SciencesPo. | Department of Economics

International Macroeconomics
Master in International Economic Policy

Money, interest rates and nominal exchange rates

Lectures 3-4

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Lectures 3 and 4
Money, interest rates and nominal exchange rates

1. The exchange rate as a relative price
2. The Foreign Exchange Market (FOREX)
3. International interest parity conditions: theory and empirics
4. Monetary models of exchange rates

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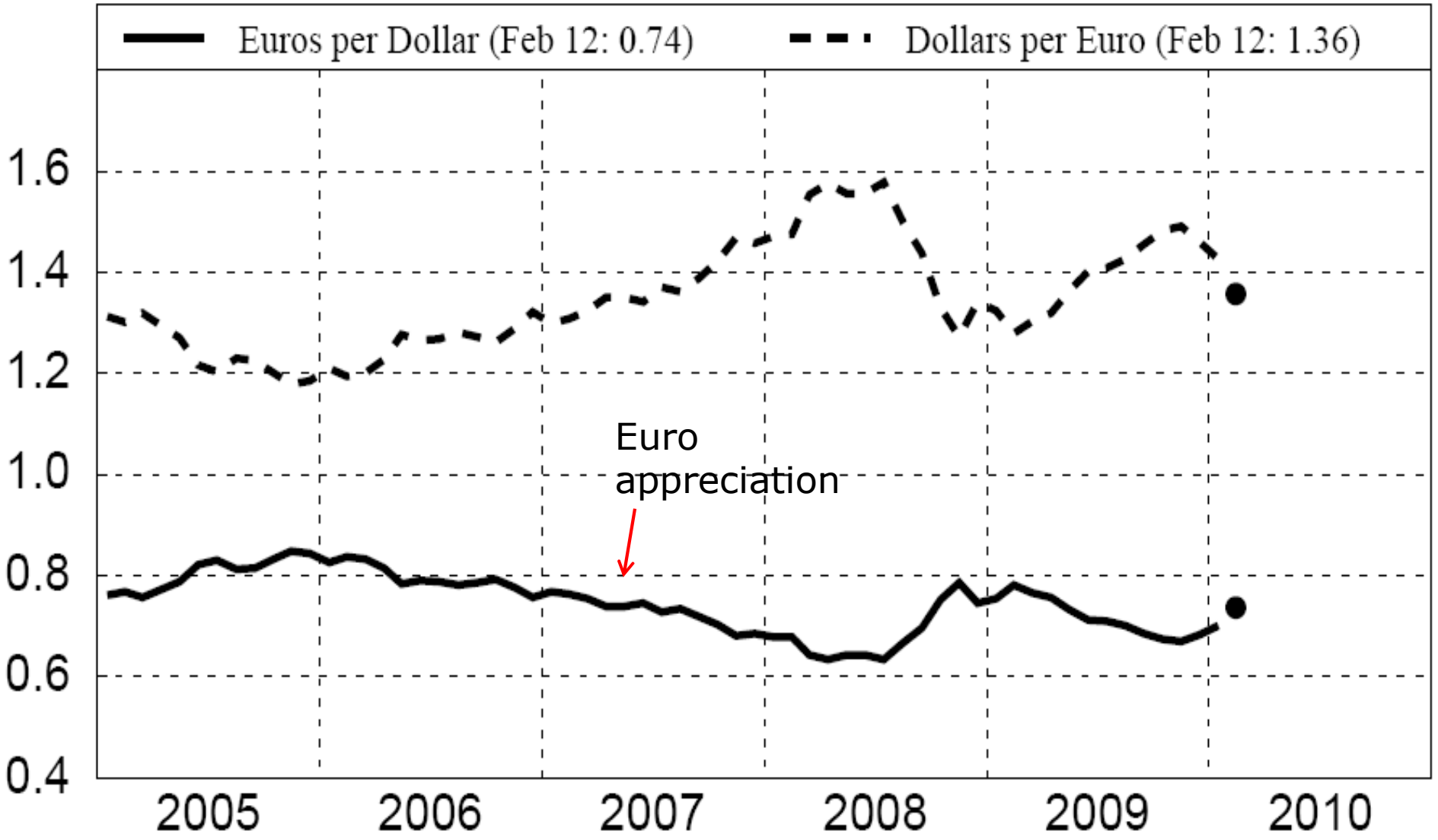
Basic notions: the exchange rate as a relative price

- Two types of quotation:
- E is the exchange rate of the euro/dollar: price of the foreign currency (dollar) in units of the domestic currency (euro)

  1 $ = E euros

  E increases means euro depreciates (it takes more euros to buy one dollar)
- E is the price of the domestic currency (euro) in units of the foreign currency (dollar)

  1 € = E $
- pure convention.
- In the following, we use the first (more standard, although not most intuitive) convention: **E increases means the euro depreciates.**


Euros per Dollar (Feb 12: 0.74)
Dollars per Euro (Feb 12: 1.36)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
Euro appreciation
2005
2006
2007
2008
2009
2010

Price conversion

$P_i^{\$}$: price of good *i* in dollar

- E is the exchange rate (nb of euros to make one $)
- $P_i^{€}$ price of good i converted in euro
- $P_i^{€} = E.\ P_i^{\$}$
- Remark:

  A depreciation of the euro (E) increases the price in euro of an American good (if the producer price $P_i^{\$}$ does not react)

  Decreases the price in $ of a European good (if the producer price in euro does not change)

Floating and fixed exchange rate regimes

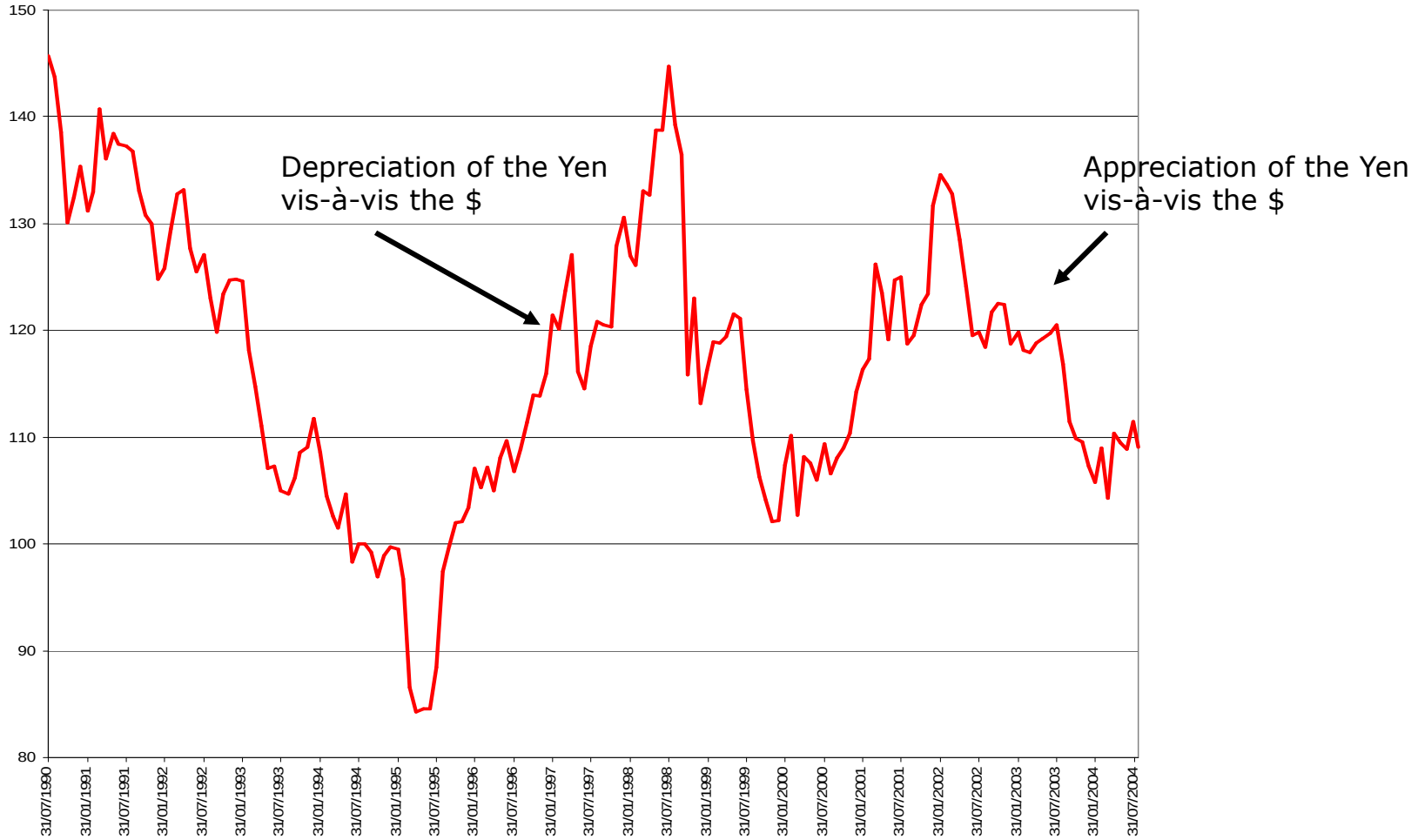
- **Floating:**

  The exchange rate is determined on exchange rate markets without interventions of central banks (euro/dollar)
- **Fixed :**

  Central banks intervene on markets to maintain the exchange rate at an announced level or around such a level (Gold standard at the end of 19th century, FF/DM, Bretton Woods system until 1971, certain developing and emerging countries)
- **Many intermediate situations**

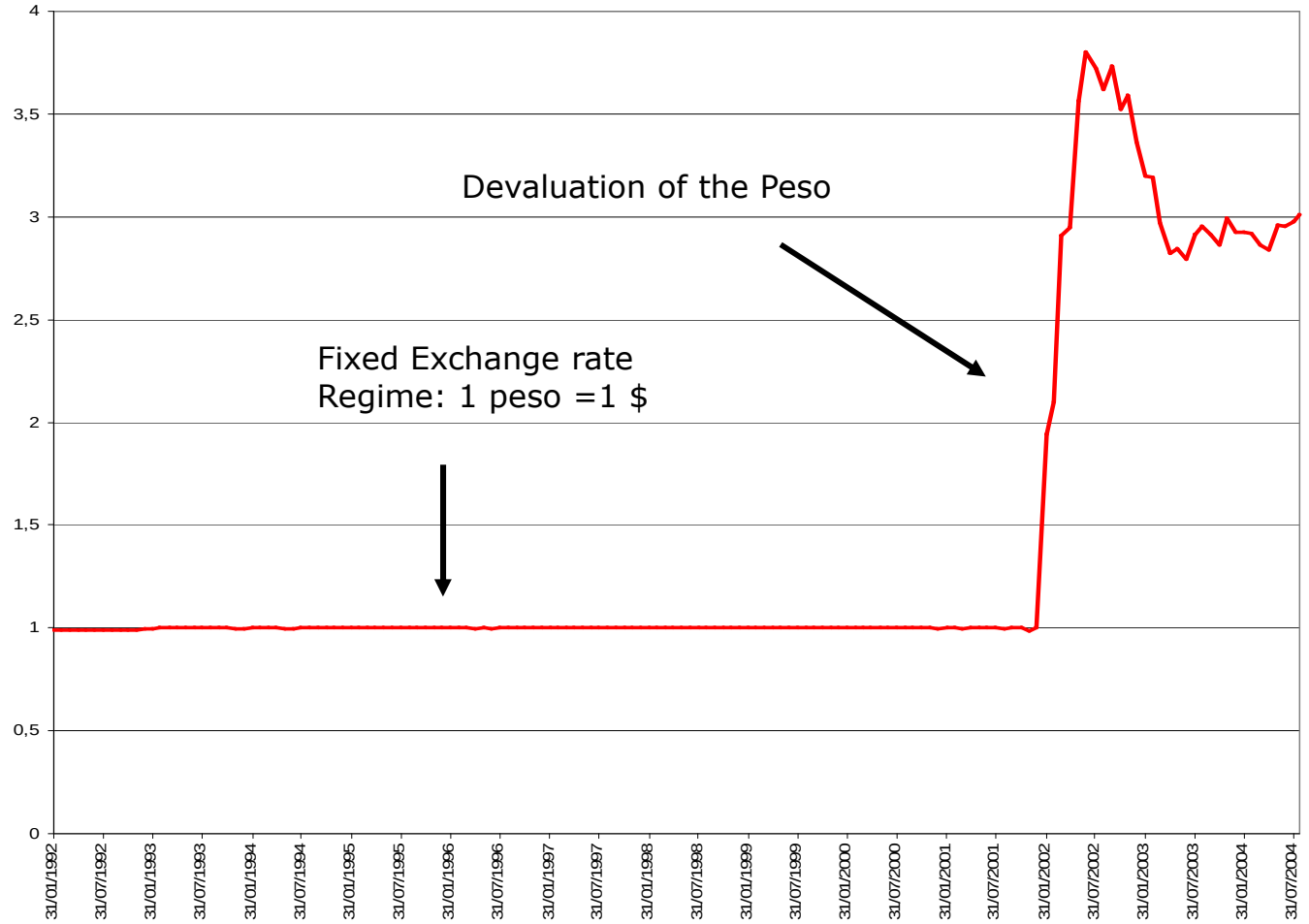
More on this later in the course, here focus on floating

Nominal Exchange Rates



An example of floating exchange rates: Japanese yen per US dollar over the period 1990-2004

Nominal Exchange Rates



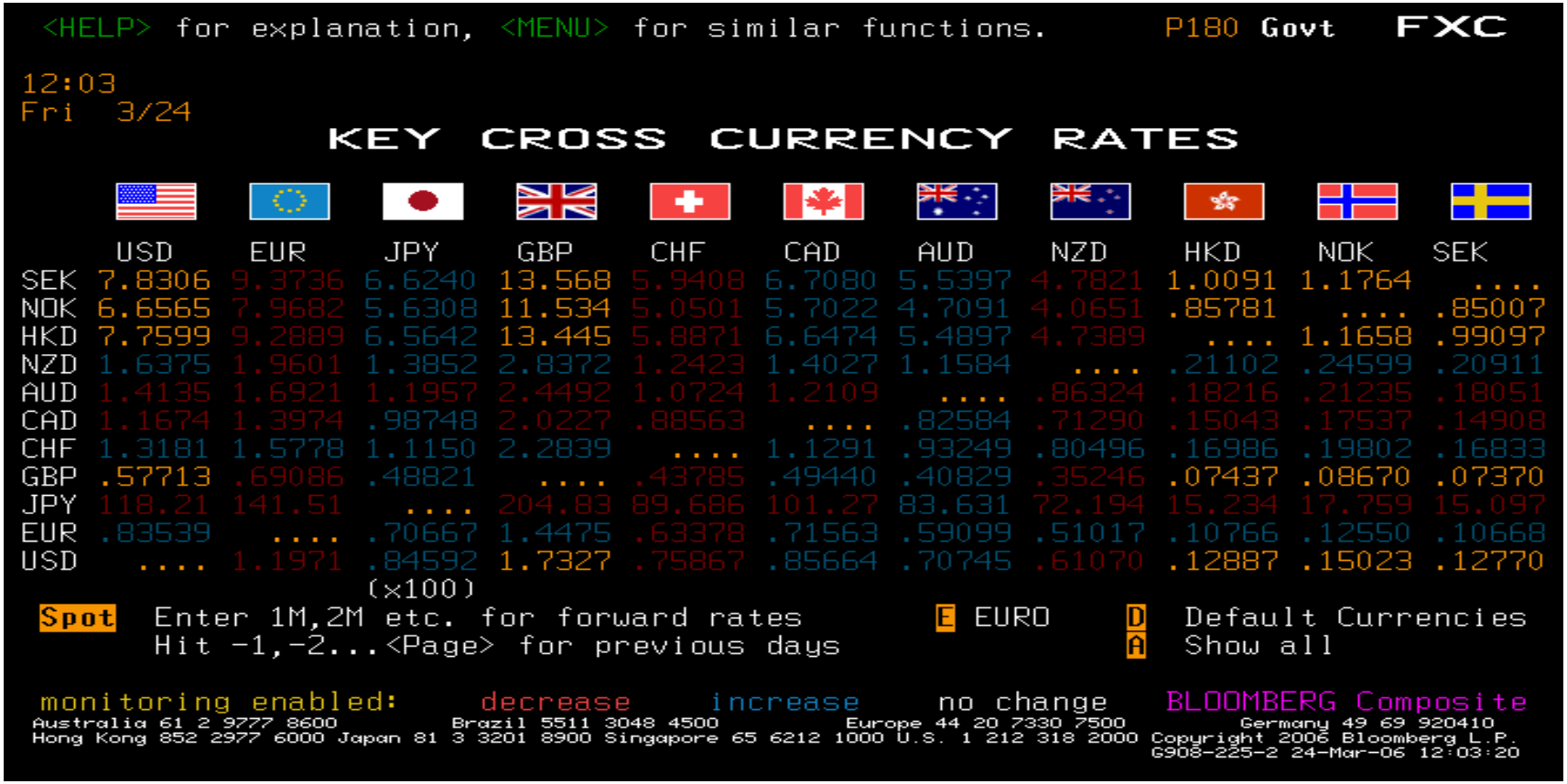
An example of fixed exchange-rate: the Currency Board in Argentina
Peso per US dollar over the period 1992-2004

Spot and forward exchange rates

- Spot rate: Price agreed today for a contract to buy and sell FOREX immediately (i.e., and immediate trade).
- Forward Rate: Price agreed today for a (forward) contract to buy and sell FOREX in the future (7, 14-day, 1, 3, 6, 12-month). No money changes hands now. Trades on futures markets.
- On January 10, 2010 two banks agree to trade on June 10, 2010, 1M € at the rate of 0.8

  Example: see next
- Swaps : spot sell a currency combined with future buy back
- Derivatives: exchange rate options and swaps of interest rate between two currencies

Spot Exchange Rates



Triangular Arbitrage: Check that if you exchange 1 CAD against 1 USD, you get the same quantity of USD than if you first exchange your CAD against euros and then euros against USD.

Example: Forward and Spot Rates

- French company imports computers from the US, and in one month they need to pay their supplier in $.
- They sell each computer for €1000 and pay their supplier $1000 per unit
- But they do not have the funds to pay the supplier until the computers have arrived and are sold.
- To avoid the risk, they make a 30-day forward exchange deal with the bank who agrees to sell them $ in 30 days at a rate of € 0.70 per $.
- There is a guaranteed profit, but no chance of benefiting from any favorable exchange rate movements (a depreciation of the $)

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Market organization

- Decentralized and permanent
- Concentrated
- Key role of the dollar
- Very small transaction costs
- High liquidity and volumes (more than 3000 billion $ / day)
- High volatility of the exchange rate

The foreign exchange rate market

Two markets concentrate most of the trading
Time difference means this is a quasi permanent market

Share of different markets in transactions:

- UK (London) 34.1 %
- USA (New York) 16.6%
- Switzerland (Zurich) 6.1%
- Japan (Tokyo) 6.0%
- Singapore 5.8%
- Hong Kong 4.4%

