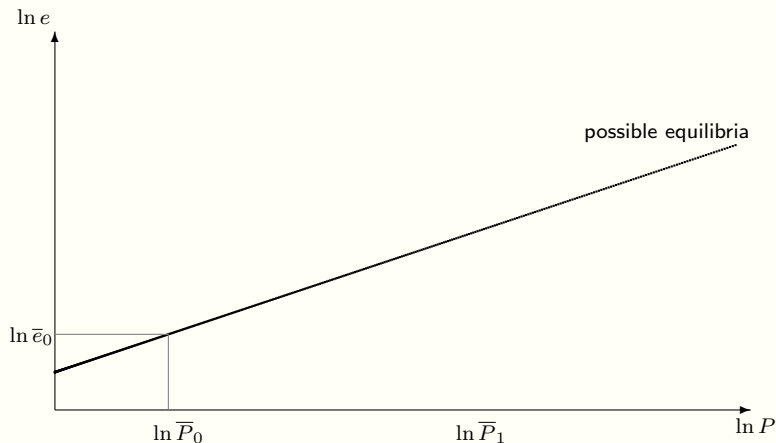
Reaction to an increase in money supply



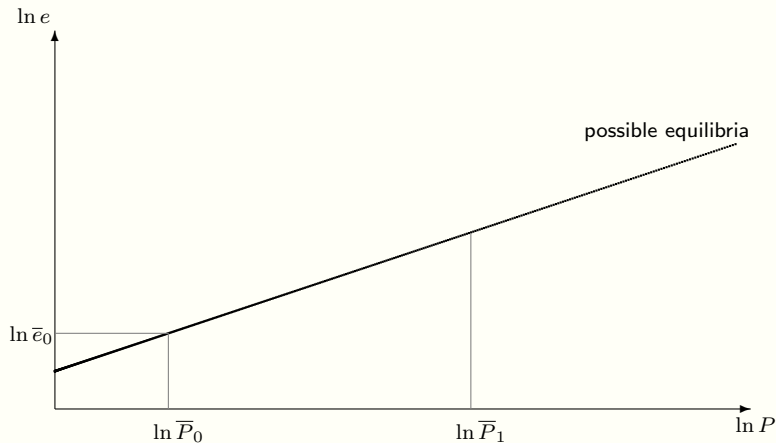
Reaction to an increase in money supply



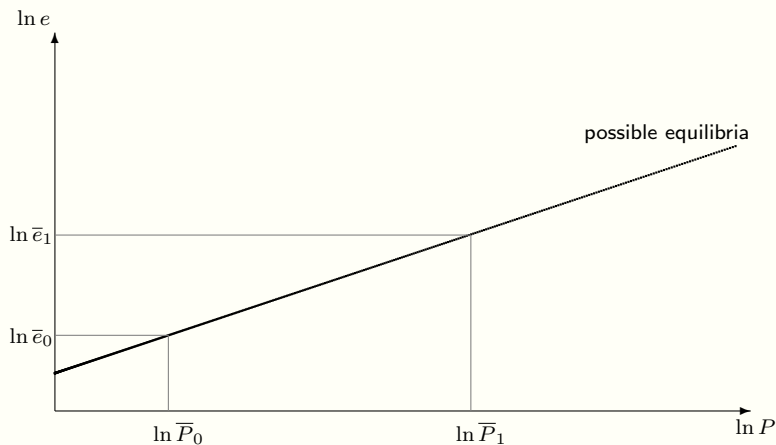
Reaction to an increase in money supply



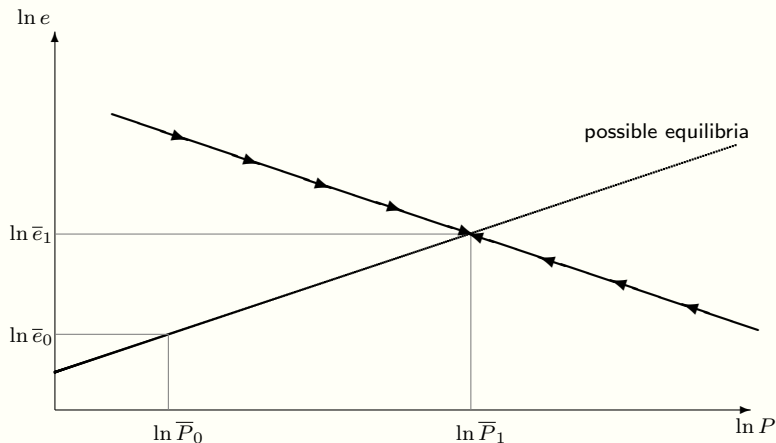
Reaction to an increase in money supply



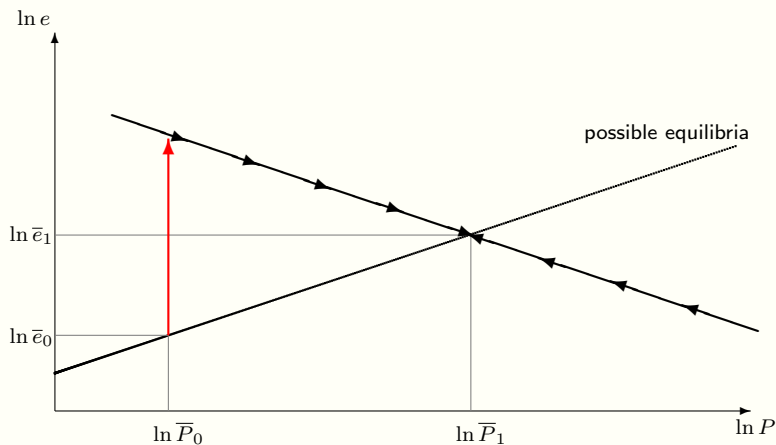
Reaction to an increase in money supply



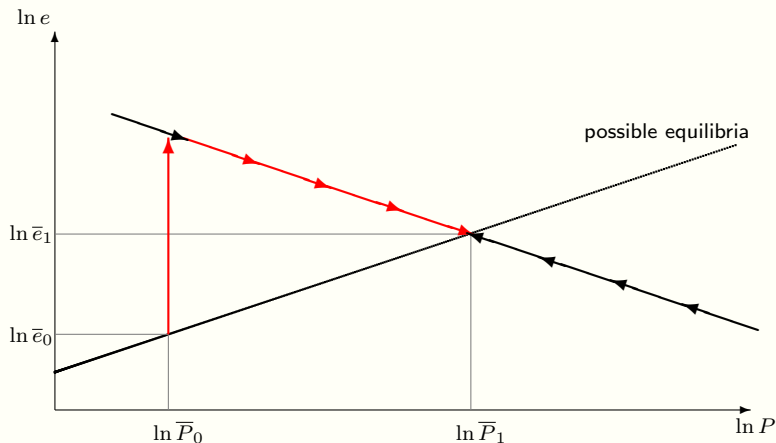
Reaction to an increase in money supply



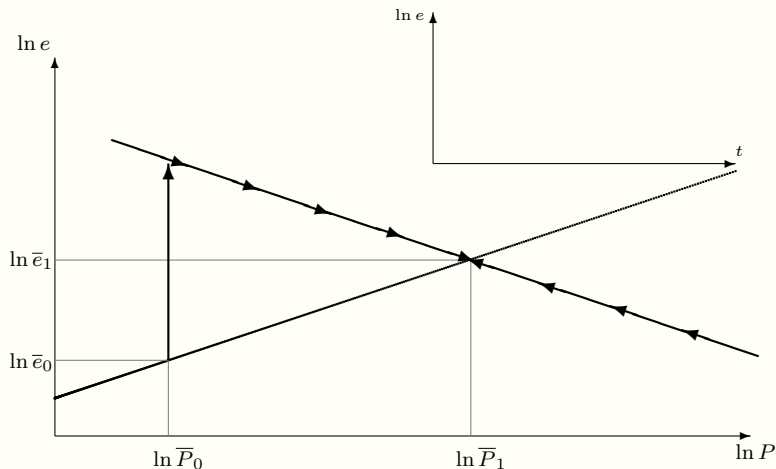
Reaction to an increase in money supply



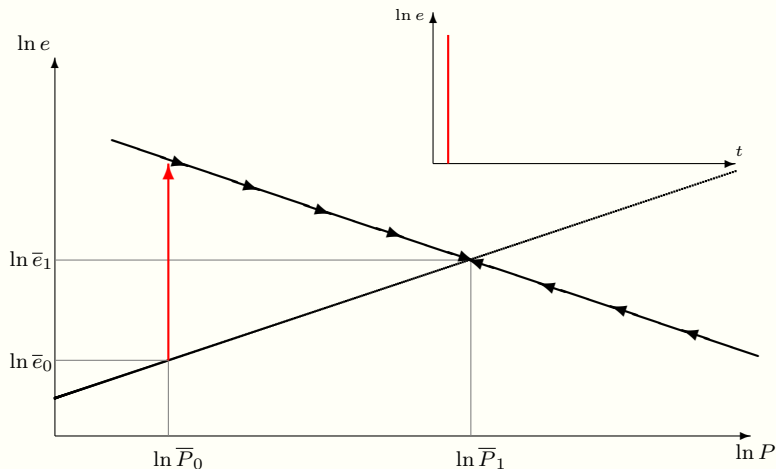
Reaction to an increase in money supply



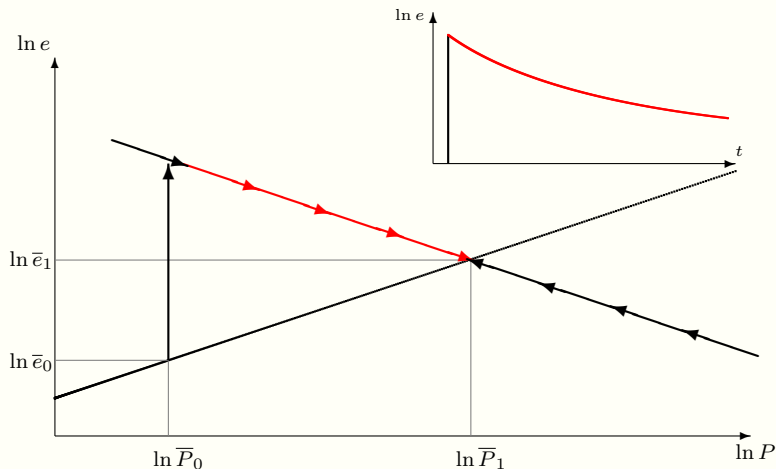
Reaction to an increase in money supply



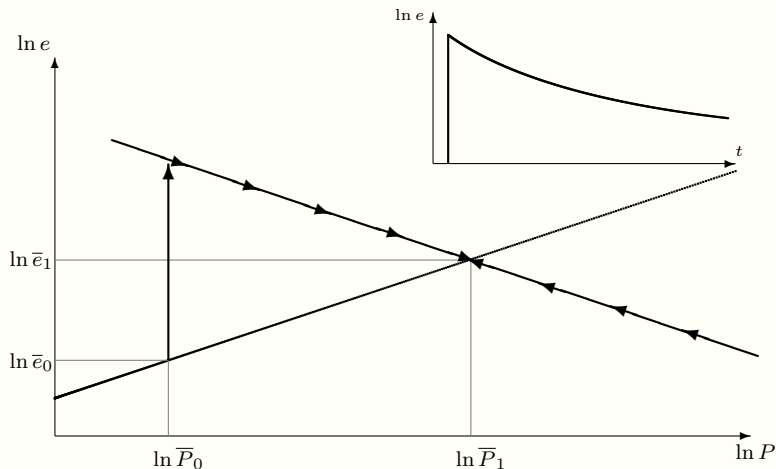
