

Purchasing Power Parity and Real Exchange Rate

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Introduction

- To determine whether a currency is over-valued or under-valued we need a benchmark that provides the true value of a currency
- Popular benchmark model is purchasing power parity (PPP), which links exchange rates to the prices of goods in different countries
 - Used to provide a basic forecast for future currency values (which influence capital budgeting decisions)
 - Hence, deviations from PPP affect profitability and hedging of future cash flows
 - Also used to assess cost-of-living differences across countries
- PPP does not hold very well (empirically) in the short run
- For major currencies PPP has some validity in the long run
- For some currencies, deviations from the theory are so large that some economists dismiss the theory

Price Indexes and the Purchasing Power

Price Levels and Purchasing Power

- To measure the purchasing power of a country:
- Calculate the nominal price of a typical bundle of consumption goods in a country, which represents the price level
 - Price level is the weighted average of the nominal prices of the goods and services consumed in the economy
 - Weights of the goods and services represent the percentage shares of the goods and services in the consumption bundle
 - When the price level is rising, inflation occurs
- Calculate what a unit of currency will purchase given the price level in the country, by taking the inverse of the price level
 - The purchasing power measures the amount of goods that can be purchased per unit of currency

Price Indexes and the Purchasing Power

Calculating the Price Level

- The nominal price level can be expressed as

$$P_{t,R} = \sum_{i=1}^N w_i P_{t,i,R}$$

- where $P_{t,i,R}$ represents the rand price of good i at time t
- w_i represents the weight of the N different goods and services
- $P_{t,R}$ is the rand price level

Price Indexes and the Purchasing Power

Calculating the Price Level

- Information is usually summarised by price indexes, which consider the ratio of price levels at two points in time
- To compare the rand price index in year $t + k$ with the base year t

$$PI_{t+k,R} = \left(\frac{P_{t+k,R}}{P_{t,R}} \right) \times 100 = \left(\frac{\sum_{i=1}^N w_i P_{t+k,i,R}}{\sum_{i=1}^N w_i P_{t,i,R}} \right) \times 100$$

- May be used to directly reflect the amount of inflation for the percentage change in average nominal prices

Price Indexes and the Purchasing Power

Price Indexes for the G7 Countries and South Africa

Year	United States	Canada	France	Germany	Italy	Japan	United Kingdom	South Africa
1960	27.6	24.6	17.2	39.4	9.8	21.2	13.2	15.7
1970	36.1	32.3	25.2	50.9	14	36.9	19.6	19.9
1980	76.5	69.7	63.3	82.6	51	87.2	70.7	52.9
1985	100	100	100	100	100	100	100	100
1990	121.4	124.1	116.3	107.7	131.2	107	133.4	209.4
1995	141.7	139.2	129.9	126.2	168.6	113.5	158.4	367.5
2000	159	150	138	133.9	188.3	115.2	179.9	507.3
2005	179.4	167.8	151.8	144.9	212	112.4	202.1	656.5
2008	197.8	179	161.1	154.5	227.8	114.3	219.3	790.6
2009	197.1	179.5	161.2	155	229.5	112.7	224	863.9
2010	199.3	181.1	162.6	155.8	231.3	111.7	228.2	916.8

Price Indexes and the Purchasing Power

Inflation

- The percentage rate of inflation between 2008 and 2009 may be calculated as

$$\left(\frac{863.9}{790.6} - 1 \right) \times 100 = 9.271\%$$

- Cumulative Rate of Inflation between 1985 and 2010 is calculated as

$$\left(\frac{916.8}{100} \right)^{1/25} = 1.09267$$

- which is 9.267%

Price Indexes and the Purchasing Power

Internal & External Purchasing Power

- Internal purchasing power of a rand relates to the amount of goods and services that can be purchased with a rand in South Africa
- Purchasing power describes the number of S.A. consumption bundles per rand
- Hence, the internal purchasing power of a rand at time t is $1/P_{t,R}$
- External purchasing power of a rand relates to the amount of goods and services that can be purchased outside South Africa with a rand
- To calculate the external purchasing power of a rand in Britain it is necessary to purchase an amount of pounds with the rand
- Thereafter, we need to examine the purchasing power of those pounds in Britain