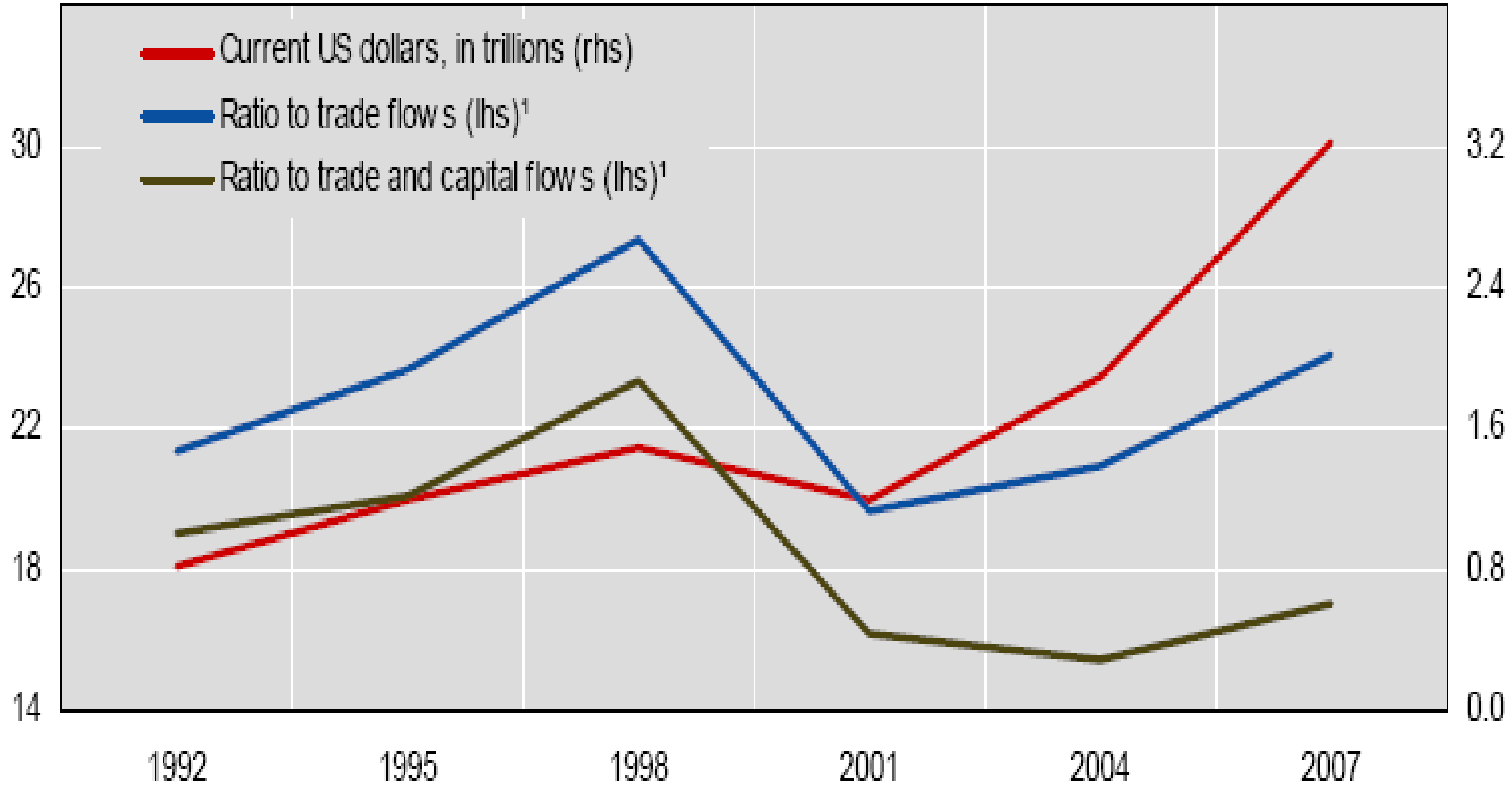
Source BIS

Year world GDP around ~$50 trillions

– ~ $3.2 trillions per day

Foreign exchange turnover

Daily averages in April

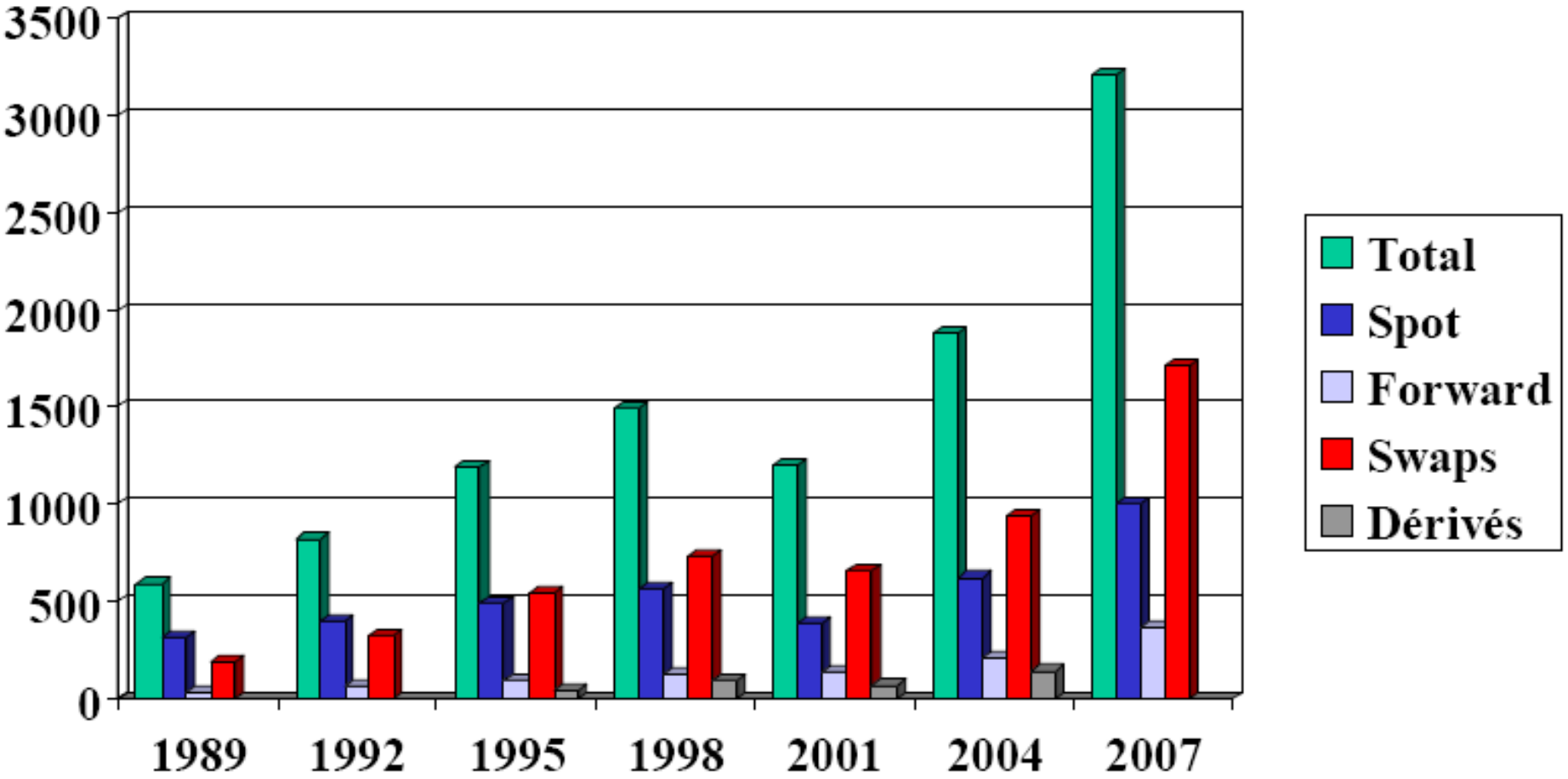


[1] 2007 trade and capital flow data are estimated by extrapolating annualised growth between 2004 and 2006.

Source: IMF.

Graph B.1

Total of transactions (per day) , 1989-2007



Source: Pisani-Ferry 2007

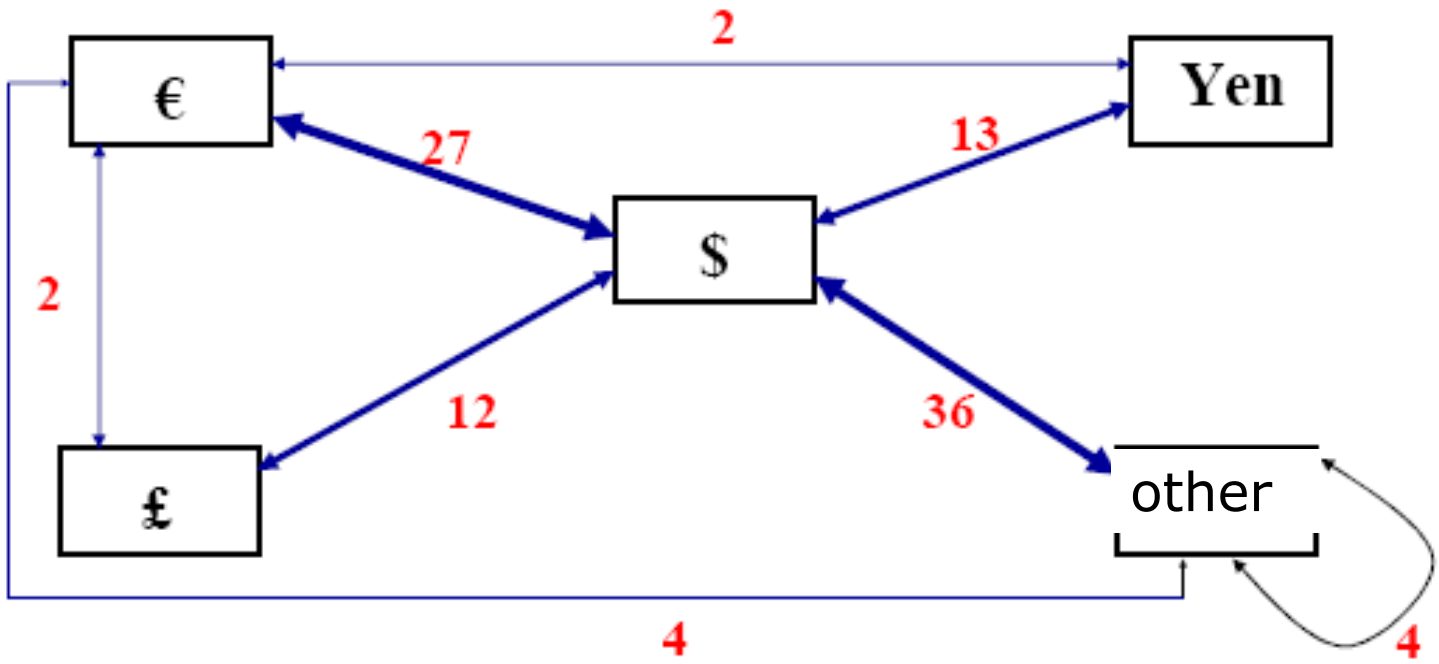
Share of different currencies in transactions

	2001	2007
Dollar	90.3%	86.3%
Euro	37.6%	37.0%
Yen	22.7%	16.5%
Pound	13.2%	15.0%
Swiss Franc	6.1%	6.8%
others	30.1%	38.4%
Total	200%	200%

Source: BIS 2007

The dollar at the center of the market

Share of transactions by currency pair



Source: BIS 2007

The dollar as a vehicle currency

- To exchange Australian dollars into Mexican peso, less expensive to transact through US $
- High liquidity so low transaction costs (1 to 2 basis points (0.01 - 0.02%) for 10 M$ on €/$)
- Economics of currency use like economics of language
- Hysteresis phenomenon: once the liquidity is established on a market, problem of coordination for market participants to coordinate on another vehicle currency (see Pound between the two world wars)

Market participants

Structure of the market: decentralized market, over the counter (unlike equity) between participants

Final clients :

- Exporters and importers
- investors (pension funds)
- speculators (hedge funds...)

Operators :

- banks (for their own account or for their clients)
- Brokers
- Central Banks

Market participants

- Interbank transactions are dominant:
  - Banks / banks : 43% of transactions
  - Banks / other financial institutions : 40%
  - Banks / non financial agents : 17%

The types of activities of banks on FOREX markets

1) intermediary for a client
- risk : zero
- profit : bid / ask spread (difference purchase/sell)

2) arbitrage between two markets
- risk : zero
- profit : gap between the rates on the two markets

3) speculation on variation in exchange rates
- risk : high
- profit (or loss) : depends on exchange rate variation

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International interest parity conditions: theory and empirics

Roadmap

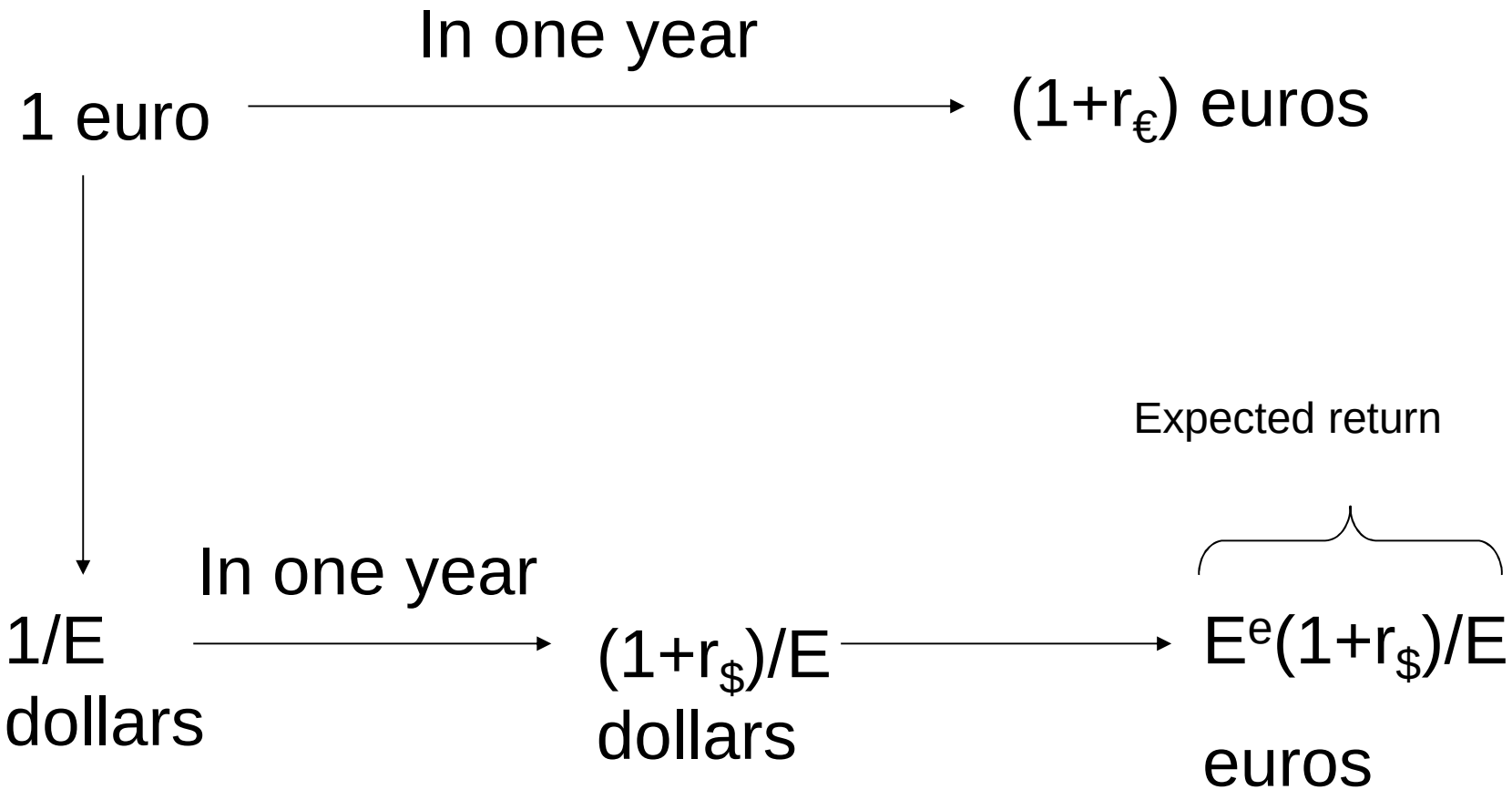
- Uncovered Interest Parity
- Covered Interest Parity
- Empirical Validity

Exchange rates and the return on assets

Uncovered interest parity condition (UIP)

- The link between the exchange rate E euro/dollar today, the expected exchange rate E^e (one year) and the interest rate differential
- An investor has the choice between:
  - Invest one euro in (riskless) bond (treasury bond) or euro interbank interest rate : $1+r_{€}$
  - Buy dollars with this euro at rate E, invest it in US Treasury bonds or dollar interbank markets at rate $1+r_{\$}$
  - In one year, at what rate, can she sell her dollars? E^e

Two possible investments



E^e: expected euro/dollar exchange rate

Uncovered interest parity condition

A risk neutral investor should be indifferent between the two : condition for equilibrium on the FOREX market
(absent of transaction costs)

$$\mathbf{(1+r_€) = E^e\,(1+r_\$)/E} \qquad \mathbf{E^e/E = (1+r_€)/(1+r_\$)}$$

$$\mathbf{(E^e - E)/E = (1+r_€-1-r_\$)/(1+r_\$) \approx r_€ - r_\$}$$

If $E^e > E$, an investor in euro must be compensated by a higher interest rate in euro than in dollar

Note 1: Uncovered is different from Covered interest parity condition with forward rates (arbitrage condition = no risk)

Note 2: Another way to take an approximation of the UIP is to take logs:

$$\ln(E^e/E) = \ln((1+r_€)/(1+r_\$)); \text{ call } e^e = \ln E^e$$
$$e^e - e = \ln(1+r_€) - \ln(1+r_\$) \approx r_€ - r_\$$$

- With approximation, equilibrium on FOREX market if

Return on € asset

Expected return on $ asset

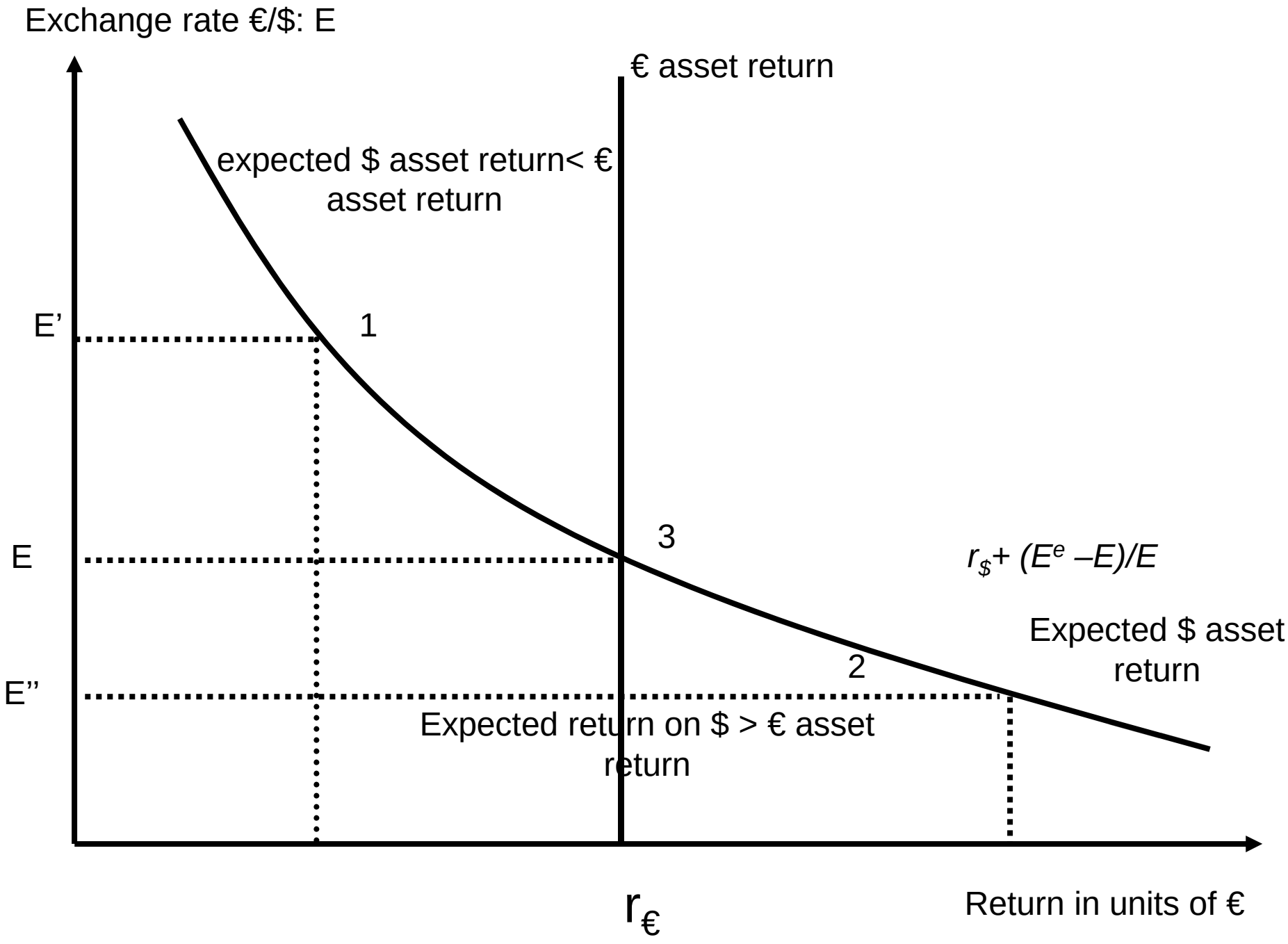
$$r_{€} = r_{\$} + (E^{e} - E)/E$$

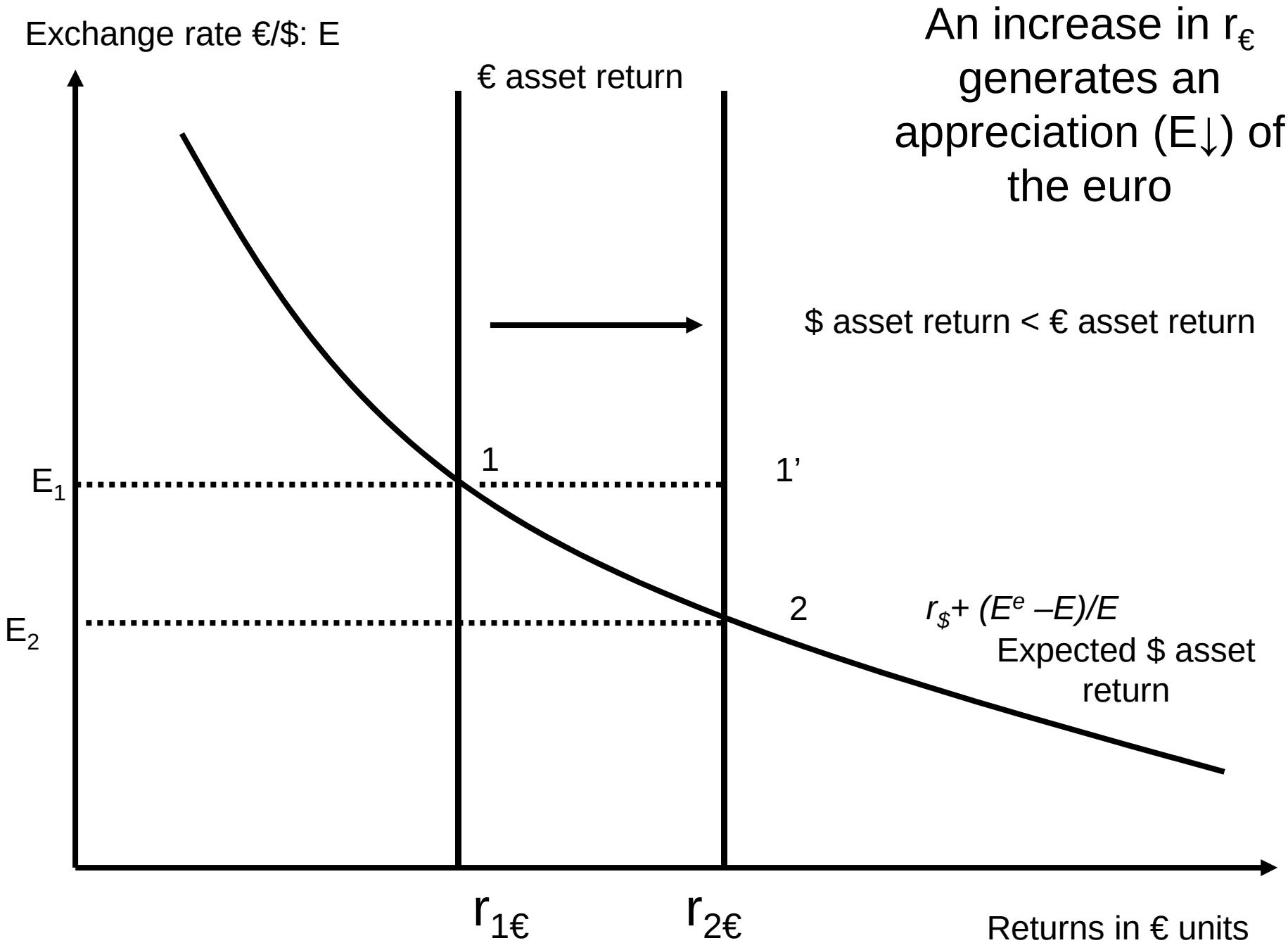
- Otherwise: expected returns on € assets and $ assets ≠