Reaction to an increase in money supply



Reaction to an increase in money supply



Reaction to an increase in money supply



Overshooting exchange rates

Overshooting exchange rates

- ▶ The exchange rate will adjust **quickly** to its new equilibrium path

Overshooting exchange rates

- ▶ The exchange rate will adjust quickly to its new equilibrium path
- ▶ As price levels adjust **slowly**, the exchange rate then adjusts **slowly** towards its equilibrium

Overshooting exchange rates

- ▶ The exchange rate will adjust quickly to its new equilibrium path
- ▶ As price levels adjust slowly, the exchange rate then adjusts slowly towards its equilibrium
- ▶ The exchange rate initially **overshoots** the equilibrium exchange rate and then slowly falls back

Overshooting exchange rates

- ▶ The exchange rate will adjust quickly to its new equilibrium path
- ▶ As price levels adjust slowly, the exchange rate then adjusts slowly towards its equilibrium
- ▶ The exchange rate initially overshoots the equilibrium exchange rate and then slowly falls back
- ▶ We have this large change in the exchange rate to compensate for the **lack of price adjustment**

Overshooting exchange rates

- ▶ The exchange rate will adjust quickly to its new equilibrium path
- ▶ As price levels adjust slowly, the exchange rate then adjusts slowly towards its equilibrium
- ▶ The exchange rate initially overshoots the equilibrium exchange rate and then slowly falls back
- ▶ We have this large change in the exchange rate to compensate for the lack of price adjustment
- ▶ Only once the prices adjust does the **exchange rate fall back** to its equilibrium value