Price Indexes and the Purchasing Power

Internal & External Purchasing Power

- One rand buys $1/S_{t,R/\pounds}$ pounds if $S_{t,R/\pounds}$ represents the spot exchange rate of rands per pound
- Purchasing power of the pound may be measured by taking the reciprocal of the price level in Britain, $1/P_{t,\pounds}$, which represents the number of consumption bundles that can be bought per pound in Britain
- The external purchasing power of the rand in Britain is then

$$\frac{1}{S(t, R/\pounds)} \times \frac{1}{P(t, \pounds)}$$

- or

$$\frac{\text{Pounds}}{\text{Rands}} \times \frac{\text{UK consumption bundles}}{\text{Pound}} = \frac{\text{UK consumption bundles}}{\text{Rands}}$$

Absolute Purchasing Power Parity

Theory of Absolute Purchasing Power Parity

- Absolute purchasing power parity states that the exchange rate will adjust to equalize the internal and external purchasing powers of a currency
- Hence, the prediction of absolute PPP for the rand-pound exchange rate is found by equating the internal and external purchasing power of a rand

$$\frac{1}{P_{t,R}} = \frac{1}{S_{t,R/\pounds}^{\text{PPP}}} \times \frac{1}{P_{t,\pounds}}$$

- where $S_{t,R/\pounds}^{\text{PPP}}$ signifies the rand-pound exchange rate that satisfies the PPP relation
- Solving for $S_{t,R/\pounds}^{\text{PPP}}$

$$S_{t,R/\pounds}^{\text{PPP}} = \frac{P_{t,R}}{P_{t,\pounds}}$$

- Hence absolute PPP could be regarded as a theory that makes a prediction about what the exchange rate should be for the given price levels in two countries

Absolute Purchasing Power Parity

Goods Market Arbitrage

- If the internal purchasing power of the rand is less than its external purchasing power in a foreign country
- Buy goods abroad, ship the goods to South Africa, and sell them for more rands than your original rand expenditure
- To demonstrate this arbitrage, consider the following example

Absolute Purchasing Power Parity

Goods Market Arbitrage

- Internal purchasing power of R1 million in the South Africa is

$$R1,000,000 \times \frac{1}{R175,000/\text{cons. bundle}} = 5.71 \text{ cons. bundle}$$

- External purchasing power of R1 million in the United Kingdom:

$$R1,000,000 \times \frac{1}{\text{GBPZAR } 16.00} = \text{£}62,500$$

$$\text{£}62,500 \times \frac{1}{\text{£}10,000/\text{cons. bundle}} = 6.25 \text{ cons. bundles}$$

- If we sell the 6.25 consumption bundles in South Africa at R175,000
 $(6.25 \text{ consumption bundles}) \times (R175,000/\text{cons. bundle}) = R1,093,750$
- Provides a 9.375% rate of return

Absolute Purchasing Power Parity

Goods Market Arbitrage

- If absolute PPP holds, the costs of the consumption bundles in different countries are equal when expressed in a common currency
- When absolute PPP does not hold, there is a potential opportunity for goods market arbitrage
- Such arbitrage would be subject to large transaction costs (shipment of goods, etc.)

Law of One Price

The Perfect Market Ideal

- If markets are competitive, we should not be able to make a profit buying and reselling goods between countries
- Arbitrage would drive the price of any good quoted in a common currency to be the same around the world (where there are no transaction costs)
- Law of one price says that the price of a good, when denominated in a particular currency, is the same wherever in the world the good is being sold
- Hence, PPP is an extension of the law of one price that considers the prices of a bundle of goods

Law of One Price

Why Violations of the Law of One Price Occur

- Tariffs and Quotas
 - Governments tax international shipments of goods to generate revenue and protect local industries
- Transaction Costs That Prevent Trade
 - If wages are not equalized by international trade, we should expect some violations of the law of one price
- Speculation and Contracts
 - Often difficult to find a buyer for a particular good at a point in time and as it takes time to ship goods between countries, a speculative element is included in the transaction
- Non-Competitive Markets
 - Without pure competition, firms may be able to effectively segment markets to charge different prices in different countries
- Sticky Prices
 - Nominal prices of many goods are set by firms for various lengths of time due to menu costs

Law of One Price

How Wide Is the Border?