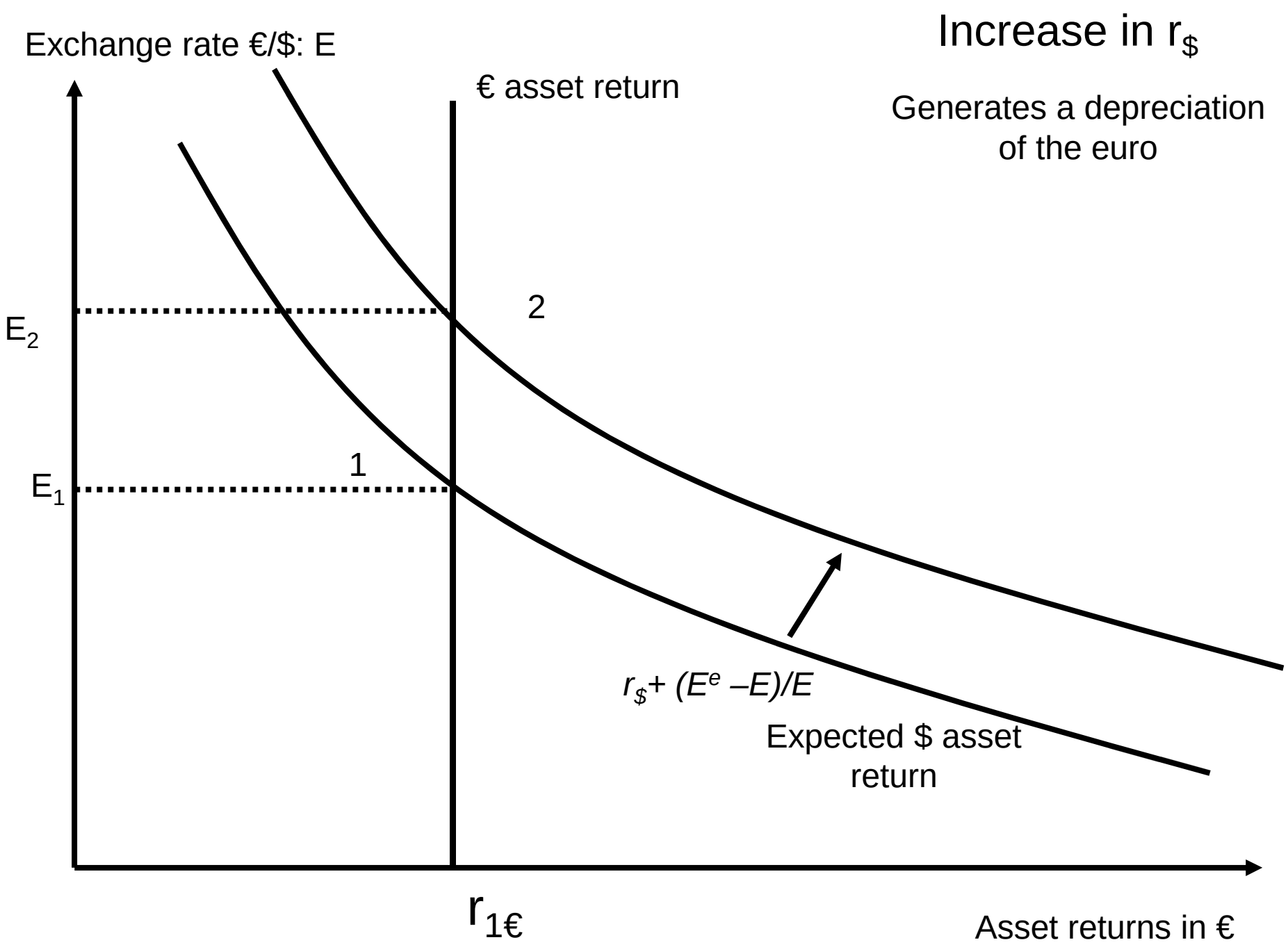
  Profit maximizer investors would buy the asset with higher expected return (capital inflows and outflows, if no transaction costs: infinite)

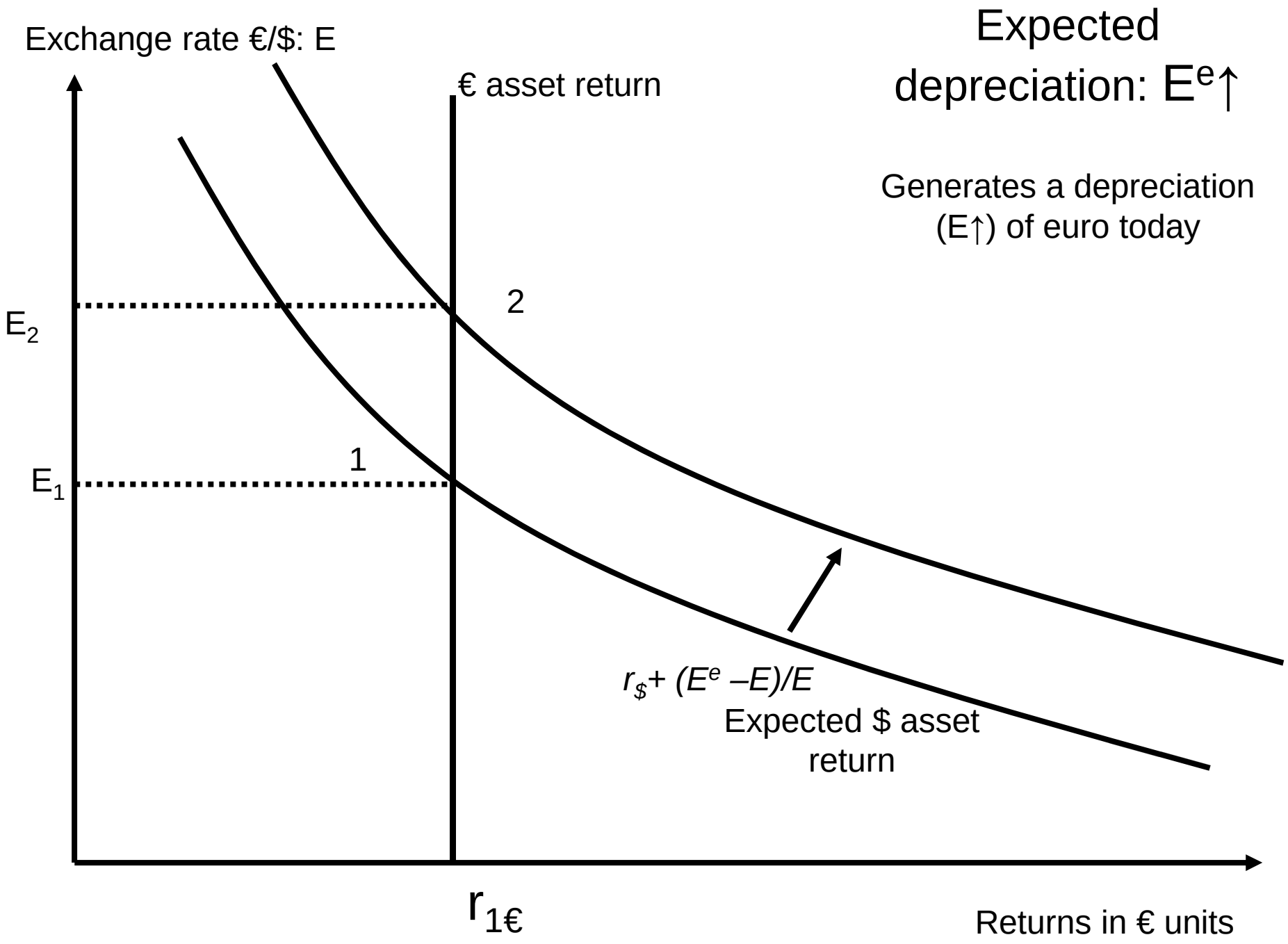
  If E ↑ (€ depreciates today) : return on $ assets $E^{e}(1+r_{\$})/E$ ↓ or $r_{\$} + (E^{e} - E)/E$ ↓ : relatively € asset return ↑

  Why? If € depreciates (cheaper), $ appreciates (for given interest rates and E^{e} given): more expensive to buy and invest in $ assets today: return in $ falls


Exchange rate €/$: E
€ asset return
expected $ asset return< € asset return
E'
1
E
3
$r_{\$} + (E^e - E)/E$
Expected $ asset return
2
E''
Expected return on $ > € asset return
$r_€$
Return in units of €


Exchange rate €/$: E
€ asset return
An increase in $r_€$ generates an appreciation (E↓) of the euro
$ asset return < € asset return
1
1'
E_1
E_2
2
$r_\$ + (E^e - E)/E$
Expected $ asset return
$r_{1€}$
$r_{2€}$
Returns in € units

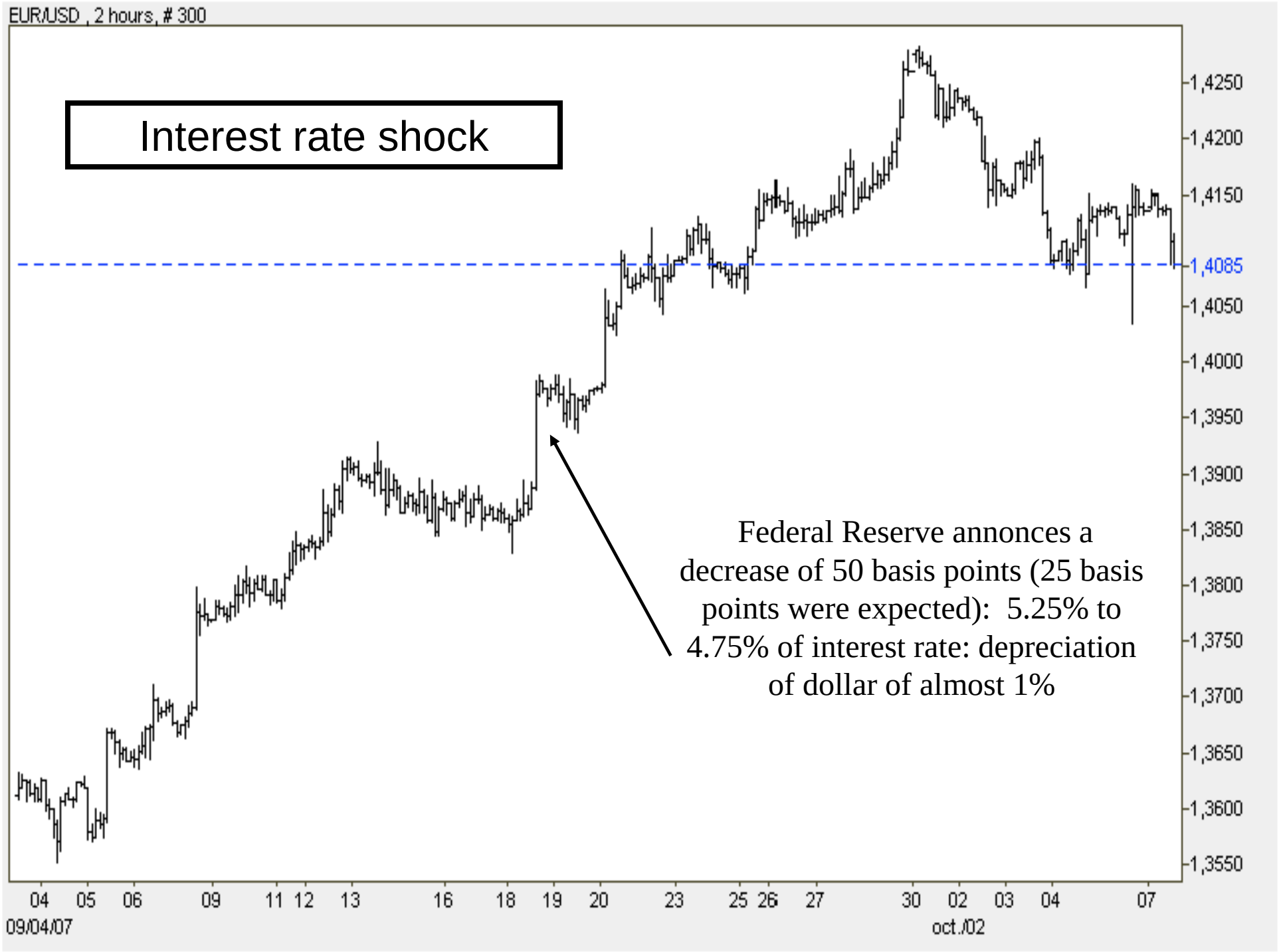

Increase in $r_{\$}$
Generates a depreciation of the euro
Exchange rate €/$: E
€ asset return
E_2
E_1
2
1
$r_{\$} + (E^e - E)/E$
Expected $ asset return
$r_{1€}$
Asset returns in €

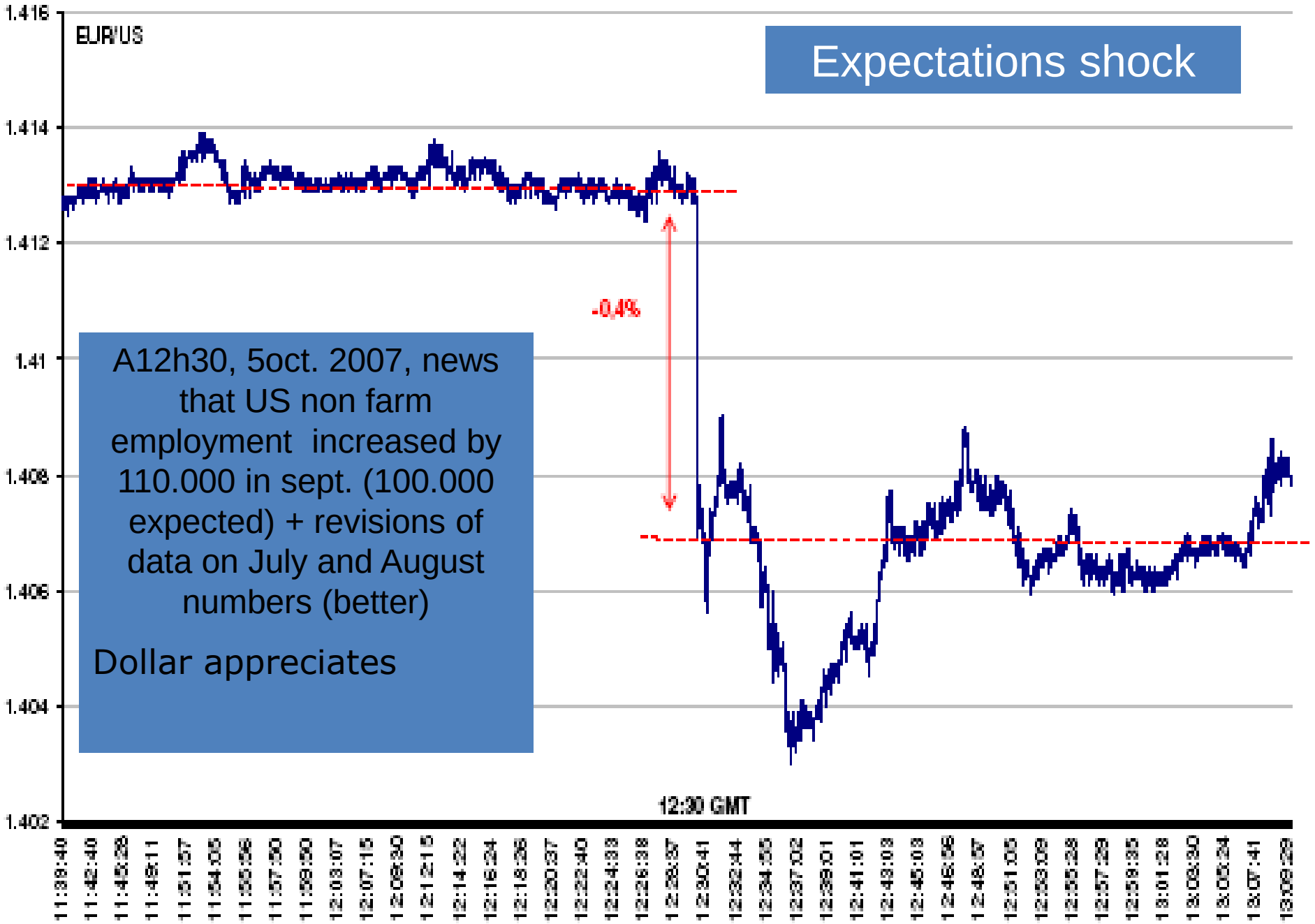

Exchange rate €/$: E
€ asset return
Expected depreciation: $E^e\uparrow$
Generates a depreciation (E↑) of euro today
E_2
E_1
2
1
$r_\$ + (E^e - E)/E$
Expected $ asset return
$r_{1€}$
Returns in € units

Exchange rate volatility

- Today's exchange rate depends on **expected** exchange rates which itself depends on all information that can influence future exchange rate

  - future differential in interest rates (which themselves depend on future monetary policies, which depend on production, inflation…)


EUR/USD , 2 hours, # 300
Interest rate shock
Federal Reserve annonces a decrease of 50 basis points (25 basis points were expected): 5.25% to 4.75% of interest rate: depreciation of dollar of almost 1%
1,4250
1,4200
1,4150
1,4085
1,4050
1,4000
1,3950
1,3900
1,3850
1,3800
1,3750
1,3700
1,3650
1,3600
1,3550
04 05 06 09 11 12 13 16 18 19 20 23 25 26 27 30 02 03 04 07
09/04/07
oct./02


EUR/US
Expectations shock
-0,4%
A12h30, 5oct. 2007, news that US non farm employment increased by 110.000 in sept. (100.000 expected) + revisions of data on July and August numbers (better)
Dollar appreciates
12:30 GMT
1.416
1.414
1.412
1.41
1.408
1.406
1.404
1.402
11:38:40
11:42:40
11:45:28
11:48:11
11:51:57
11:54:05
11:55:56
11:57:50
11:59:50
12:03:07
12:07:15
12:09:30
12:12:15
12:14:22
12:16:24
12:18:26
12:20:37
12:22:40
12:24:33
12:26:38
12:28:57
12:30:41
12:32:44
12:34:55
12:37:02
12:39:01
12:41:01
12:43:03
12:45:03
12:46:56
12:48:57
12:51:05
12:53:09
12:55:28
12:57:29
12:59:35
13:01:28
13:03:30
13:05:24
13:07:41
13:09:29

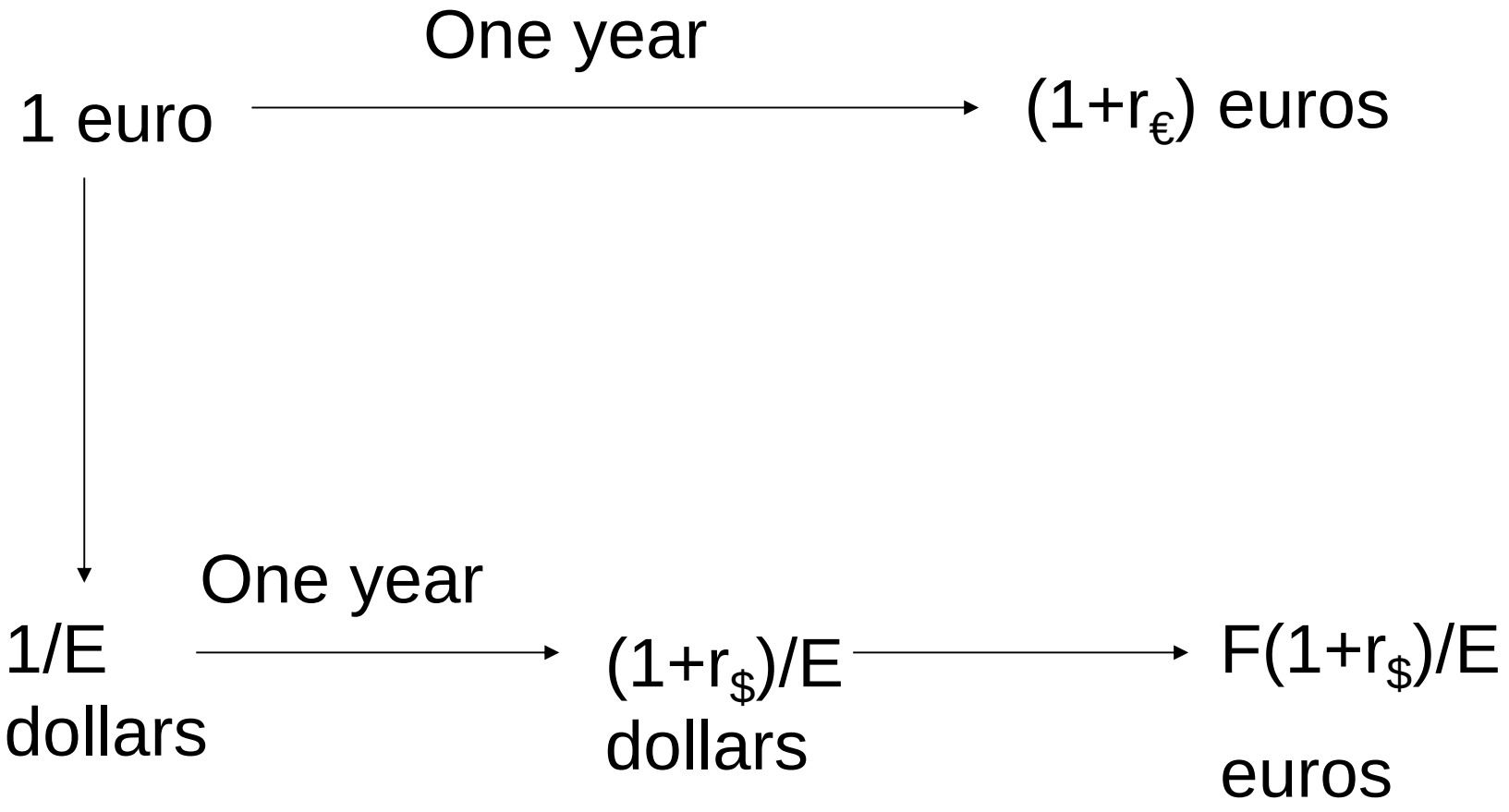
Exchange rates and the returns on assets

One possible (riskless) arbitrage :

Covered interest parity condition

- Link between E, the forward rate F (one year) and the interest rate differential
- An investor has the choice between:
  - Invest one euro in a euro denominated bond : $1+r_{€}$
  - Convert this euro in dollar at rate, invest this in $ denominated bond: $1+r_{\$}$
  - Will resell dollars at rate F **contracted** today (no risk)

Two possible investments



F: forward exchange rate (known and contracted today: no risk)

Covered interest parity condition (CIP)

- Arbitrage between two riskless investments:

$$\mathbf{(1+r_{€}) = F(1+r_{\$})/E}$$

Or

$$F/E = \frac{1+r_{€}}{1+r_{\$}}$$

$$\text{\$ Forward Premium} = \frac{F-E}{E} = \frac{1+r_{€}-1-r_{\$}}{1+r_{\$}} \cong r_{€} - r_{\$}$$

If not true, easy to make a profit (riskless)

If F>E, an investor must be compensated with a higher interest rate on euro than on dollar

Forward Rates Calculations

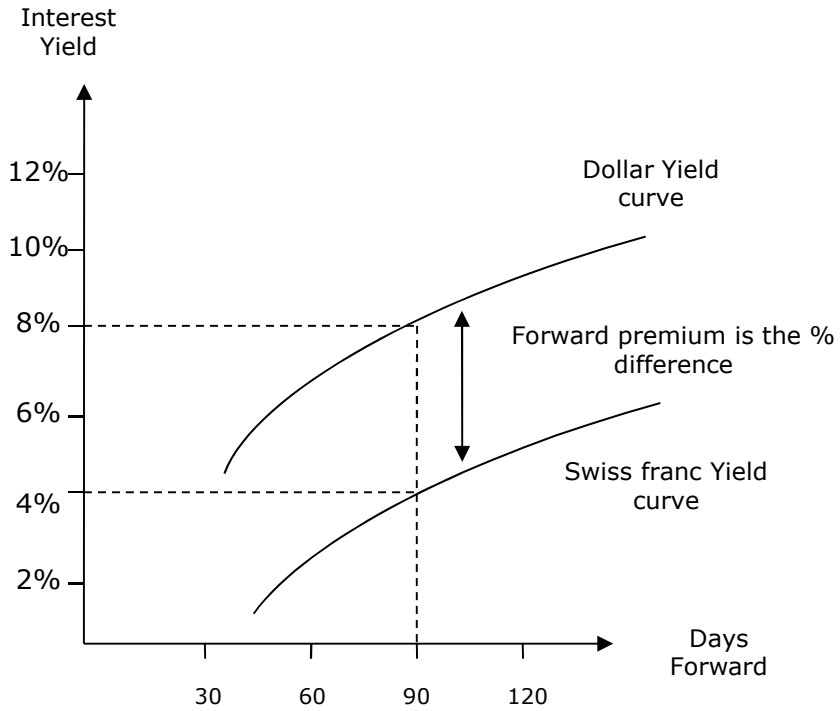
The spot rate between the Swiss Franc (SF) and the dollar is 1.140 SF/$. The 90-day Swiss Franc deposit rate is 4% per annum (1% per 90-days) and the 90-day dollar deposit rate is 8% per annum. Calculate the forward rate implied by interest rates

$$F_{t,90} = S_t \frac{1+\frac{90}{360} r_{SF}}{1+\frac{90}{360} r_{\$}} = 1.140 \times \frac{1+0.01}{1+0.02} = 1.129 \$ / SF$$

$$f_t = \left(\frac{r_{SF} - r_{\$}}{1+\frac{90}{360} r_{\$}} \right) = -\frac{4}{1.02} = -3.92\%$$

The USD is at a 3.92% per annum discount with the SF.

