

**There are a couple of subtle points worth noting about the answers to the Problem Set.**

**Question 3.**

To calculate a real interest rate, we can use Irving Fisher's formula:

$$r_t = i_t - \pi_t$$

real interest rate = nominal interest rate – inflation rate.

This is an approximation to the formula

$$r_t = \frac{1+i_t}{1+\pi_t} - 1.$$

If you are working with a pair of countries with a lot of inflation, you need to use his second equation.

You need to be careful with units. It is also worth noting that Fisher thought of  $\pi_t$  as expected inflation. When we approximate  $\pi_t$  with realized inflation, it is usual to think of inflation going forward, that is,

$$\pi_t = P_{t+1} / P_t - 1,$$

In other words, we assume that consumers have something like perfect foresight. We could also assume that consumers expect inflation to stay constant and approximate  $\pi_t$  with realized inflation in the current period, that is,

$$\pi_t = P_t / P_{t-1} - 1.$$

Let me work through an example. Suppose that in 1980 the price index (GDP deflator or CPI) is 112 and in 1981 it is 120. Suppose that the nominal interest rate (best some sort of loan rate — government bond rates are usually so low that real interest rates are often negative) is 11.2 percent. The inflation rate is

$$\pi_{1980} = 120 / 112 - 1 = 0.0714$$

or 7.14 percent. The real interest rate is

$$r_t = 0.112 - 0.0714 = 0.0406$$

or 4.16 percent. If we use the other formula, we get

$$r_t = \frac{1.112}{1.0714} - 1 = 0.0379$$

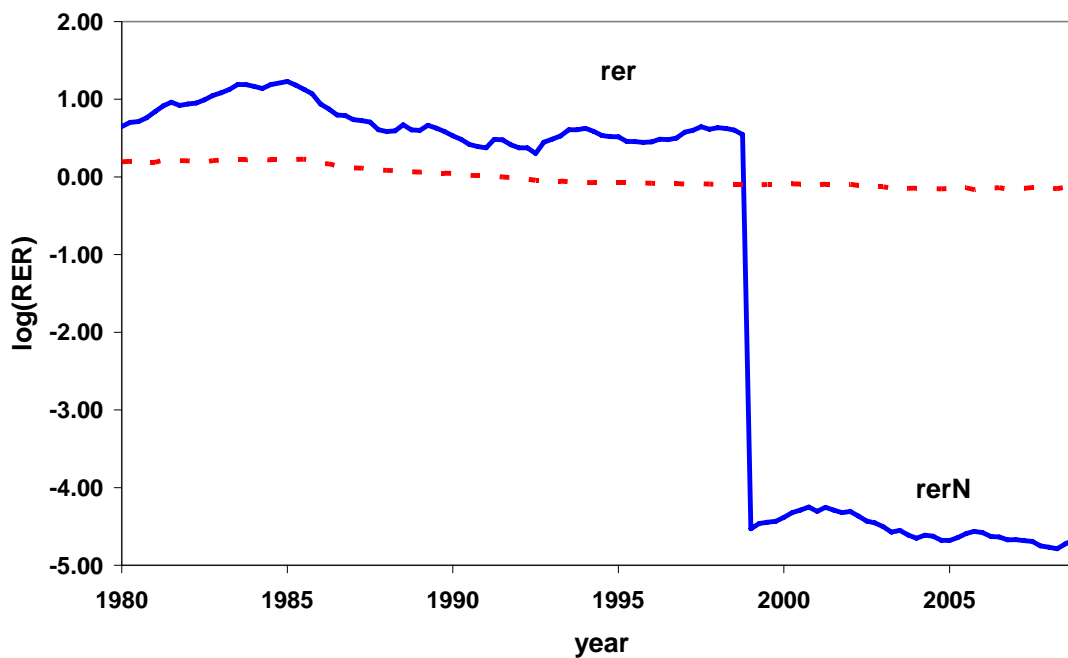
or 3.79 percent.

#### Question 4

Suppose that you are doing an analysis of the real exchange rate, one of which switched to the euro in 1999 (or some after). You need to take that into account. The IMF is inconsistent about this: when they do exchange rates of countries, like Argentina or Brazil, that do currency reforms, changing the name of the currency and so forth, they do the sort of adjustment that I describe below.