- Prices of comparable goods differ across cities within a country as well as across countries
- Typical difference, measured as the standard deviation of log price differences, is 22.3% between U.S. cities and 18.7% between Canadian cities (Broda & Weinstein, 2008)
- When comparing prices across countries, the typical difference rises to 26.7%
- Engel & Rogers (1996) suggest that crossing a border between countries adds as much variability to the relative prices of similar goods as does adding 2,500 miles to the distance between two cities in the same country
- Broda & Weinstein (2008) suggest that when using disaggregated data this may reduce to between 36 and 100 miles
- Lawrence Edwards has done similar work for goods in African countries

Describing Deviations from PPP

Overvaluations and Undervaluations of Currencies

- A currency is said to be overvalued if its external purchasing power is greater than its internal purchasing power
- Similarly, an undervalued currency's external purchasing power is less than its internal purchasing power
- Since purchasing power parity makes one prediction for the actual exchange rate between two currencies, if currency A is overvalued relative to currency B , currency B must be undervalued relative to currency A

Describing Deviations from PPP

Overvaluations and Undervaluations of Currencies

- Calculate the external purchasing power of R1 million in the United Kingdom

$$\begin{aligned} & R1,000,000 \times \frac{1}{\text{GBPZAR } 16.00} \times \frac{1}{\text{£}10,000/\text{consumption bundle}} \\ & = 6.25 \text{ consumption bundles} \end{aligned}$$

- This is larger than the internal purchasing power of R1 million in South Africa

$$R1,000,000 \times \frac{1}{R175,000/\text{consumption bundle}} = 5.71 \text{ consumption bundles}$$

- Thus, the rand is overvalued as it can purchase more goods in a foreign currency

Describing Deviations from PPP

Predictions Based on Overvaluations and Undervaluations

- The logic of overvaluations or undervaluations of currencies leads to predictions of currency depreciation or appreciation
- When a currency is overvalued on foreign exchange markets it must depreciate on the foreign exchange markets if the prediction of PPP is to hold
- The depreciation, of the currency lowers its external purchasing power and returns the external purchasing power of the currency to its internal purchasing power

Describing Deviations from PPP

MacPPP

- One criticism of using CPI data is that the consumption bundles of the different countries are not the same
- *The Economist* calculates implied PPP exchange rates for a number of countries, using a McDonald's Big Mac
- The advantages to using the Big Mac as an index of prices include:
 - McDonald's strives to make the burger the same way in all outlets
 - Use local suppliers to reduce international transportation costs
- Implied PPP exchange rates for currencies relative to the dollar are calculated by taking the ratio of the local currency price of the Big Mac to the average dollar price in four U.S. cities

Describing Deviations from PPP

MacPPP

- Deviations of actual exchange rates from implied PPP values are usually similar to those that arise from conventional CPI data
- Degree of overvaluation or undervaluation of particular currencies is used by *The Economist* to make a few relatively accurate predictions
- By way of example the following table gives MacPPP values for 2016 that was published by *The Economist*

Describing Deviations from PPP

MacPPP in 2016

		Big Mac Prices		Exchange Rates		% Under(-) / Over (+) Valuation against the dollar
		Local		PPP	Actual	
	Currency	Dollars				
United States	dollar	5.04	5.04	1	1	
South Africa	rand	30	2.1	5.95	14.27	-58.3%
Australia	dollar	5.75	4.3	1.14	1.34	-14.59%
Britain	pound	2.99	3.94	0.59	0.76	-21.82%
Canada	dollar	6	4.6	1.19	1.3	-8.64%
China	yuan	18.6	2.79	3.69	6.68	-44.74%
Egypt	pound	23	2.59	4.56	8.88	-48.61%
Euro area	euro	3.82	4.21	0.76	0.91	-16.55%
Hungary	forint	900	3.15	178.57	285.64	-37.48%
Indonesia	rupiah	31000	2.36	6150.79	13112.5	-53.09%
Japan	yen	370	3.47	73.41	106.73	-31.21%
Malaysia	ringgit	8	1.99	1.59	4.03	-60.58%
Mexico	peso	44	2.37	8.73	18.54	-52.9%
Norway	kroner	46.8	5.51	9.29	8.49	9.33%
Poland	zloty	9.6	2.42	1.9	3.97	-51.97%
Russia	ruble	130	2.05	25.79	63.41	-59.32%
Saudi Arabia	riyal	12	3.2	2.38	3.75	-36.52%
South Korea	won	4400	3.86	873.02	1140.95	-23.48%
Switzerland	franc	6.5	6.59	1.29	0.99	30.79%
Taiwan	dollar	69	2.15	13.69	32.03	-57.26%
Thailand	baht	119	3.4	23.61	34.97	-32.47%
Turkey	lire	10.75	3.53	2.13	3.04	-29.91%
UAE	dirham	13	3.54	2.58	3.67	-29.78%