Forward premium and interest rates

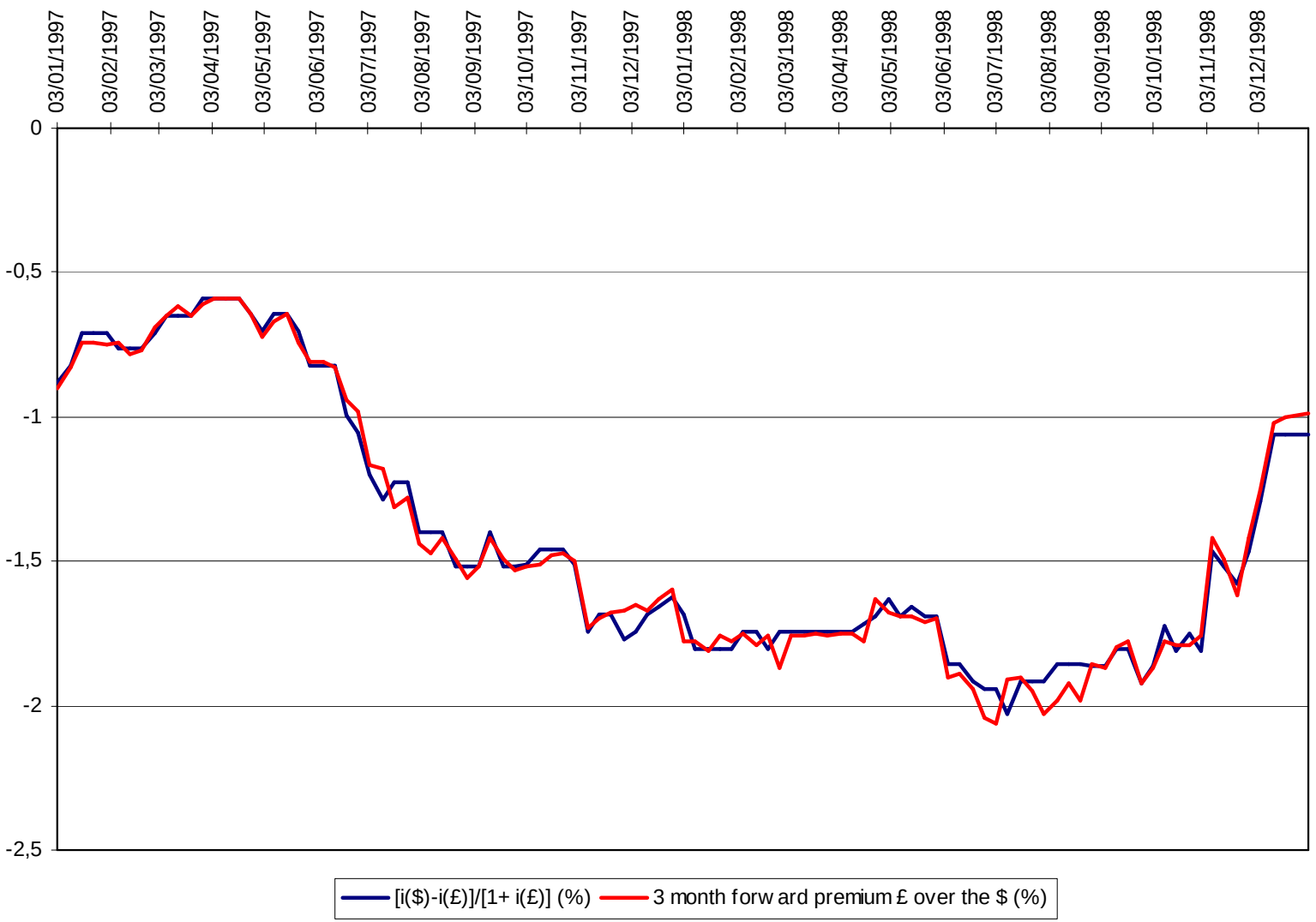


Under CIP, the forward premium should very close to the difference between the domestic and foreign interest rate for the same maturity.

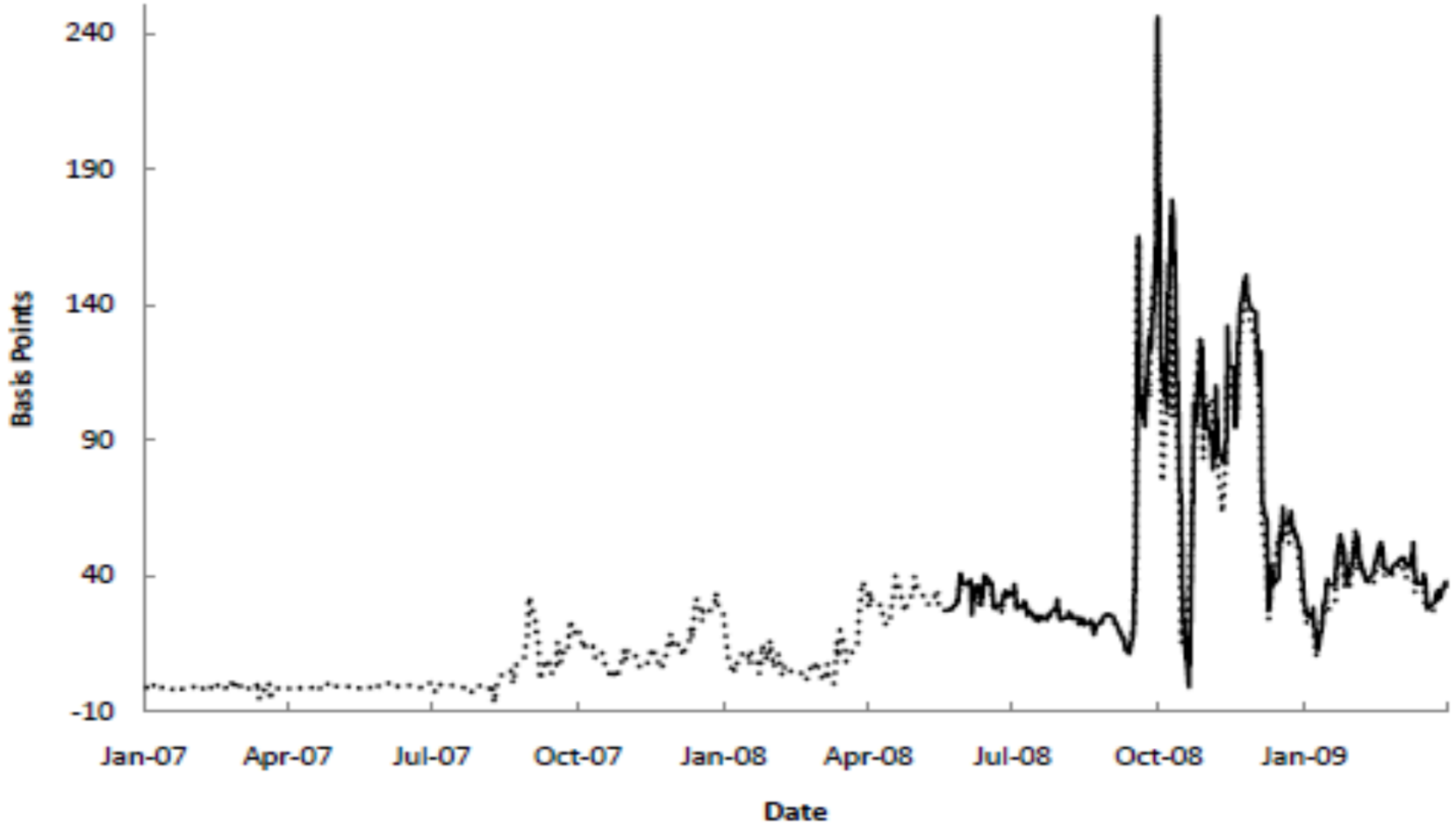
Empirical validity of the CIP

- Free capital movements (arbitrage)
- Agents are profit maximizers (do not give up a riskless opportunity of profit)
- Covered interest parity condition is perfectly satisfied except in exceptional circumstances (cf. recent crisis)
- Not true in the 80s (restrictions on capital movements)

Empirical validity of the CIP



CIP deviations during the financial crisis



Deviations from CIP on euro/dollar markets (Libor rates)

Source: Federal Reserve

Empirical validity of uncovered interest parity condition

$$r_{€} = r_{\$} + (E^{e} - E)/E$$

Stronger assumptions:

- Perfect mobility of capital (zero transaction costs)
- Assets are perfectly substitutable (US Treasury bond and German bond)
- Rational expectations: agents do not make systematic errors in forecasting and use all information
- No speculative bubble
- **No risk aversion** : only expected returns matter for the choice of investors

Risk premium

- If agents are risk averse, they want to diversify assets and do not want to hold too many assets in one currency (for example in €): if share of € assets increases in portfolio then must be compensated by a “risk premium” on holding € assets:

$$r_{€} = r_{\$} + \frac{E^e - E}{E} + \rho$$

- This risk premium depends on the portfolio structure and can vary with time

Can the uncovered interest parity condition be validated empirically?

- Increase of differential of interest rate ($r_{€}$ - $r_{\$}$) implies a € appreciation today. For given expectations on E^e implies an **expected depreciation** (or less of expected appreciation)

$$r_{€} = r_{\$} + \frac{E^e - E}{E} + \rho$$

- If rational expectations, E^e is **on average** = future realized exchange rate E_{t+1}

$$\frac{E_{t+1} - E_t}{E_t} = r_{t€} - r_{t\$} + error_t \quad \text{with } \mathcal{E}(error_t) = 0$$

$$\frac{E_{t+1} - E_t}{E_t} = r_{t€} - r_{t\$} + error_t$$

This can be tested easily (see later):

- First result: a random walk does better

  Best predictor of future exchange rate is today's exchange rate: $\mathcal{E}(E_{t+1}) = E_t$ (with $\mathcal{E}$ =expectations operator)

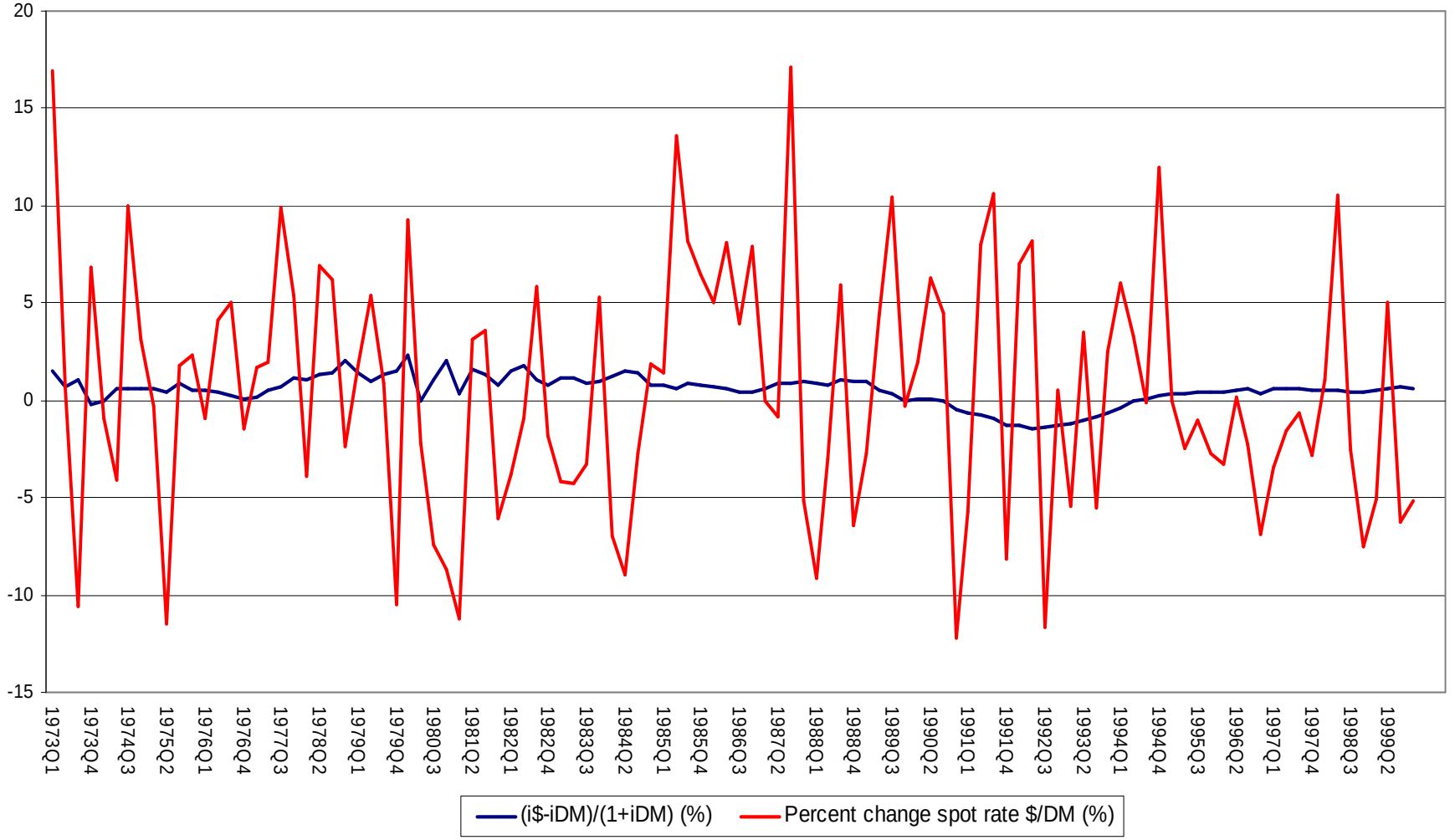
  Better than UIP (fundamentals based prediction) for horizons of 1 to 12 months (UIP does better in medium/long-run)

- Second result: an increase in the interest differential ($r_{t€} - r_{t\$}$) followed by an appreciation of euro in the future (see later).

  Theory says depreciation!

Uncovered Interest Parity in the short-run

(Source: R. Levich)



UIP and the Forward Rate Unbiased Condition

- Using CIP and UIP:

  The following terms are both equal to $(r_{€,t} - r_{\$,t})/(1+ r_{\$,t})$

  $$(F_{t,T}-E_t)/E_t = \mathcal{E}_t[(E_T - E_t)/E_t]$$

  = **Forward Rate Unbiased Condition**

- It tells you that the forward premium should be equal to the expected change of the spot exchange rate.
- This is equivalent to: $F_{t,T} = \mathcal{E}_t[E_T]$. Prices of forward contract should equal the expectations of future spot rates.
- True if and only if both CIP **and** UIP holds

Testing the Forward Rate Unbiased Condition

– In levels: Forward rate should be a predictor of the future spot rates.

Run the following regression:

$$E_{t+1} = \alpha + \beta F_{t,t+1} + \varepsilon_{t+1}$$

β should be close to one (and α close to zero).

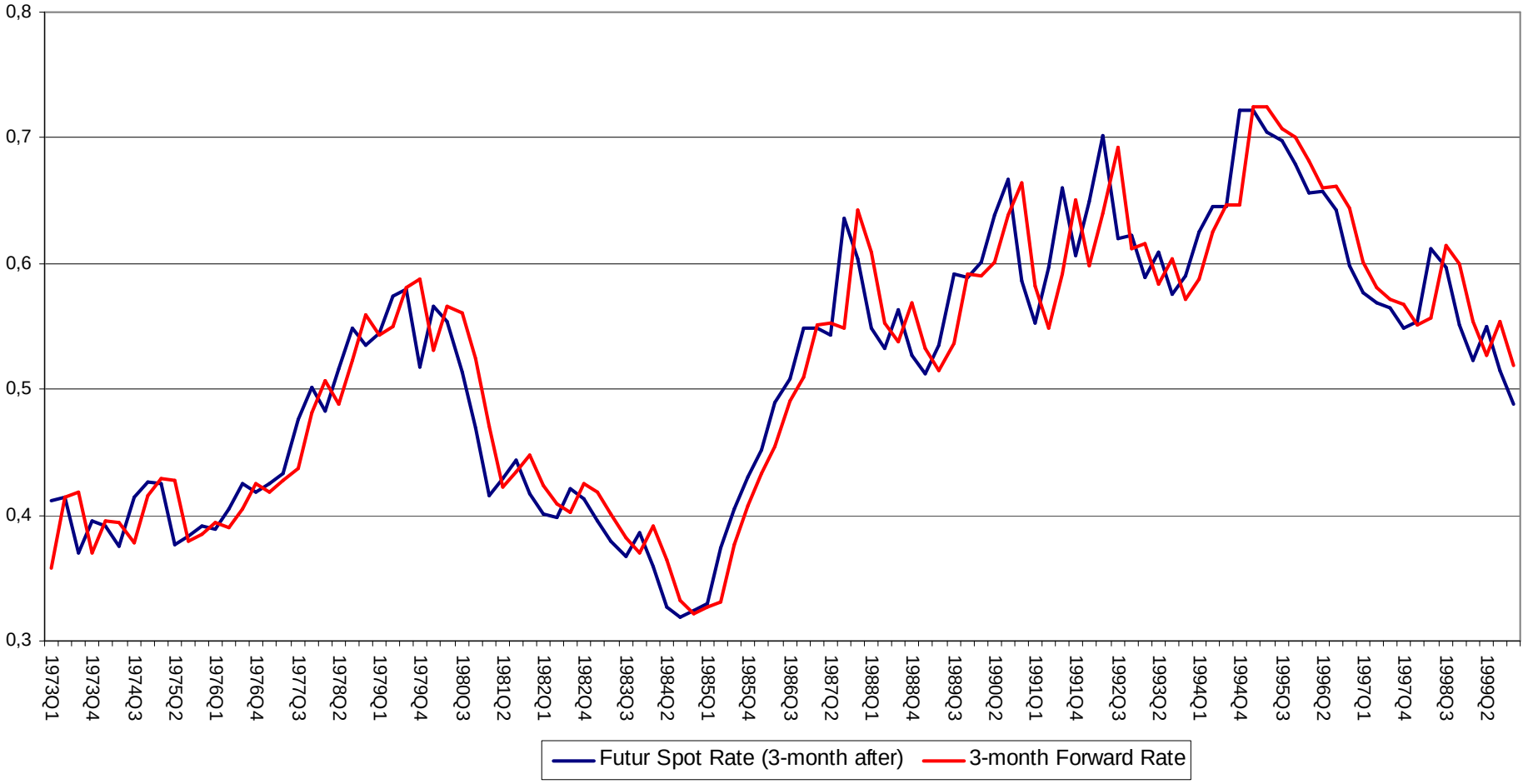
Works pretty well. β is very close to one.

BUT the spot rate is clearly « leading » the forward rate : the forward rate misses all the « turning points » in the spot rate series.

Not very useful for arbitrageurs who exploits spot exchange rate changes (currency returns).

3-month Forward Rate and « 3-month after » Spot Rate ($/Deutsch Mark)

(Source: R. Levich).



Testing the Forward Rate Unbiased Condition

– In variations:

Is the forward premium a good predictor of spot rates changes? Run the following regression:

$$\frac{E_{t+1}-E_t}{E_t}=\alpha+\beta\frac{F_{t,t+1}-E_t}{E_t}+\varepsilon_{t+1} \qquad \text{or} \qquad \frac{E_{t+1}-E_t}{E_t}=\alpha+\beta\left(\frac{i_{e,t}-i_{\$,t}}{1+i_{\$,t}}\right)+\varepsilon_{t+1}$$

β should be close to one (and α close to zero).

β is found negative (and significant) for many currencies.

In the short-run, currencies with raising interest rates tends to appreciate.

Works better at longer horizon.

UIP Regressions, 1976-2005

	1 Month Regression			3 Month Regression		
	α	β	R^2	α	β	R^2
Belgium†	-0.002	-1.531	0.028	-0.005	-0.625	0.008
	(0.002)	(0.714)		(0.006)	(0.669)	
Canada	-0.003	-3.487	0.045	-0.007	-2.936	0.072
	(0.002)	(0.803)		(0.005)	(0.858)	
France†	0.000	-0.468	0.004	0.001	-0.061	0.000
	(0.002)	(0.589)		(0.005)	(0.504)	
Germany†	-0.005	-0.732	0.005	-0.012	-0.593	0.007
	(0.003)	(0.704)		(0.008)	(0.650)	
Italy†	0.005	-0.660	0.010	0.008	-0.012	0.000
	(0.002)	(0.415)		(0.006)	(0.392)	
Japan*	-0.019	-3.822	0.030	-0.063	-4.482	0.100
	(0.005)	(0.924)		(0.014)	(1.017)	
Netherlands†	-0.009	-2.187	0.029	-0.018	-1.381	0.026
	(0.004)	(1.040)		(0.009)	(0.816)	
Switzerland	-0.008	-1.211	0.012	-0.020	-1.050	0.022
	(0.003)	(0.533)		(0.008)	(0.536)	
USA	-0.003	-1.681	0.017	-0.008	-1.618	0.037
	(0.002)	(0.880)		(0.006)	(0.865)	

* Data for Japan begin 7/78

† Data for Euro legacy currencies ends 12/98

Notes: Regression of [S(t+1)/S(t)-1] on [F(t)/S(t)-1]. Standard errors in parentheses.

