**Purchasing Power Parity**

**Purchasing Power Parity and the Law of One Price**

The law of one price says that the same good will cost the same amount everywhere. If not, there is an arbitrage opportunity.

Buy the good one place and sell it in another place where the price is higher.

This means that PD = SD/F (direct) x PF Note: D = Domestic and F = Foreign

The price of a good domestically is the same as its price on a foreign market, adjusted for the exchange rate.

This presumes frictionless markets

In reality, there are transportation costs, goods are not always identical, differences in tastes in different countries, and taxes and tariffs.

Test of PPP – The Big Mac Standard

 Can you buy Big Macs in Ukraine, take them to Switzerland, and sell them for a profit?

Even though The Big Mac does not have the same price everywhere, it is not arbitragable.

Absolute PPP deals with specific goods such as a Big Mac.

Relative PPP deals with **changes** in prices (inflation or deflation).

Relative PPP says that prices in different markets should change at the same rate, and that unequal changes in prices will be reflected in their exchange rate.

1 + domestic inflation rate = 1 + change in exchange rate

1 + foreign inflation rate

(1 + ΠD) = St+1 Or, (1 + ΠD) = 1 + ΔSD/F

(1 + ΠF) S­t (1 + ΠF)

Tests have shown that relative PPP tends to hold true in the long-run much better than in the short run.

**International Fisher Effect**

The Fisher effect says that nominal (observed) interest rates are approximately equal to the real interest rate plus the expected inflation rate. To be exact, the formula is:

1 + real rate = 1 + nominal rate

 1 + inflation rate

Investors are only concerned with the real rate and will invest where it is highest, and borrow where it is lowest. In order for an absence of arbitrage, every country’s real rate must be equal.

This means that differences between two countries’ nominal interest rates must be entirely due to differences in expectations about their relative rates of inflation.

The spot exchange rate should change in an amount equal to but in the opposite direction from the difference in interest rates between two countries.

The percentage change in the spot rate should equal the percentage relative change in interest rates or the percentage relative change in inflation.

To better understand the differences between real and nominal rates and cash flows, let’s step outside of the world of international finance for a moment and look more closely at inflation in the context of retirement planning.

**Inflation** means a drop in the purchasing power of money. If goods cost $100 last year and $103 today, we have 3% inflation.

**CPI** - Consumer Price Index - The most commonly used measure of inflation. It is based on changes in prices of a standard basket of goods. Some say that it overstates the inflation rate because it doesn’t allow for substitution.

You calculate inflation the same way you calculate interest.

3% inflation for 10 years is (1.03)10

$100 of goods in 10 years will cost $134.39

Inflation must be considered in investment decisions.

**Nominal cash flow** - The actual number of dollars to be received in the future (adjusted upwards to reflect expected inflation).

**Real cash flow** - Expressed in terms of time zero purchasing power.

**Nominal Interest Rate** - The rate of growth of your money

**Real Interest Rate** - The rate of growth of your purchasing power

**Fisher Equation:**

1 + Real Interest Rate = 1 + Nominal Interest Rate

 1 + Inflation Rate

**Approximation**: Real Interest Rate = Nominal Interest Rate – Inflation rate

**Example**:

Nominal interest rate = 7%

Inflation = 3%

What is the real interest rate?

1.07 = 1.0388 ⇒ Real rate = 3.88%

1.03

Approximation: 7% - 3% = 4%

If inflation expectations increase, nominal interest rates increase in order to maintain purchasing power. Note: we often refer to inflation, but it’s really inflation expectations since the interest rates declared in the present are matched with inflation expectations for the future.

To convert nominal dollars to real dollars:

Real Dollars = Nominal Dollars / (1+inflation rate)t

To convert real dollars to nominal dollars:

Nominal Dollars = Real Dollars (1+inflation rate)t

You must account for inflation in any problem involving the time value of money.

You must either adjust the dollars or the interest rate.

Nominal cash flows must always be discounted at the nominal rate.