Here I describe the computation of the Spain-United States real exchange rate, 1980Q1–2009Q1. If I just link the two nominal exchange rates on the IFS, pesetas per dollar and euros per dollar together, I get a graph with a wild jump from 1998Q4 to 1991Q1, when the euro was introduced.

**Spain-United States Real Exchange Rate**



quarter	pesetas/dollar	euros/dollar	NER
1998.50	149.642		149.642
1998.75	141.474		141.474
1999.00		0.89093	0.89093
1999.25		0.94631	0.94631

What we need to do is to multiply all of the exchange rates in 1999Q1 and after by the conversion factor 166.386 pesetas/euro:

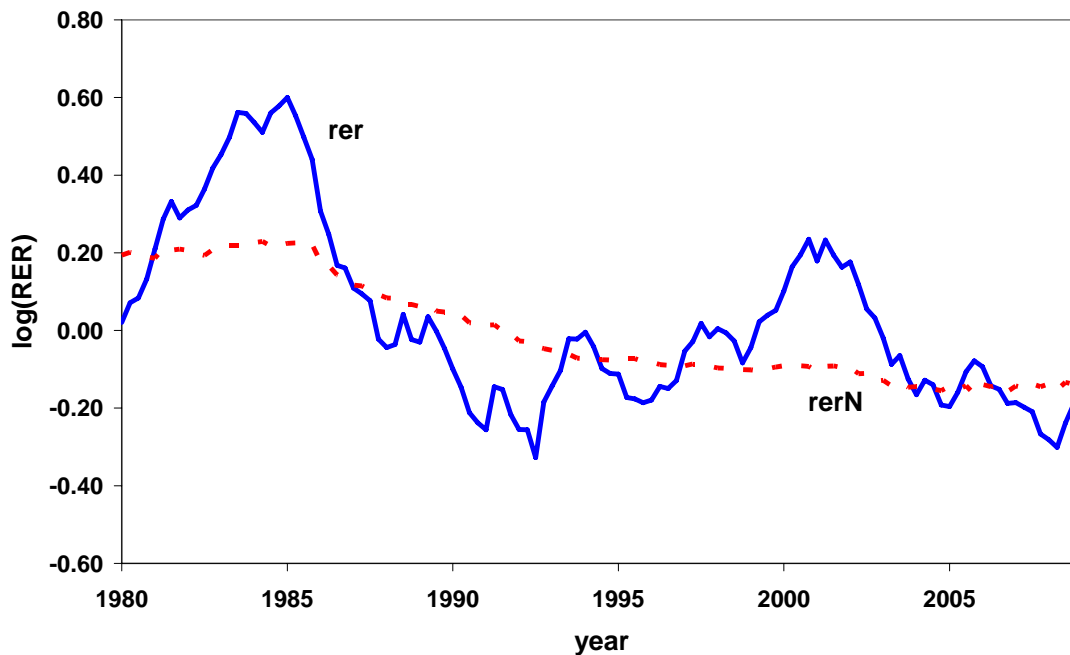
quarter	pesetas/dollar	euros/dollar	NER
1998.50	149.642		149.642
1998.75	141.474		141.474
1999.00		0.89093	148.238
1999.25		0.94631	157.453

We could do the equivalent by dividing all of the exchange rates in 1998Q4 and after by this factor:

quarter	pesetas/dollar	euros/dollar	NER
1998.50	149.642		0.89937
1998.75	141.474		0.85028
1999.00		0.89093	0.89093
1999.25		0.94631	0.94631

Either way, we get a very different picture, with very different statistics associated with it.

**Spain-United States Real Exchange Rate**



There are a couple of points worth noting:

I found the conversion factor 166.386 pesetas/euro on the web. I could have used the pesetas/ECU rate in 1998Q4 from the IFS, 167.165, but my calculations would have been off by a little bit.

Do we need to do similar calculations for the Spanish CPI and PPI? No, because INE and the IMF have already done them.

All of the calculations discussed here, both the correct ones and the wrong ones are on the course web page in SpainUS.xls.