Source: Burnside et al.

The empirical failure of UIP

Why?

- Risk premium is non observable, varies with time: biases the estimate
- Interest rate changes are not “exogenous shocks” if central banks follow policy rules: when € interest rate increases it is because expectations on future output, inflation have changed!
- Presence of “noise traders” who are unable to distinguish random signals from real news
- Carry trade speculation

UIP still useful? Yes to understand unexpected changes of fundamentals (interest rate…) but need complete (general) equilibrium models with risk aversion, endogenous monetary policies and “noise traders”

Lectures 3 and 4
Money, interest rates and nominal exchange rates

1. The exchange rate as a relative price
2. The Foreign Exchange Market (FOREX)
3. International interest parity conditions: theory and empirics
4. Monetary models of exchange rates

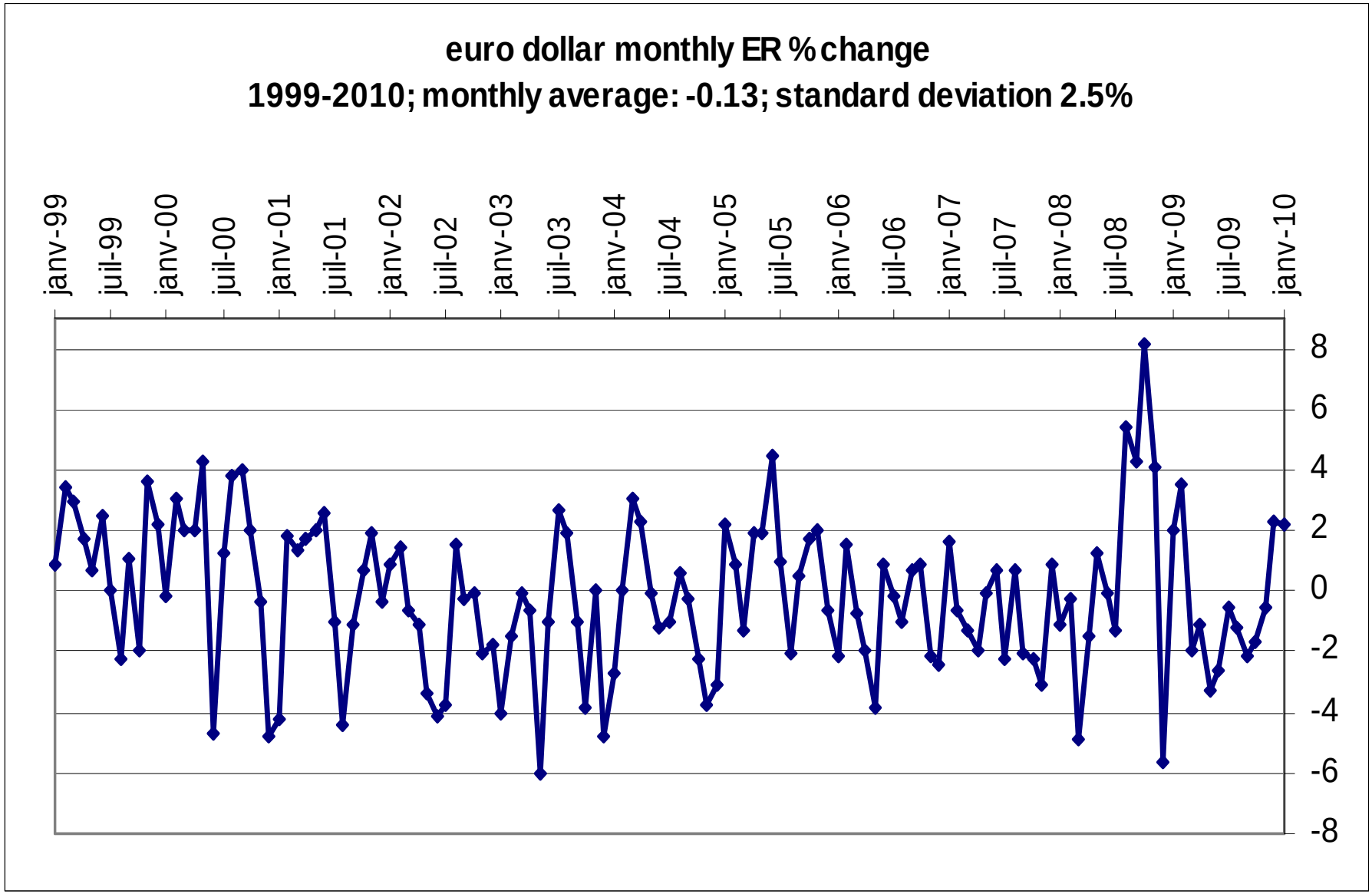
Monetary Policy and Exchange Rates

Two important questions:

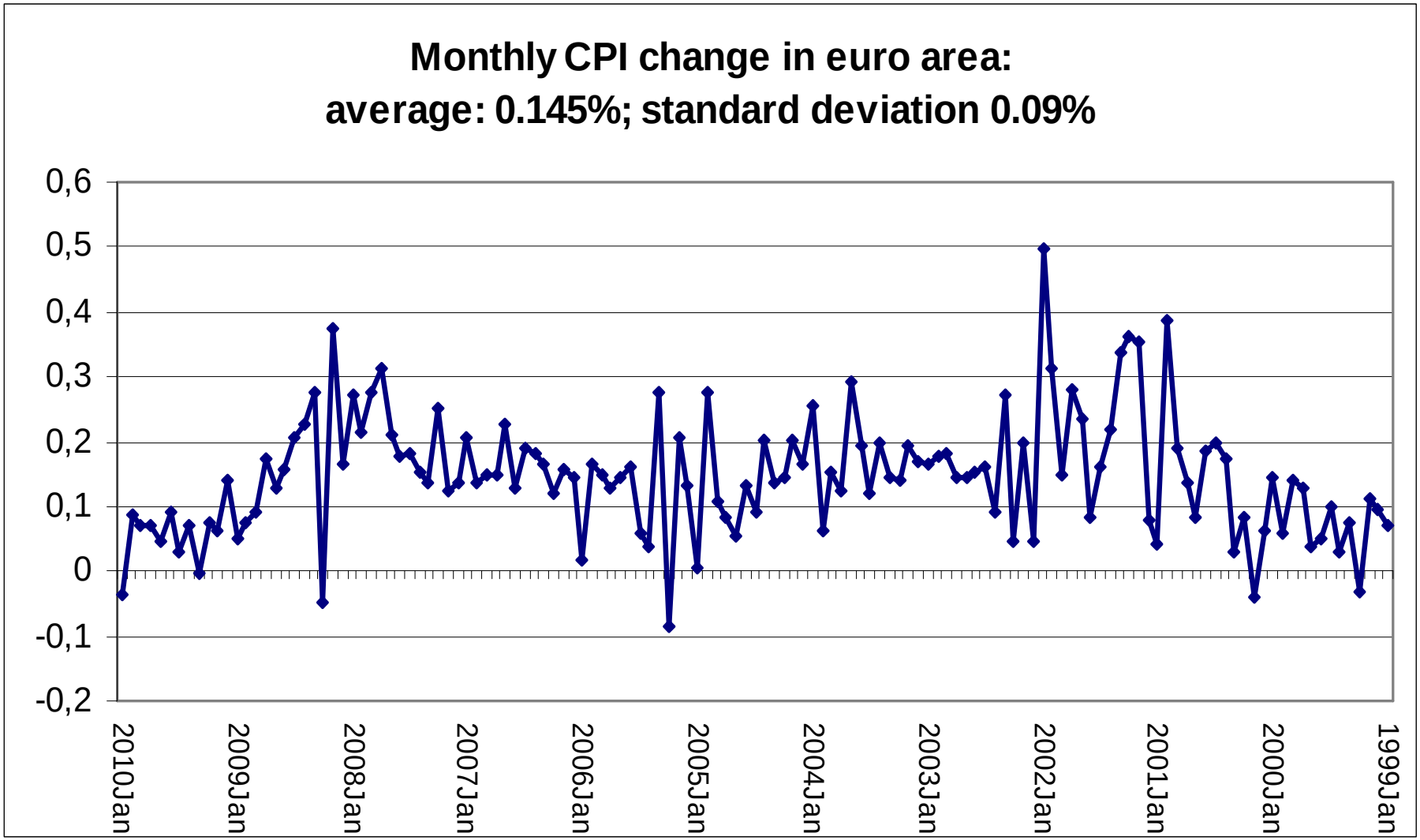
- Why are exchange rates so volatile compared to goods prices?
- How does monetary policy affect exchange rates?

- Some empirical evidence on volatility
- Review on monetary policy and interest rates
- Integrating interest rate determination and exchange rate determination
- The dynamics of exchange rate in the short and long term: the overshooting result

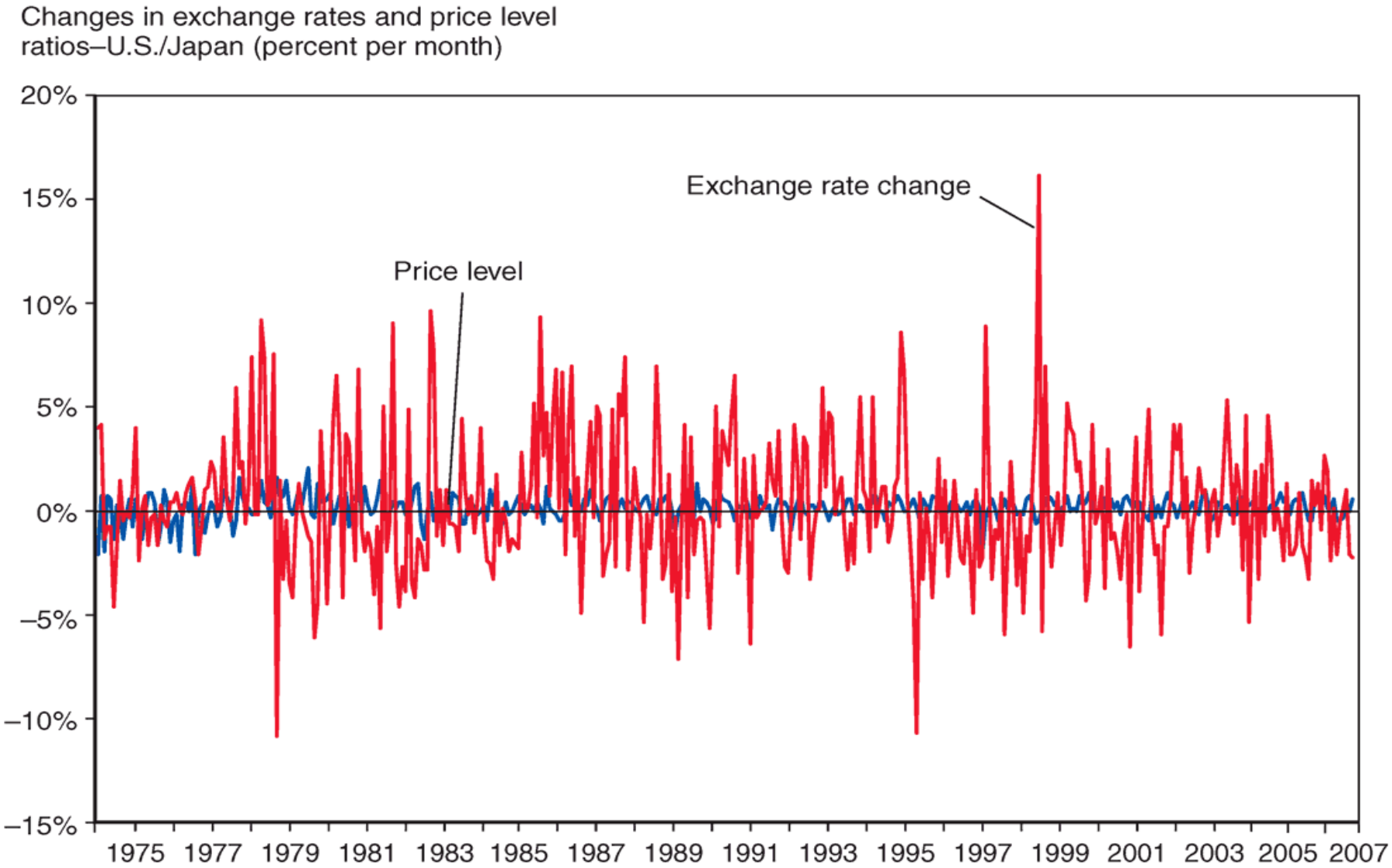
Exchange rates are volatile



Goods prices are not!



The exchange rate adjusts instantaneously but goods prices are much more rigid



Source : IMF

Quick review on monetary policy and interest rates

- Three factors on the demand for liquidity (firms and households) :
  - Interest rate (on a riskless asset such as Treasury Bond, TB) $r_{€}$
  - Price level $P_{€}$
  - Transactions (GDP) $Y_{€}$

Interest rate and the demand for liquidity

- The interest rate is the opportunity cost of holding the most liquid asset, money : easily used to pay for goods and services or to repay debt without substantial transaction costs.
- Money does not pay interest rate (or lower than less liquid assets such as TBs)
- ↑ of interest rate $r_€$ → ↓ demand of money : firms and households buy assets less liquid (TBs, saving accounts,…) that pay $r_€$

Demand for money and economic activity

- Demand for money increases with economic activity (GDP).
  - firms and households transactions increase
- Demand for money increases with GDP ($Y_{€}$)

Determinants of money demand

- $M^d_{€} = P_{€} x\ L\ (r_{€}, Y_{€})$

In real terms

- $M^d_{€} / P_{€} = L\ (r_{€}, Y_{€})$

In short term, P is rigid (Keynesian assumption)

Demand for money decreases with ($r_{€}$) and increases with GDP ($Y_{€}$)

$$dL/dr_{€} < 0 \qquad dL/dY_{€} > 0$$

Money market equilibrium such that:

$M^S_{€} = M^d_{€} = P_{€} x\ L\ (r_{€}, Y_{€})$

Money supply determined by Central Bank

Another way to write the money demand function

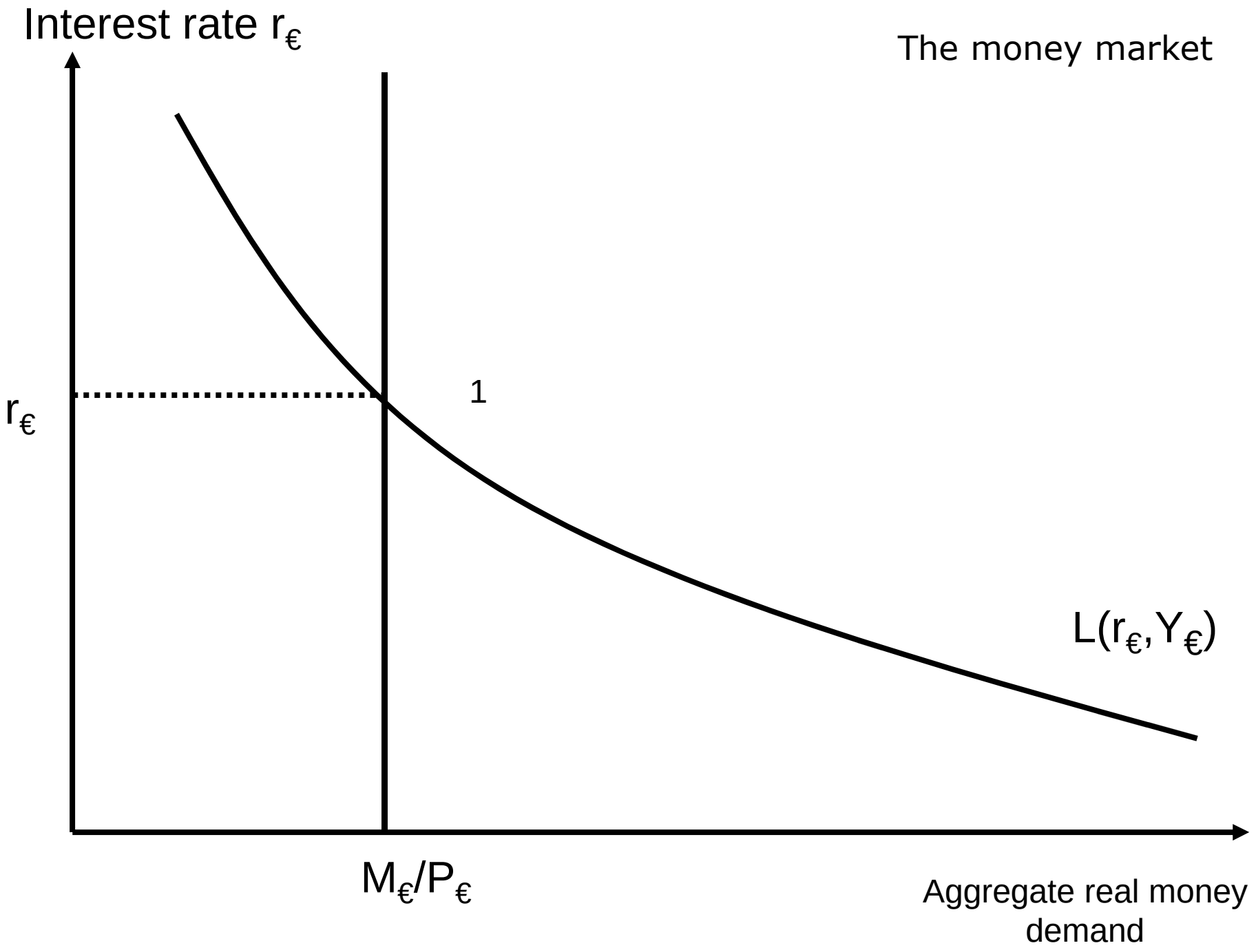
- $M^d_€ / P_€ = L(r_€, Y_€)$
- Demand for money decreases with $r_€$ and increases with GDP $Y_€$
- $dL/d\,r_€ < 0$ $\qquad\qquad$ $dL/dY_€ > 0$

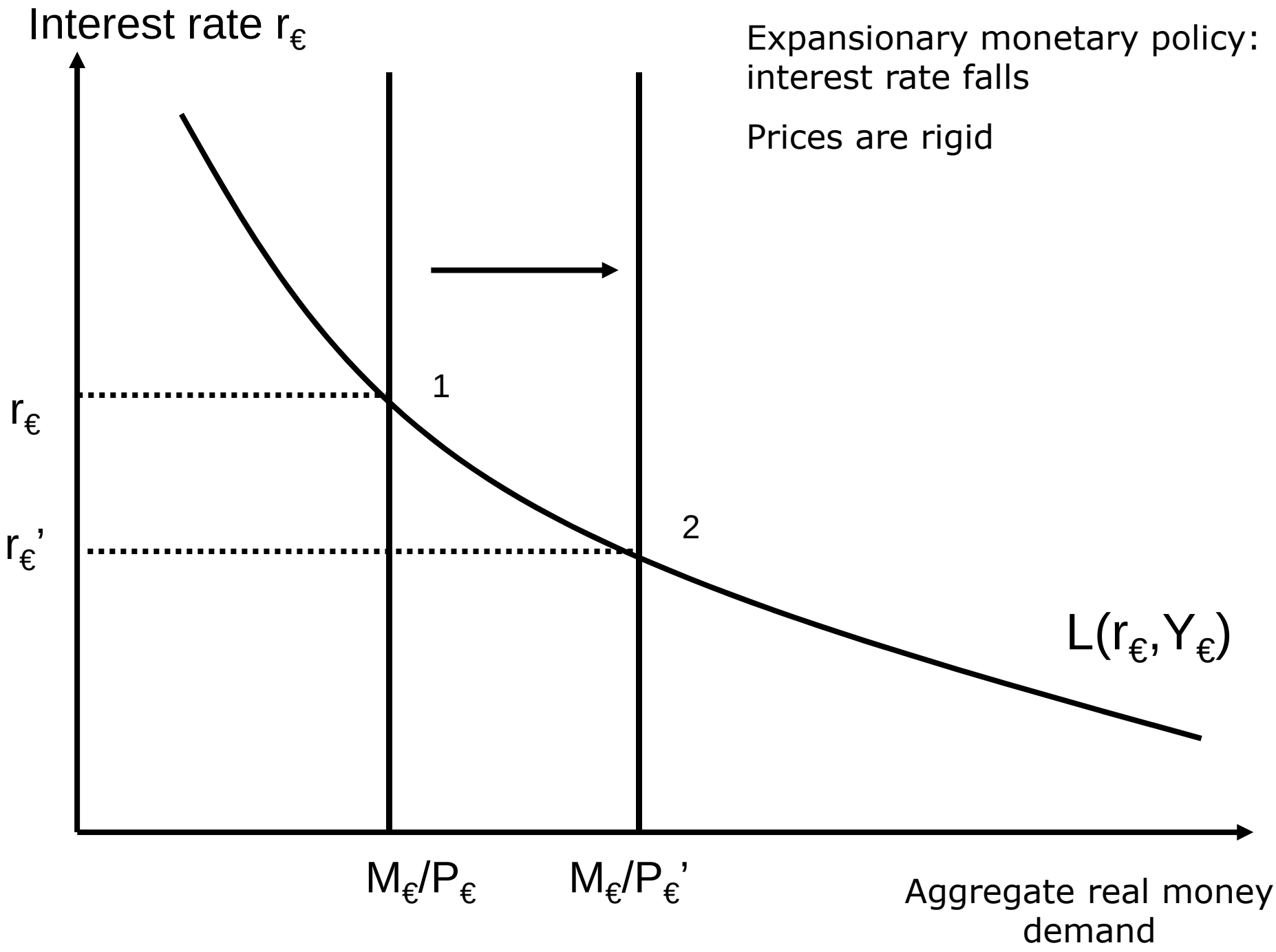
$M^S_€ = M^d_€ = P_€ \times L(r_€, Y_€)$