Overshooting exchange rates

- ▶ The exchange rate will adjust quickly to its new equilibrium path
- ▶ As price levels adjust slowly, the exchange rate then adjusts slowly towards its equilibrium
- ▶ The exchange rate initially overshoots the equilibrium exchange rate and then slowly falls back
- ▶ We have this large change in the exchange rate to compensate for the lack of price adjustment
- ▶ Only once the prices adjust does the exchange rate fall back to its equilibrium value

Overshooting exchange rates

- ▶ The exchange rate will adjust quickly to its new equilibrium path
- ▶ As price levels adjust slowly, the exchange rate then adjusts slowly towards its equilibrium
- ▶ The exchange rate initially overshoots the equilibrium exchange rate and then slowly falls back
- ▶ We have this large change in the exchange rate to compensate for the lack of price adjustment
- ▶ Only once the prices adjust does the exchange rate fall back to its equilibrium value

Overshooting exchange rates

- ▶ The exchange rate will adjust quickly to its new equilibrium path
- ▶ As price levels adjust slowly, the exchange rate then adjusts slowly towards its equilibrium
- ▶ The exchange rate initially overshoots the equilibrium exchange rate and then slowly falls back
- ▶ We have this large change in the exchange rate to compensate for the lack of price adjustment
- ▶ Only once the prices adjust does the exchange rate fall back to its equilibrium value

■ Monetary policy decisions

■ Money market

■ Goods market

■ Equilibrium

■ Summary

Sticky prices

Sticky prices

- ▶ **Price levels** only adjust slowly to changes in the money supply

Sticky prices

- ▶ Price levels only adjust slowly to changes in the money supply
- ▶ **Exchange rates** will adjust instantaneously and put the economy on an equilibrium path

Sticky prices

- ▶ Price levels only adjust slowly to changes in the money supply
- ▶ Exchange rates will adjust instantaneously and put the economy on an equilibrium path
- ▶ The adjustment of the exchange rate is **more** than the new equilibrium requires

Sticky prices

- ▶ Price levels only adjust slowly to changes in the money supply
- ▶ Exchange rates will adjust instantaneously and put the economy on an equilibrium path
- ▶ The adjustment of the exchange rate is more than the new equilibrium requires
- ▶ As prices adjust slowly, the exchange rate also **slowly adjusts towards its equilibrium**

Sticky prices

- ▶ Price levels only adjust slowly to changes in the money supply
- ▶ Exchange rates will adjust instantaneously and put the economy on an equilibrium path
- ▶ The adjustment of the exchange rate is more than the new equilibrium requires
- ▶ As prices adjust slowly, the exchange rate also slowly adjusts towards its equilibrium

Exchange rates over-adjust

Exchange rates over-adjust

- ▶ In response to monetary policy **exchange rates** initially bear the full adjustments

Exchange rates over-adjust

- ▶ In response to monetary policy exchange rates initially bear the full adjustments
- ▶ As the **remainder of the economy** adjusts, exchange rates slowly fall back

Exchange rates over-adjust

- ▶ In response to monetary policy exchange rates initially bear the full adjustments
- ▶ As the remainder of the economy adjusts, exchange rates slowly fall back
- ▶ This leads to a **reversal** of the initially excessive exchange rate movement

Exchange rates over-adjust

- ▶ In response to monetary policy exchange rates initially bear the full adjustments
- ▶ As the remainder of the economy adjusts, exchange rates slowly fall back
- ▶ This leads to a reversal of the initially excessive exchange rate movement



Copyright © by Andreas Krause

Picture credits:

Cover: Tobias Deml, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons, https://upload.wikimedia.org/wikipedia/commons/2/26/Gaming-Wall-Street_BTS_Prodigium-266.jpg

Back: Michael Vadon, CC BY 2.0 <https://creativecommons.org/licenses/by/2.0/>, via Wikimedia Commons, [https://upload.wikimedia.org/wikipedia/commons/9/97/Manhattan\(NYC-New-York-City\)Skyline\(31769153946\).jpg](https://upload.wikimedia.org/wikipedia/commons/9/97/Manhattan(NYC-New-York-City)Skyline(31769153946).jpg)

Andreas Krause
Department of Economics
University of Bath
Claverton Down
Bath BA2 7AY
United Kingdom

E-mail: mnsak@bath.ac.uk