Real cash flows must always be discounted at the real rate.

Note that at time zero, nominal dollars equals real dollars.

An important time to consider inflation is in retirement planning.

Suppose I’m 25 and plan to retire at age 65

I want $60,000/yr for 35 years (I think I’ll live to age 100), but what I really want is what $60,000/yr can buy me today (the purchasing power of $60,000 each year)

Assumptions:

* Inflation is expected to be level at 2%
* Interest (investment) rates are 7%

How much must I save per year?

Real Interest Rate: 1.07 = 1.049 ⇒ real return = 4.9%

 1.02

To get a $60,000/yr annuity for 35 years – in real dollars:

PVA = 

 = $994,725.79

So I need $994,725.79 of today’s dollars at age 65 to be able to consume $60,000 (today’s dollars) per year for 35 years.

To get $994,725.79 of today’s purchasing power, what I’ll actually need is $2,196,393.99 at age 65. This means converting Real Dollars to Nominal Dollars.

 994,725.79 (1.02)40 = 2,196,393.99

I must save $\_\_\_/yr. to get to $2,196,393.99 in 40 years.

We can most easily do this as the Future value of an annuity.

2,196,393.99 = C [(1.07)40 – 1]

 .07

C = $11,002.04

So, if I save $11,002.04 (nominal dollars) per year for 40 yrs. at 7%, I’ll have $2,196,393.99.

But due to inflation, the $2,196,393.99 will only be worth the equivalent of $994,725.79.

However, this will be enough to generate (at 7% interest with 2% inflation), a 35-year annuity worth the equivalent of $60,000 per year.

How much money will I withdraw from my retirement account when I turn 66?

$60,000 in real dollars

$60,000 (1.02)41 = $135,132.03 in nominal dollars

You will then withdraw 2% more (in nominal dollars) each year to keep up with inflation.

I can also determine how many real dollars I need to invest into my retirement account each year. This is a bit more complex because it means I have to invest a different amount of money (in nominal dollars) each year, but it means that I’m setting aside the same purchasing power each year.

Discount real dollars at the real interest rate:

994,725.79 = C [(1.049)40 – 1]

 .049

C = 8,433.56

So each year, you set aside $8,433.56 of today’s purchasing power.

In nominal dollars, this is:

$8,433.56 (1.02) = $8,602.23 at age 26

$8,433.56 (1.02)2 = $8,774.28 at age 27

$8,433.56 (1.02)3 = $8,949.76 at age 28

etc.

**Relationship between Relative Purchasing Power Parity and Interest Rate Parity**

**Fisher Effect says:**

1 + Real Rate ($) = 1 + Nominal Rate ($) / 1 + Inflation Rate (U.S.)

And

1 + Real Rate (€) = 1 + Nominal Rate (€) / 1 + Inflation Rate (Eur)

**International Fisher Effect says:**

1 + Real Rate ($) = 1 + Real Rate (€)

Therefore:

1 + Nominal Rate ($) / 1 + Inflation Rate (U.S.) = 1 + Nominal Rate (€) / 1 + Inflation Rate (Eur)

And therefore:

1 + Nominal Rate ($) / 1 + Nominal Rate (€) = 1 + Inflation Rate (U.S.) / 1 + Inflation Rate (Eur)

**Relative PPP says:**

1 + Inflation Rate (U.S.) / 1 + Inflation Rate (Eur) = Spot XRt+1 / Spot XRt

Therefore:

1 + Nominal Rate ($) / 1 + Nominal Rate (€) = Spot XRt+1 / Spot XRt

**Interest Rate Parity says:**

1 + Nominal Rate ($) / 1 + Nominal Rate (€) = Forward XR ($/€) / Spot XR ($/€)

Therefore:

Forward XR ($/€) / Spot XR ($/€) = Spot XRt+1 / Spot XRt

And therefore:

Forward XR ($/€) = Spot XRt+1($/€)

And therefore:

Forward XR = Expected Future Spot Rate