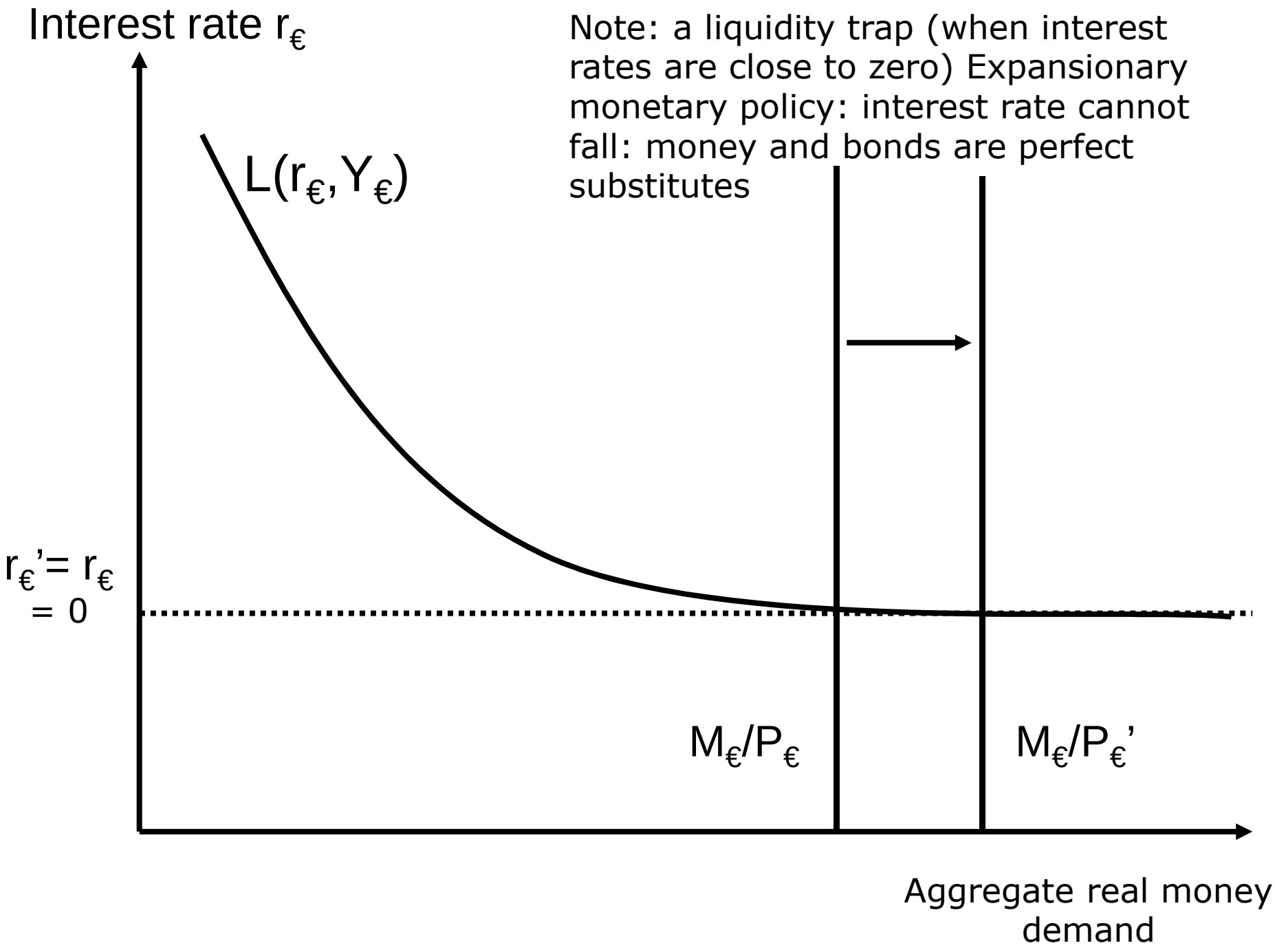
Take logs (small letters):

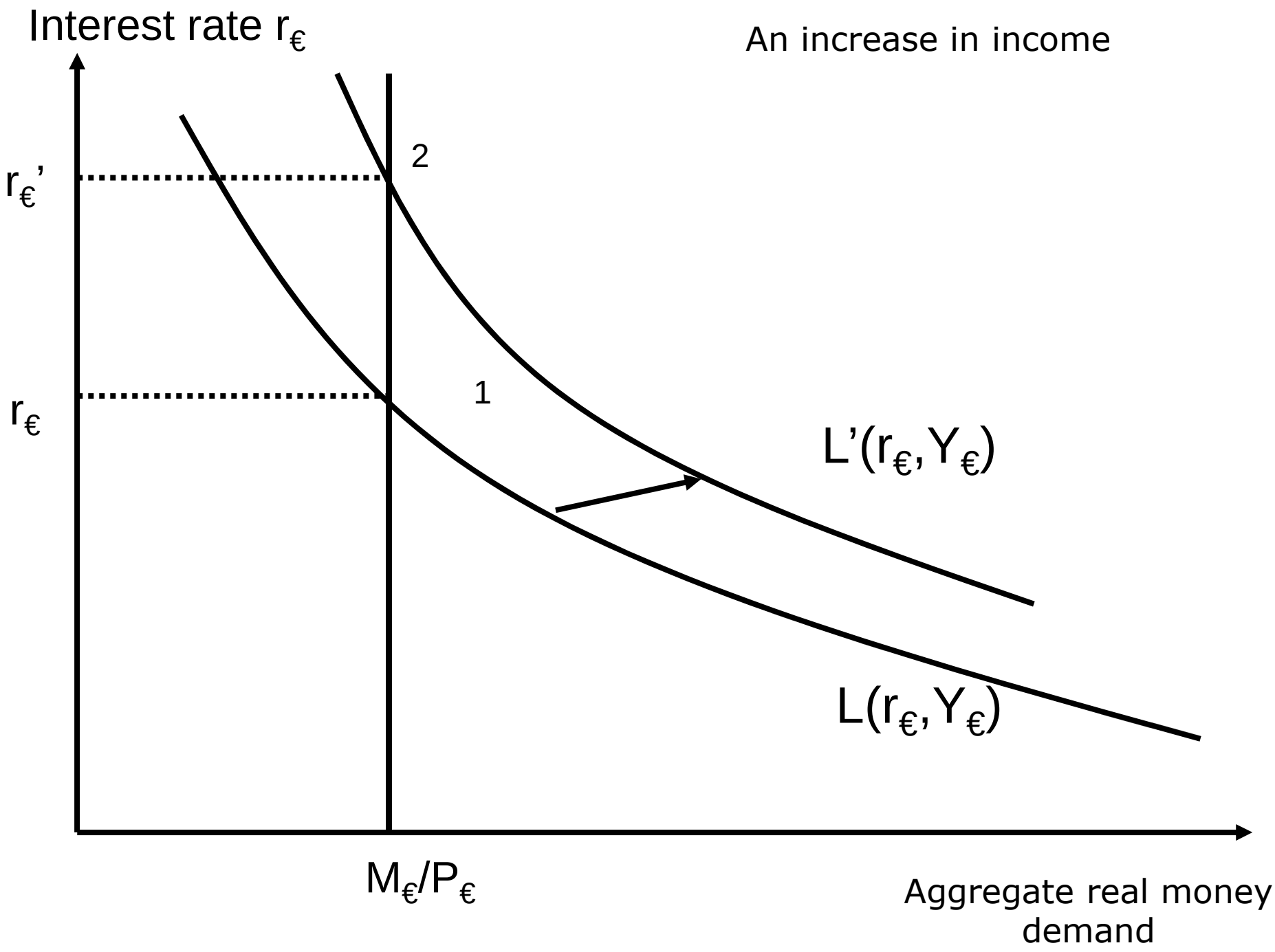
$m^S_€ = m^d_€ = p_€ - \alpha r_€ + \beta y_€$ (α and β positive parameters)

See Rogoff paper in the reading list.


Interest rate $r_€$
The money market
$r_€$
1
$L(r_€, Y_€)$
$M_€/P_€$
Aggregate real money demand


Interest rate $r_€$
Expansionary monetary policy: interest rate falls
Prices are rigid
1
2
$r_€$
$r_€$'
$L(r_€, Y_€)$
$M_€/P_€$
$M_€/P_€$'
Aggregate real money demand


Interest rate $r_€$
Note: a liquidity trap (when interest rates are close to zero) Expansionary monetary policy: interest rate cannot fall: money and bonds are perfect substitutes
$L(r_€, Y_€)$
$r_€' = r_€ = 0$
$M_€/P_€$
$M_€/P_€'$
Aggregate real money demand


Interest rate $r_€$
An increase in income
$r_€'$
$r_€$
2
1
$L'(r_€, Y_€)$
$L(r_€, Y_€)$
$M_€/P_€$
Aggregate real money demand

The €/$ exchange rate results from both US and euro monetary policies

European monetary policy

$M^S_{€} = M^d_{€} = P_{€} \times L(r_{€}, Y_{€})$

US monetary policy

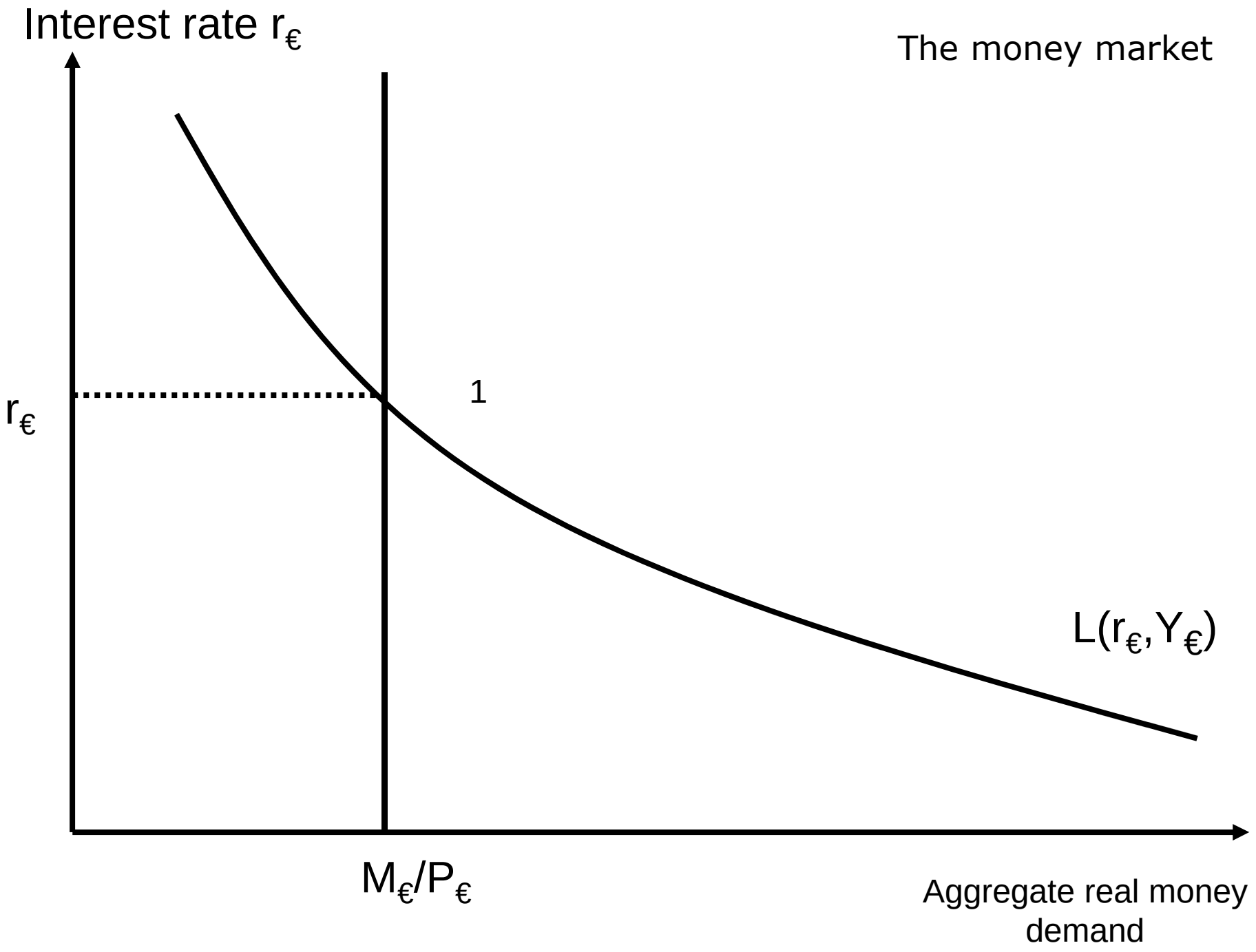
$M^S_{\$} = M^d_{\$} = P_{\$} \times L(r_{\$}, Y_{\$})$

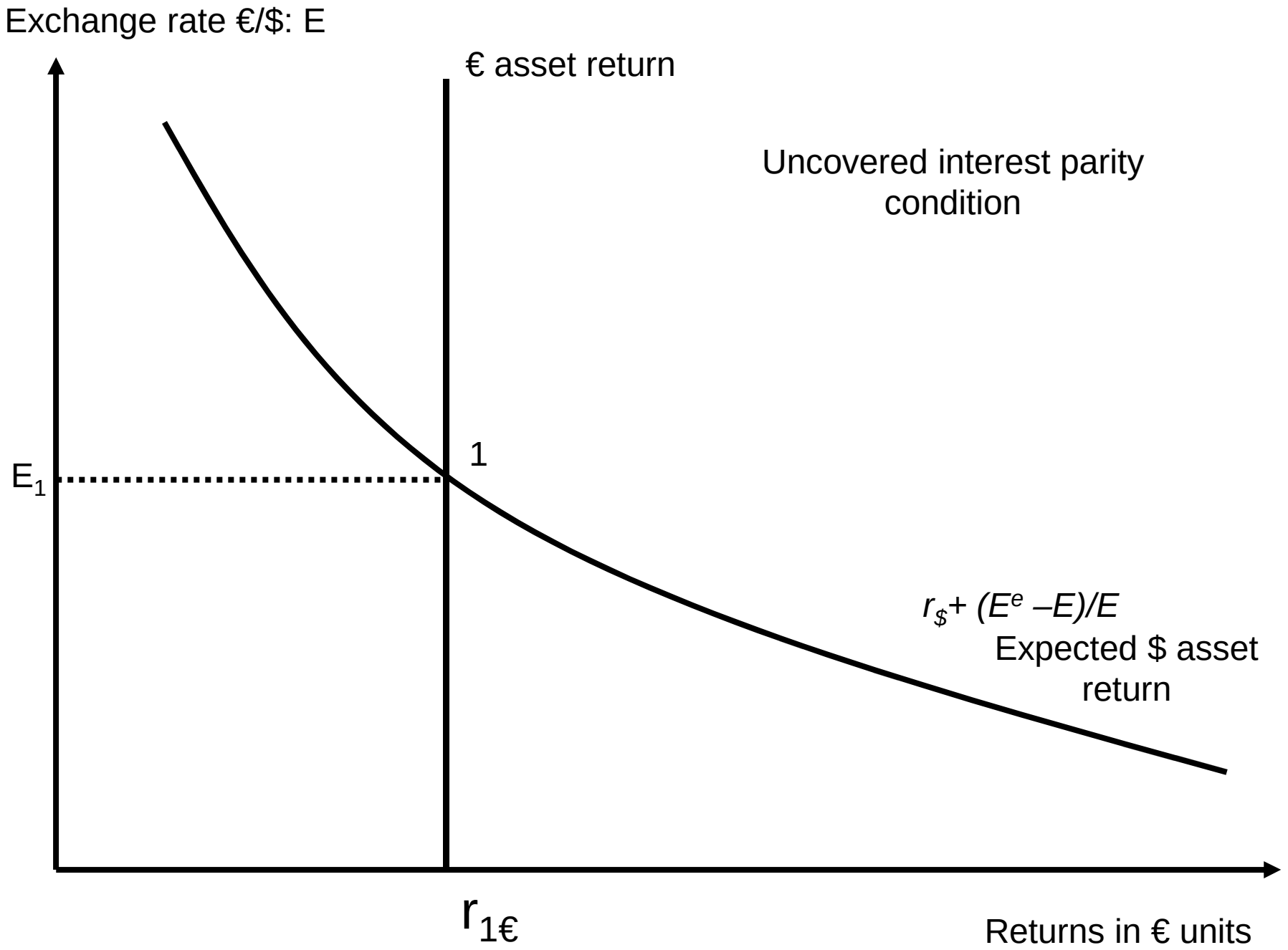
€ interest rate

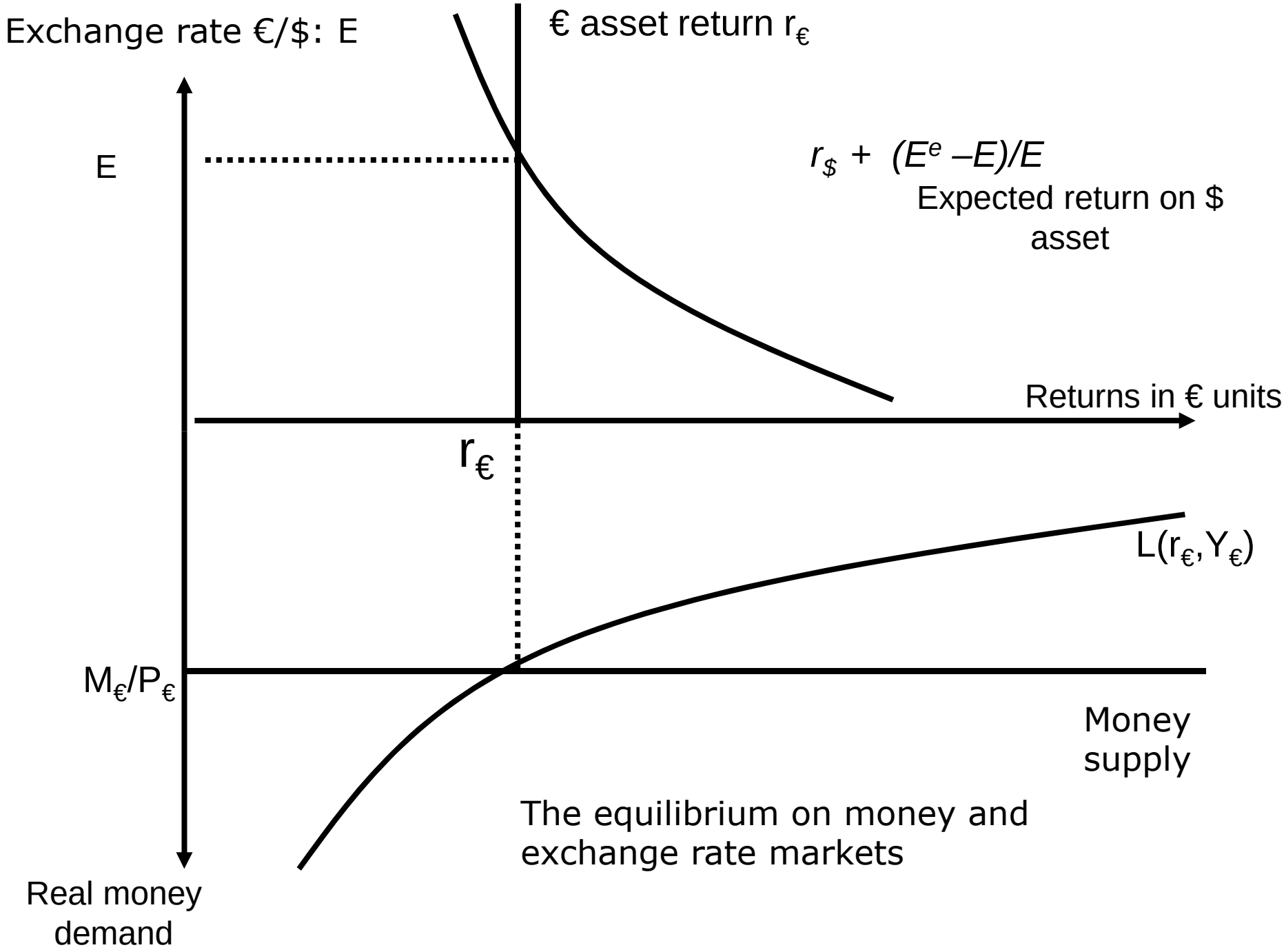
$ interest rate

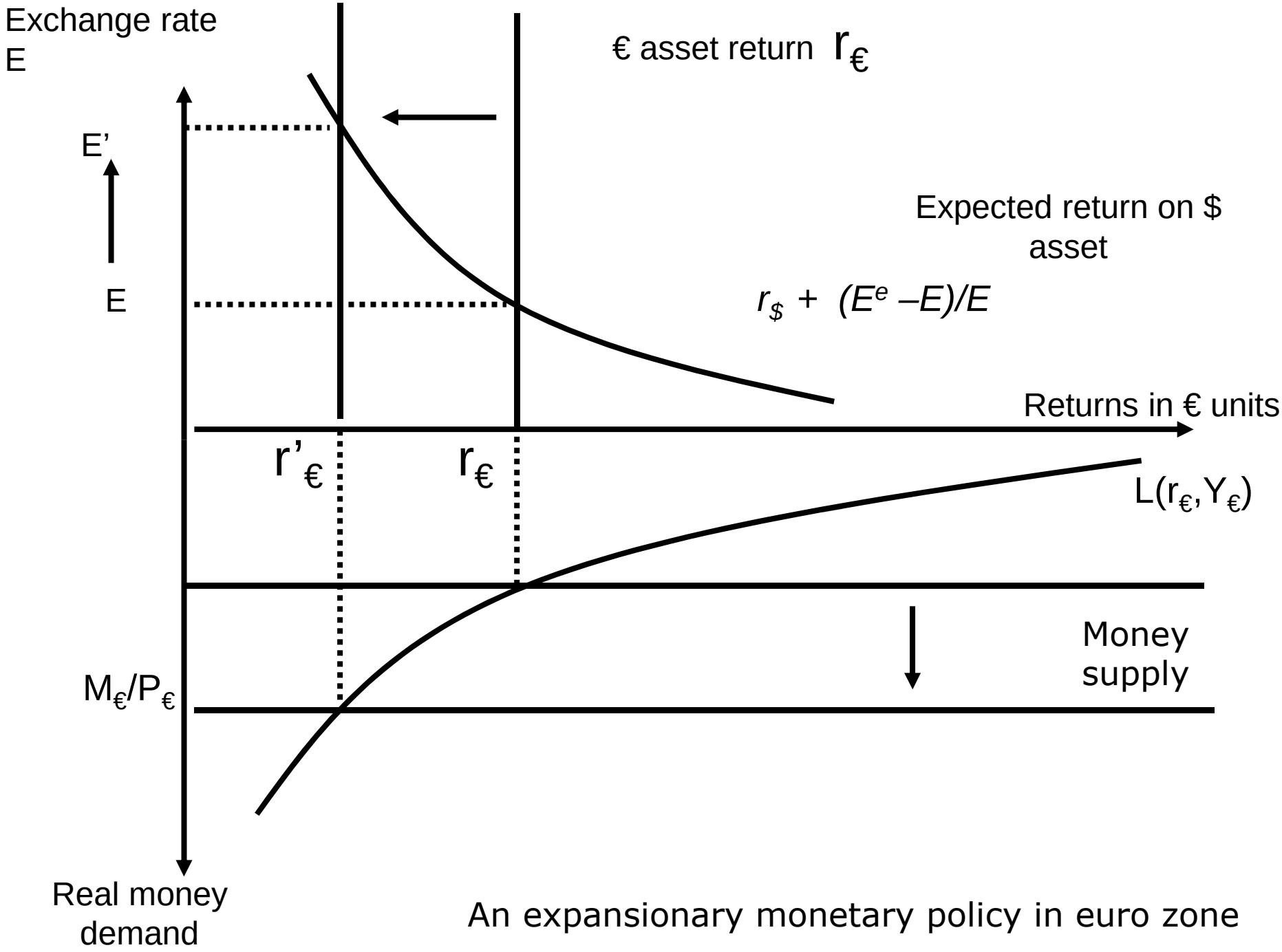
Interest parity condition $r_{€} = r_{\$} + (E^e - E)/E$

Exchange rate E

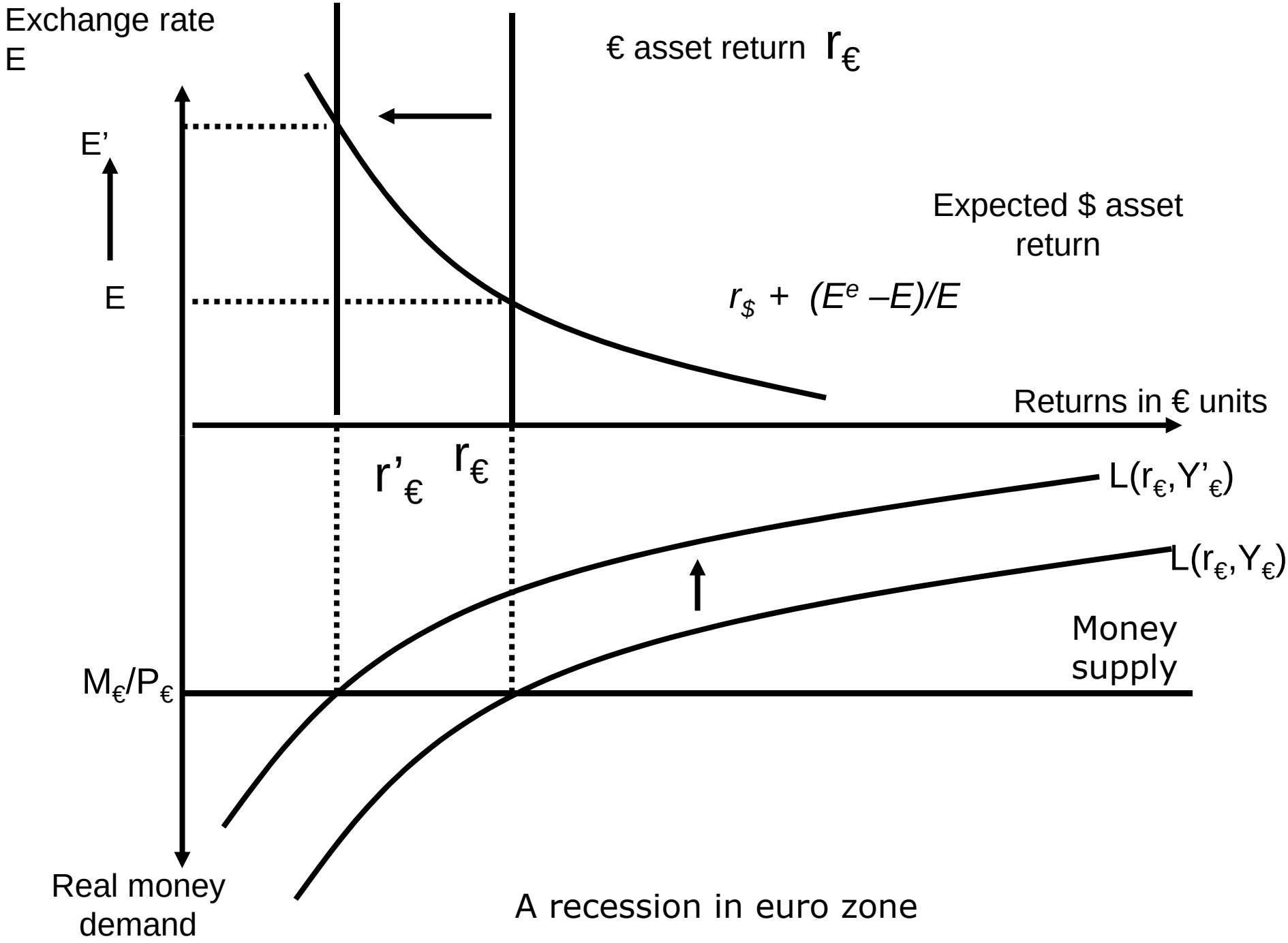

Interest rate $r_€$
The money market
$r_€$
1
$L(r_€, Y_€)$
$M_€/P_€$
Aggregate real money demand


Exchange rate €/$: E
€ asset return
Uncovered interest parity condition
1
E_1
$r_\$ + (E^e - E)/E$
Expected $ asset return
$r_{1€}$
Returns in € units


Exchange rate €/$: E
€ asset return $r_€$
E
$r_$ + (E^e – E)/E$
Expected return on $ asset
Returns in € units
$r_€$
$L(r_€, Y_€)$
$M_€/P_€$
Money supply
The equilibrium on money and exchange rate markets
Real money demand



An expansionary monetary policy in euro zone


Exchange rate
E
€ asset return $r_€$
E'
E
Expected $ asset return
$r_{\$} + (E^e - E)/E$
Returns in € units
$r'_€$
$r_€$
$L(r_€, Y'_€)$
$L(r_€, Y_€)$
Money supply
$M_€/P_€$
Real money demand
A recession in euro zone

What about expectations on exchange rate E^e?

- Up to now, a change in monetary policy has no impact on expected exchange rates E^e
- But should have an impact on future exchange rates if prices are flexible in the long term
- A change in money supply only affects prices in the long run: monetary neutrality in the long run
- The Dornbush model only requires that prices adjust over time to a monetary shock

Prices and money in the long run

- Money market equilibrium

$$M^S_{€} = P_{€} \times L\,(r_{€}, Y_{€})$$

In the long run, prices adjust

$P_{€} = M^S_{€} / L\,(r_{€}, Y_{€})$ where $r_{€}, Y_{€}$ are long term values

⟶ An increase of $M^S_{€}$ has **no real effect** ($r_{€}, Y_{€}$) and only impacts $P_{€}$

= Monetary neutrality

Quantity theory of money

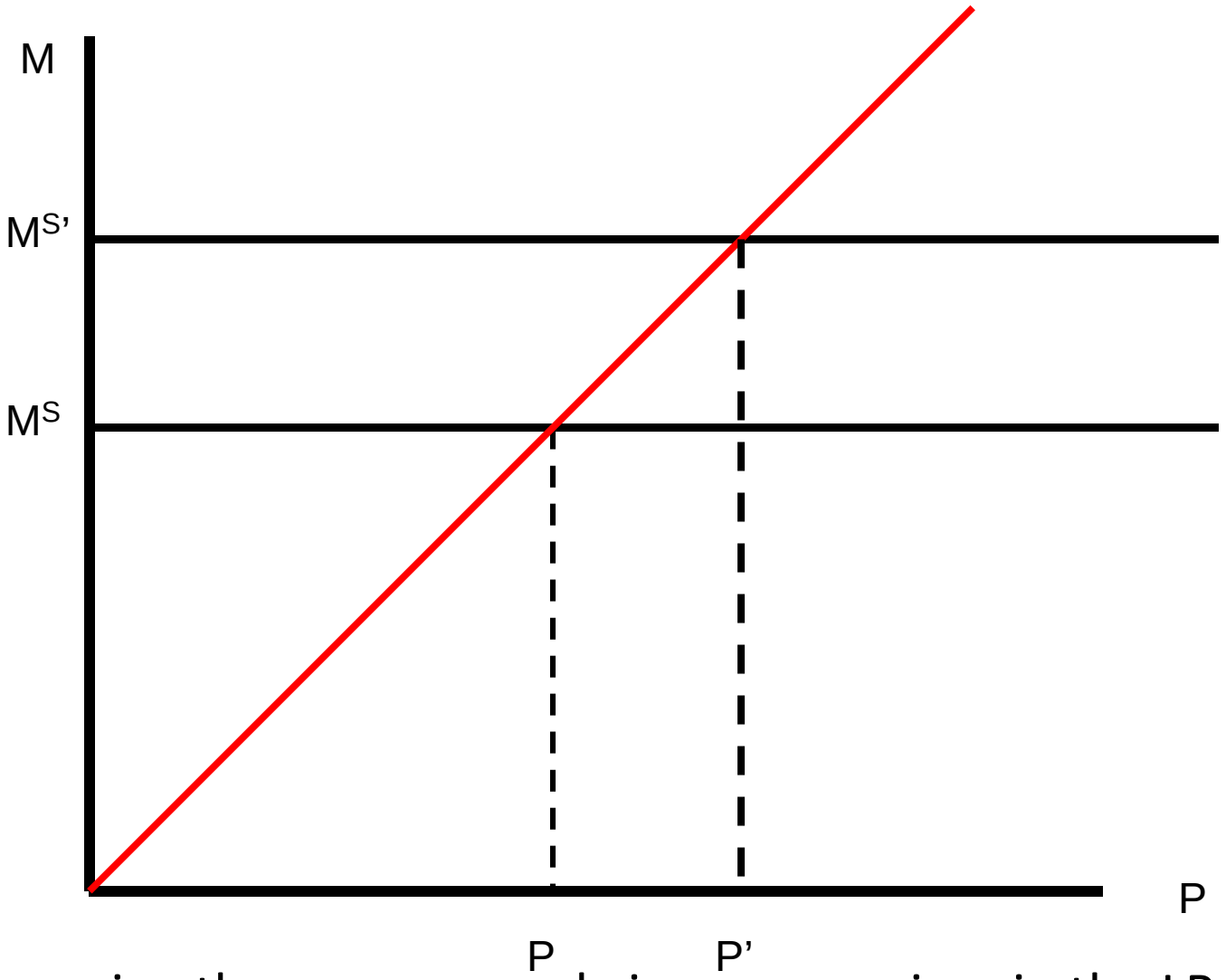
- LR Money market equilibrium

  = Quantity Theory of money

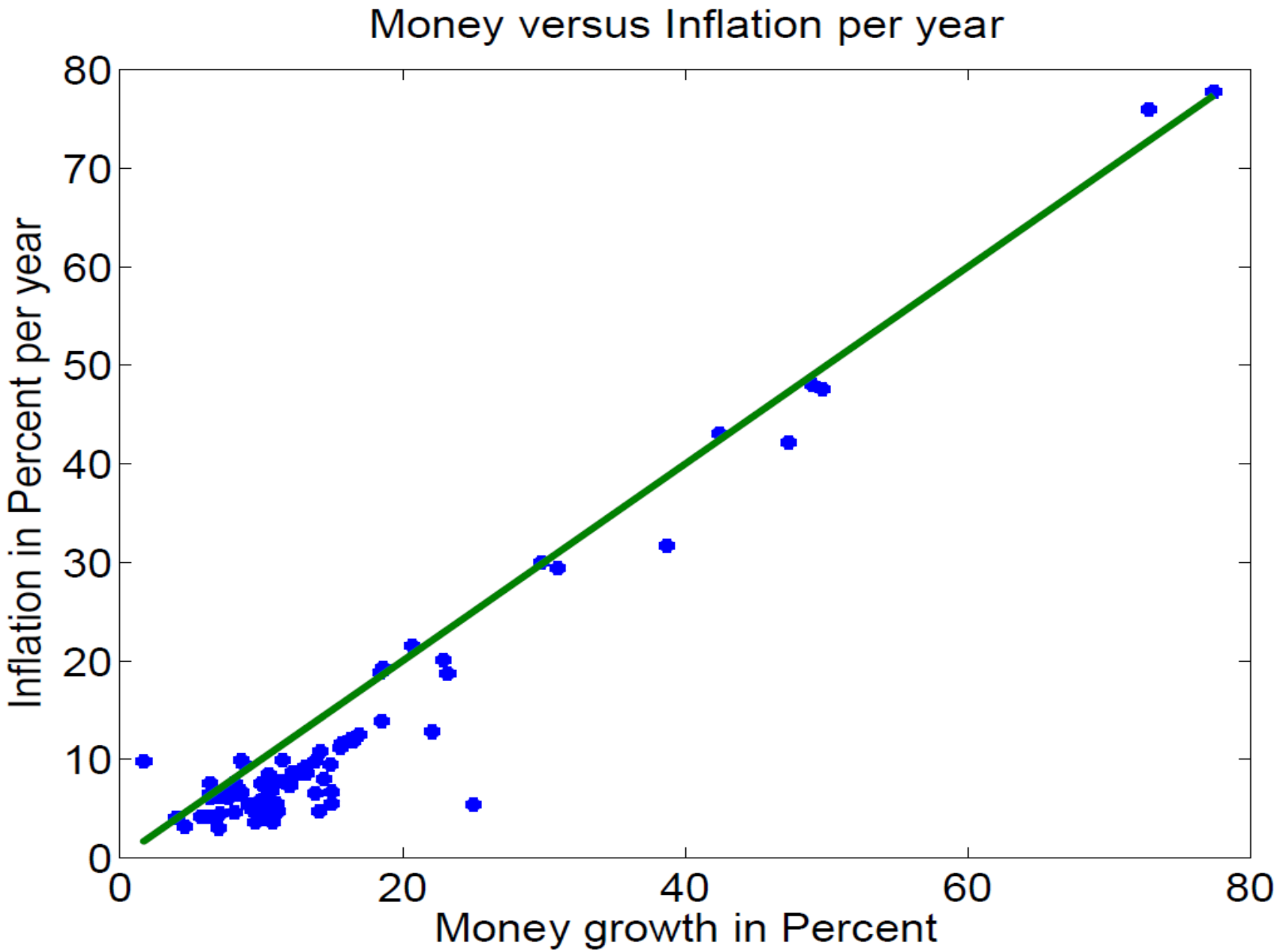
  An increase of $M^S_€$ has **no real effect** ($r_€$, $Y_€$) and only impacts $P_€$

  '%Changes in money supply (money growth) translates into equivalent %Changes in prices (inflation)'

Prices and money in the long run

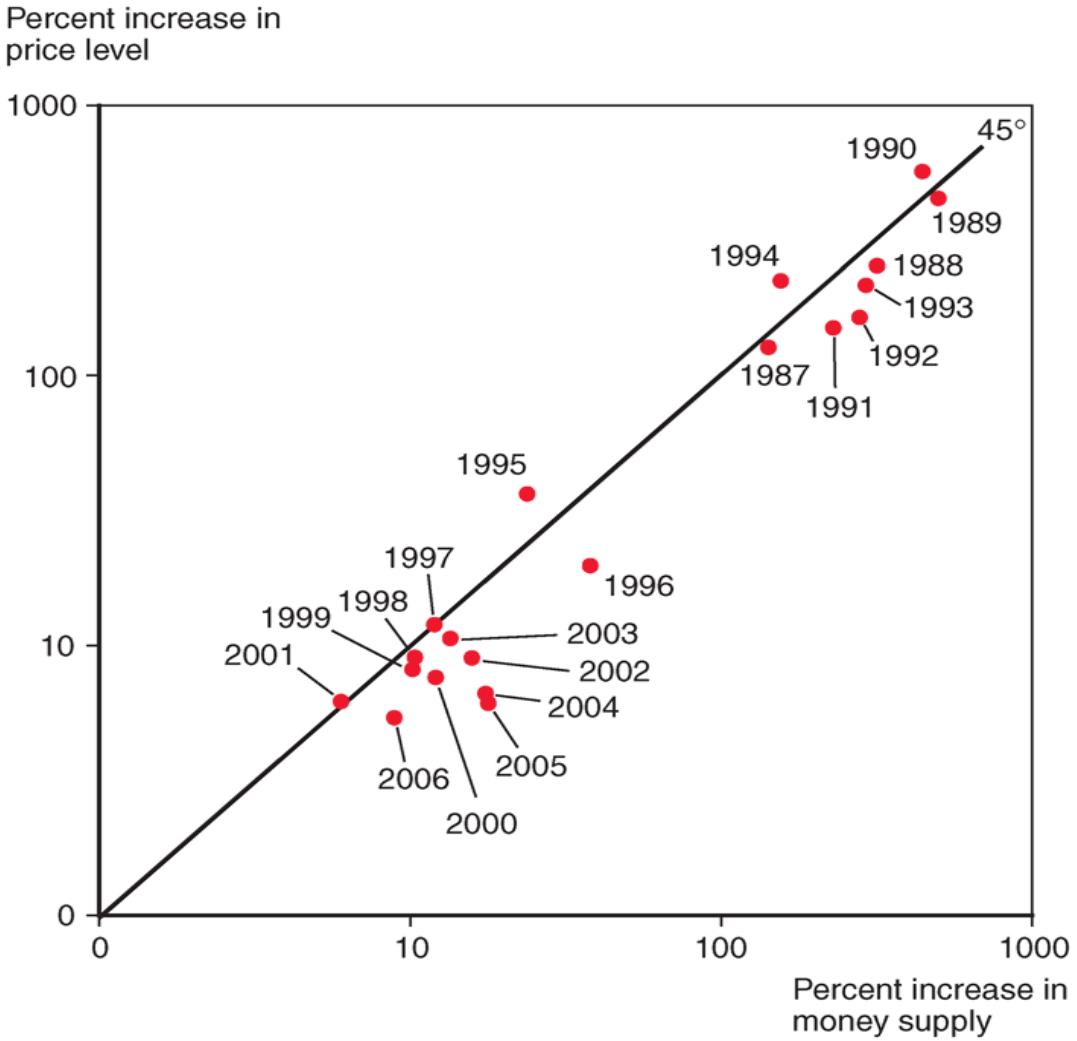


Increasing the money supply increases prices in the LR



1950's to 1990s ; sample of 79 countries; Source: Teles and Uhlig, 2010

Average Money Growth and Inflation in Latin America, 1987–2006

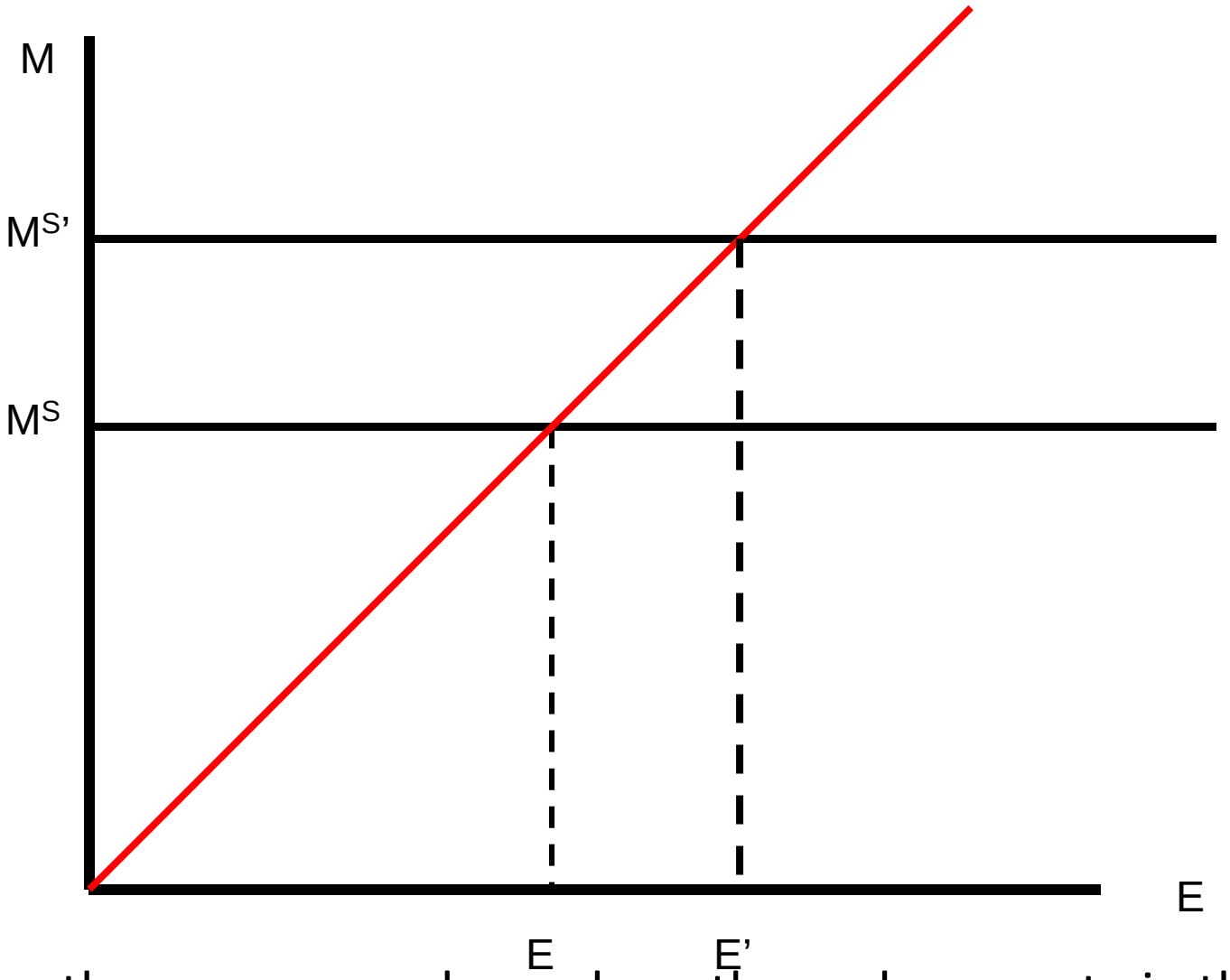


Source: IMF, *World Economic Outlook*, Regional aggregates are weighted by shares of dollar GDP in total regional dollar GDP.

Exchange rate and money in the long run

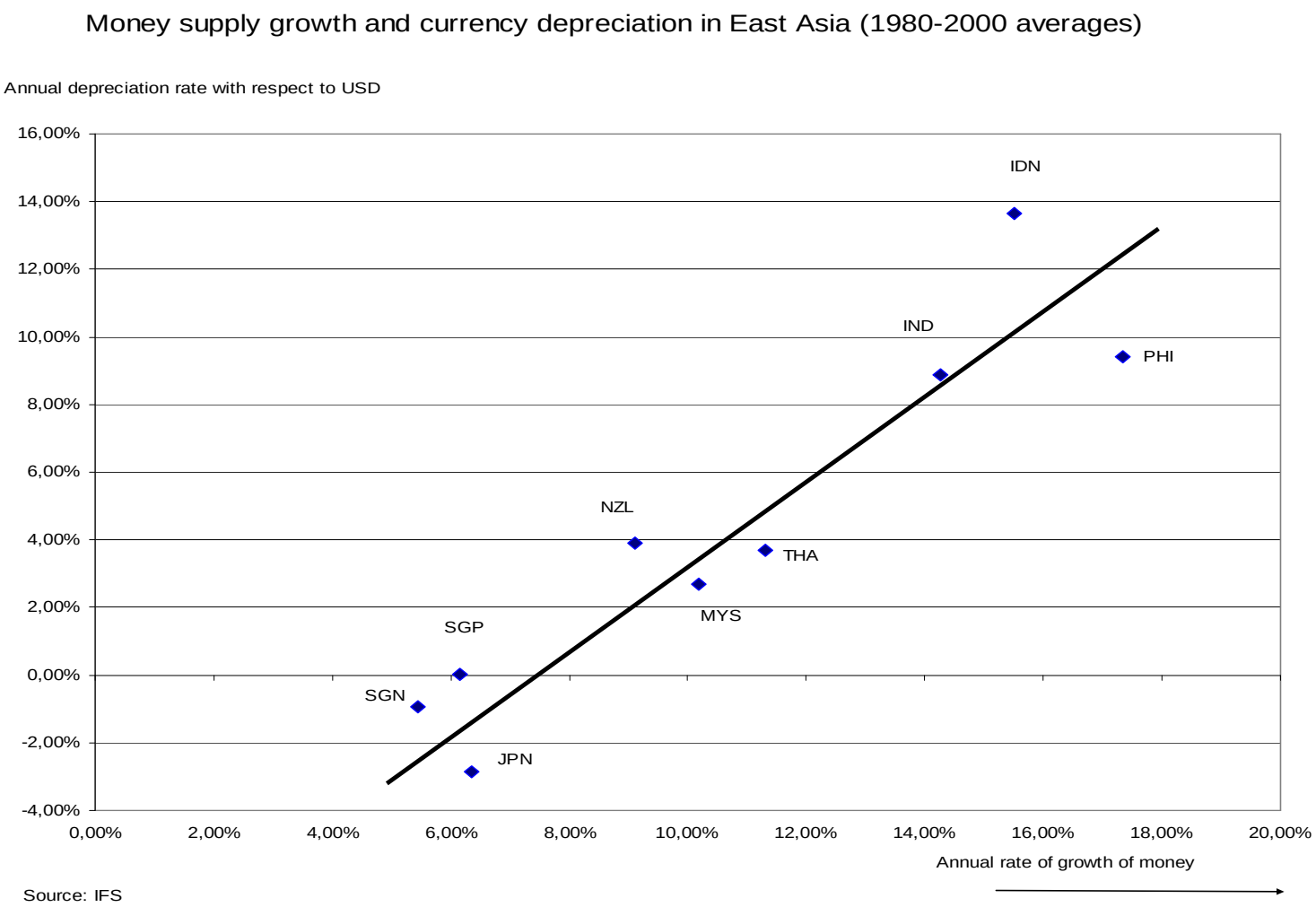
- The exchange rate is a price: price of foreign currency in units of the domestic currency
- So in long term : $M^S_{€}\uparrow \rightarrow E_{€}\uparrow$ and $P_{€}\uparrow$
- Depreciation of € with respect to $ in long term (for $M^S_{\$}$ given)
- Otherwise, some relative prices (European to US) would be affected with real effects : monetary neutrality requires that no such effect exists
- See later Purchasing Power Parity (PPP) also implies that in long term $E_{€} = P_{€} / P_{\$}$ so if $P_{€}\uparrow$ then $E_{€}\uparrow$

Exchange rate and money in the long run



Increasing the money supply weakens the exchange rate in the LR

Exchange rate and money in the long run



Monetary policy, exchange rates and overshooting: the Dornbush model

- What is the effect of a permanent increase in money supply $M^S_€$ on exchange rate dynamics?
- Main result: instantaneously, the € overshoots its long run value; it depreciates by more than in long run
- Result of : slow adjustment of goods prices and immediate adjustment of the exchange rate
- Short run volatility of exchange rate even with forward looking rational agents

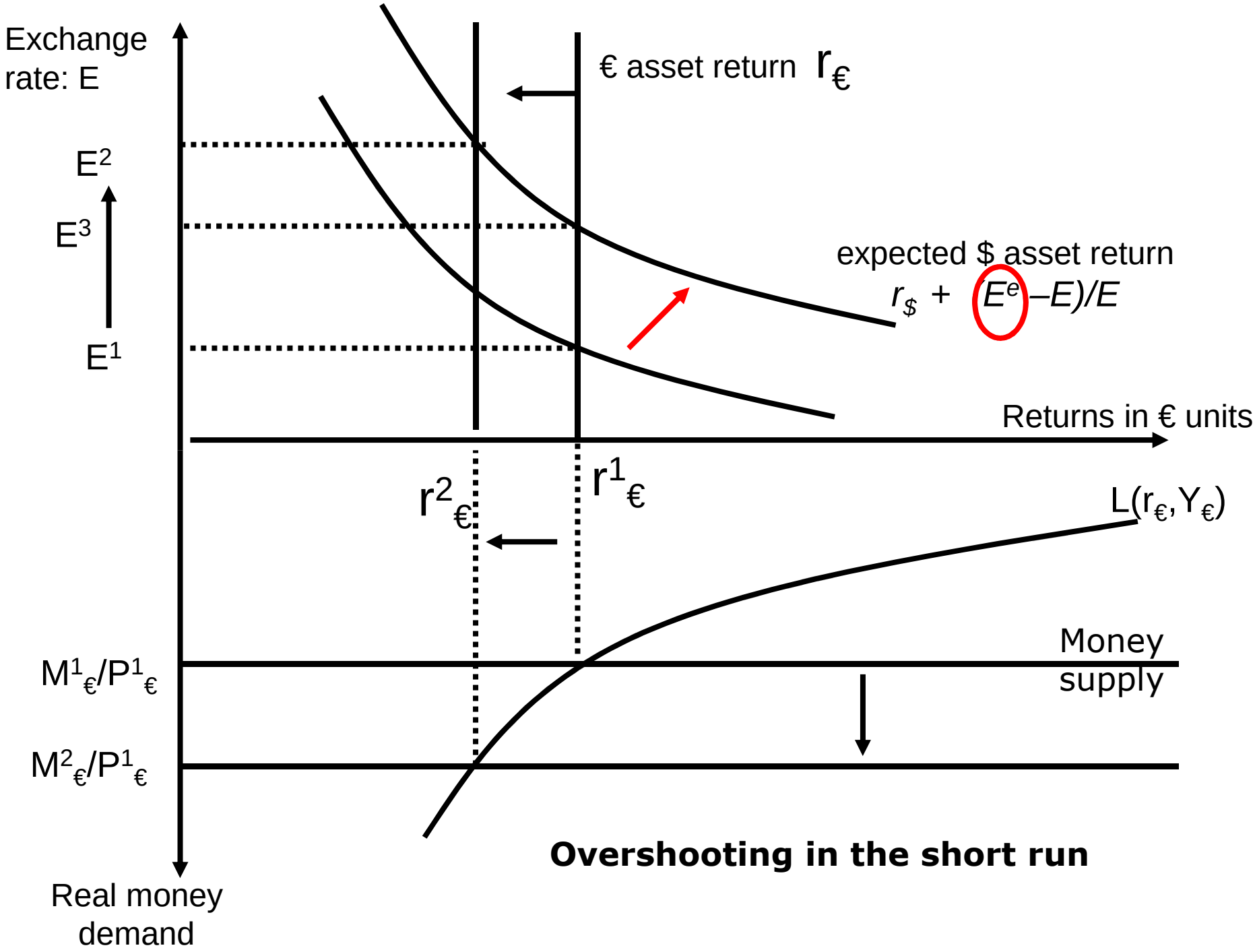
Monetary policy, exchange rates and overshooting: the Dornbush (1976) model

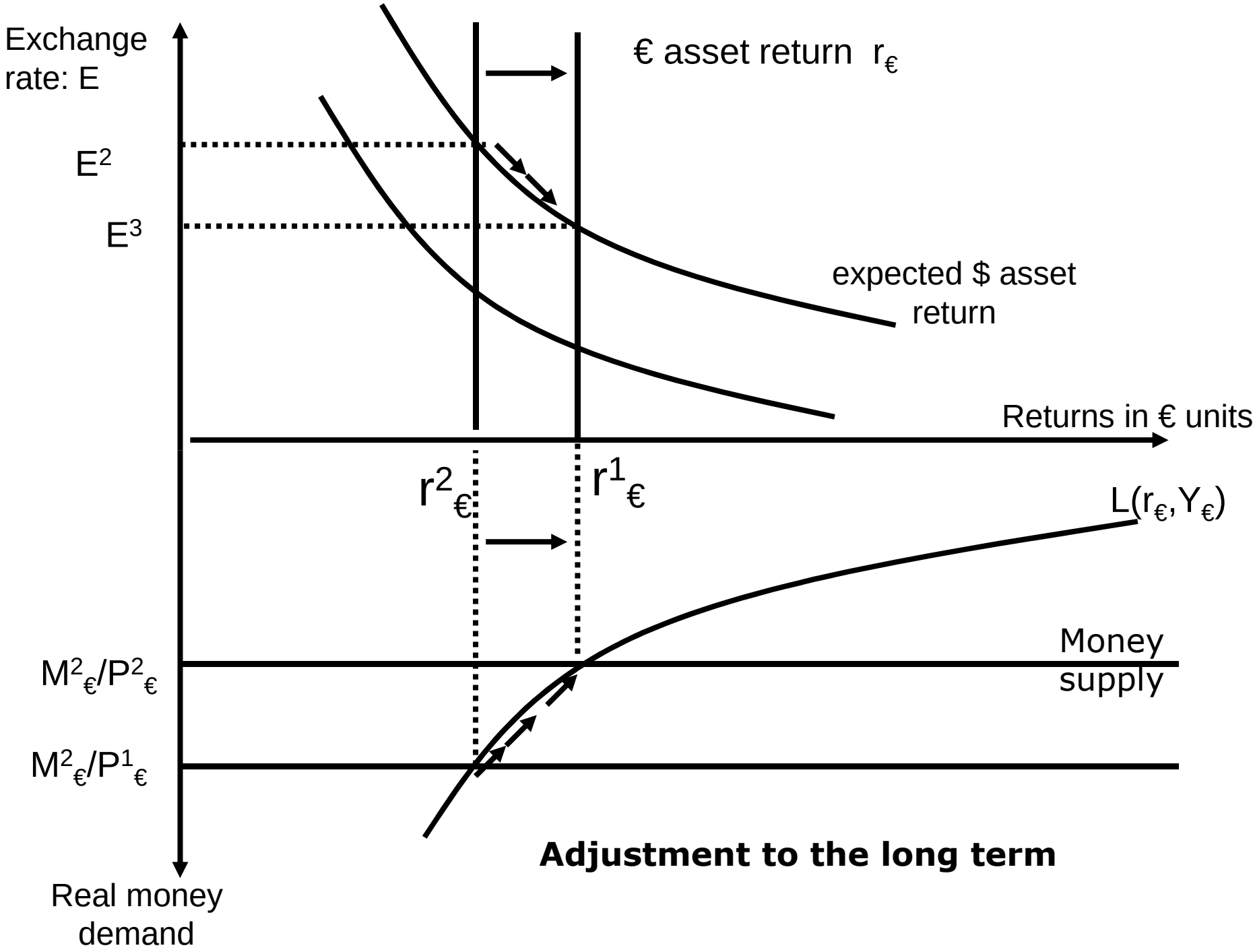
- In long run: E↑
- Short term:

  1) rational agents know that in the future, E↑ : change the expectations (E^e ↑) and E ↑ immediately

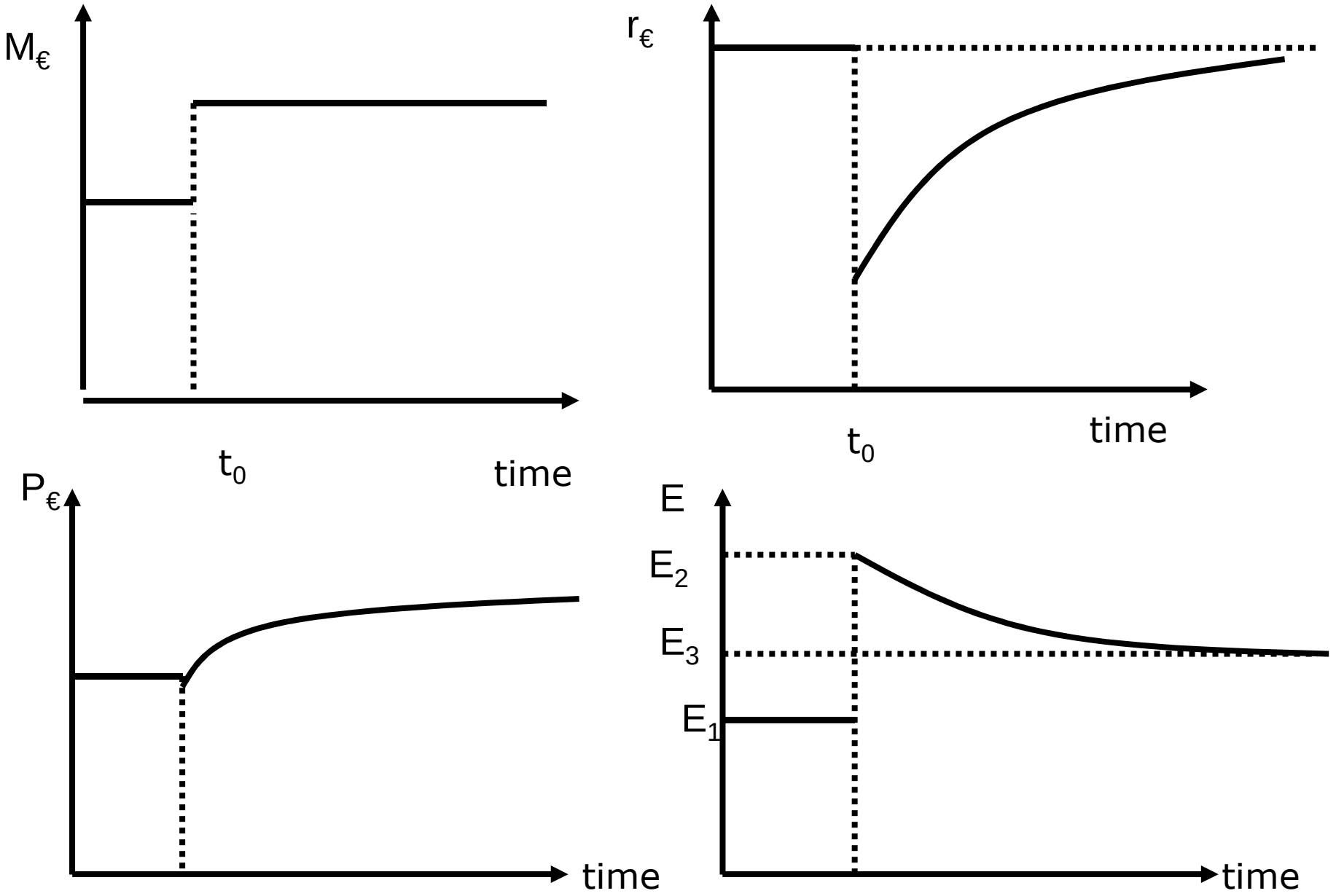
  2) Interest rate fall $r_€$ ↓ (prices are rigid)
- Between ST and LT, prices adjust slowly :

  $P_€$↑ ; $M^S_€$ / $P_€$↓ ; $r_€$ ↑


Exchange rate: E
E2
E3
E1
€ asset return r€
expected $ asset return
r$ + (Ee–E)/E
Returns in € units
r2€
r1€
L(r€,Y€)
Money supply
M1€/P1€
M2€/P1€
Real money demand
Overshooting in the short run


Exchange rate: E
€ asset return $r_€$
E^2
E^3
expected $ asset return
Returns in € units
$r^2_€$
$r^1_€$
$L(r_€, Y_€)$
Money supply
$M^2_€/P^2_€$
$M^2_€/P^1_€$
Real money demand
Adjustment to the long term

Adjustment from the short to the long run



Intuition of the overshooting result

Interest parity condition: $r_{€} = r_{\$} + (E^{e} - E)/E$

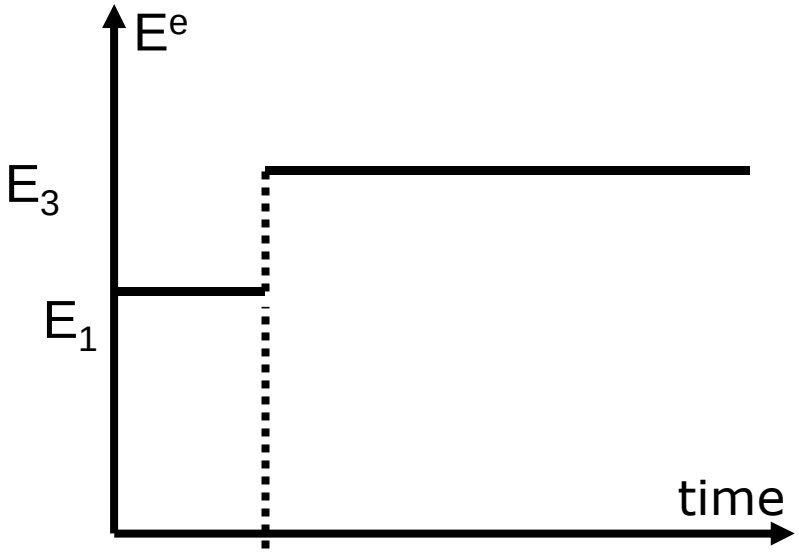
Due to monetary shock: interest rate $r_{€}$ falls

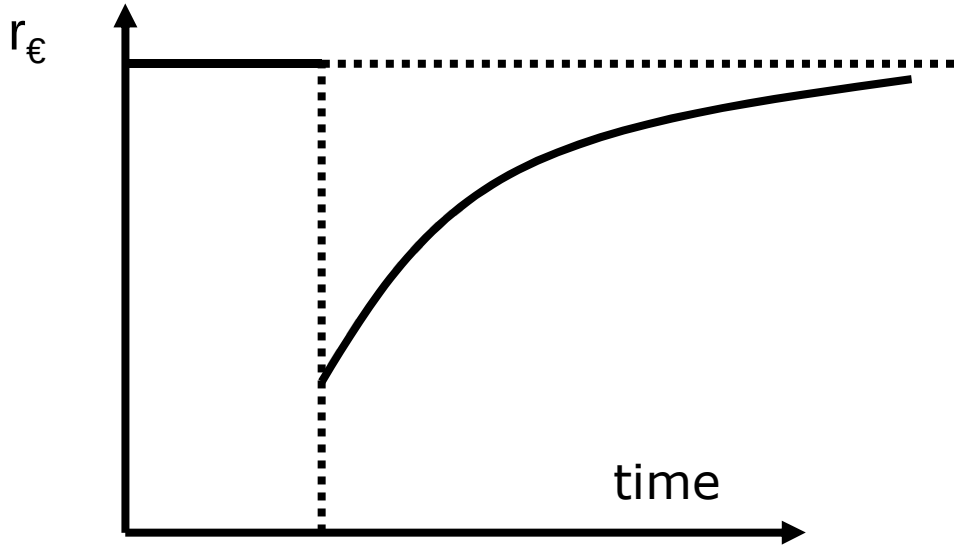
AND E^{e} ↑

For investors to be willing to hold euros, a large immediate depreciation of € (overshooting) must occur: so that an appreciation can take place between now t_0 and the future (that compensates for the fall in interest rate)

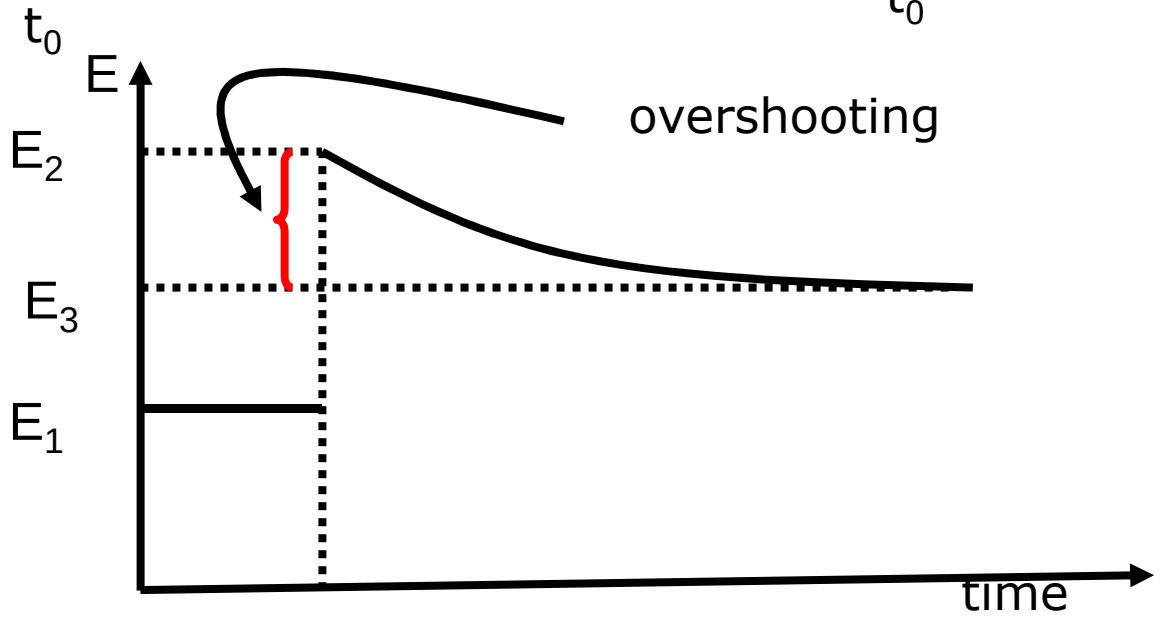
Price rigidity is key for overshooting result

Exchange rate dynamics to maintain $r_{€} = r_{\$} + (E^e - E)/E$





t_0



Brief Summary

- Forex markets are very liquid and the volume of transactions is huge, predominantly in dollar, the vehicle currency.
- Equilibrium in Forex markets rely on an arbitrage condition that leaves investors indifferent between holding two currencies (uncovered interest parity).
- Without risk premium nor transaction costs, this condition states that future exchange rate changes should reflect interest rate differentials. This does not hold in the data in the short-run but UIP remains a good benchmark to interpret how exchange rates react to news (on interest rates, economic activity).
- Monetary models of exchange rates show that permanent changes in money supply lead to a depreciation in the long-term of the currency, with some overshooting in the short-run due to price rigidities.