Describing Deviations from PPP

Implied MacPPP Rates

- The average price of a Big Mac in the United States was \$5.04, whereas it cost ¥370.00 in Japan, and R30 in South Africa
- Second column gives the dollar price of a Big Mac in the different countries, which uses the exchange rate in fourth column

$$\frac{(\text{R}30.00/\text{Big Mac})}{(\text{R}14.27/\$)} = \$2.10 \text{ Big Mac}$$

- Most expensive Big Mac for a person paying in U.S. dollars was in Switzerland, where it cost \$6.59
- Cheapest Big Mac for a dollar purchaser was in Malaysia, where it cost only \$1.99

Describing Deviations from PPP

Implied MacPPP Rates

- Third column gives implied PPP exchange rates of the currency versus the dollar
- The ratio of the local currency price of the Big Mac to the dollar price of the Big Mac in the United States
- For Big Macs to satisfy the law of one price, implied PPP exchange rates in the third column should equal the actual exchange rates
- Since they do not equal each-other it indicates that the local currencies are either overvalued or undervalued relative to the dollar
- Fifth column presents the overvaluation or undervaluation of the local currency in percentage points
- For example, the South African rand is 58.3% undervalued because with the actual exchange rate at R14.27/\$, a 58.3% appreciation of the rand versus the dollar would be required to increase the exchange rate to the implied PPP value of R5.95/\$

Describing Deviations from PPP

Overvaluations and Undervaluations of Currencies

- At this point, you might be feeling that PPP would appear to be well off the mark
- However, it is important to realize that *The Economist* made surprisingly accurate predictions using its MacPPP standard
- For example, in April 1991, *The Economist* noted that the implied PPP of the DEM relative to the GBP was DEM2.58/£
- However, the central parity of the two currencies in the ERM was DEM2.95/£ when Britain entered the ERM in October 1990
- Given this difference of more than 14% between the implied PPP and the central parity, *The Economist* noted that the pound was overvalued, and the Deutsche mark was undervalued
- *The Economist* also suggested that the British Treasury would eventually get severe “heartburn” if it tried to defend the actual exchange rate rather than devalue the pound within the ERM

Describing Deviations from PPP

Overvaluations and Undervaluations of Currencies

- If the pound began to weaken in ERM to correct the overvaluation British Treasury would be forced to buy pounds with Deutsche marks
- Given the limited amount of DEM that the BOE had the market could force a devaluation of the pound by borrowing pounds and lending Deutsche marks
- Investors expect to profit from the devaluation because the pounds they would borrow would be easy to repay with the appreciated Deutsche marks they own
- Only way this would not occur would be if pound-denominated interest rates were increased sufficiently by the BOE to make it unattractive to borrow pounds
- In September 1992 British authorities were essentially forced to withdraw from the ERM and lost \$12 billion

Describing Deviations from PPP

Econometric Evidence

- More formal statistical studies by economists also support the usefulness of MacPPP
- Cumby (1996) finds that deviations from MacPPP are temporary, where one-half of the deviation from parity disappears in 1 year
- Evidence also indicates that both the exchange rate and the prices of the burgers are adjusting to eliminate the deviation
- Clements & Lan (2010) confirm that exchange rate forecasts using MacPPP have value, especially at 2- or 3-year horizons
- Parsley & Wei (2007) suggest that local labour costs account for 45.6% of its price
- They also find a very high correlation between PPPs calculated with Big Mac prices and those from CPI data

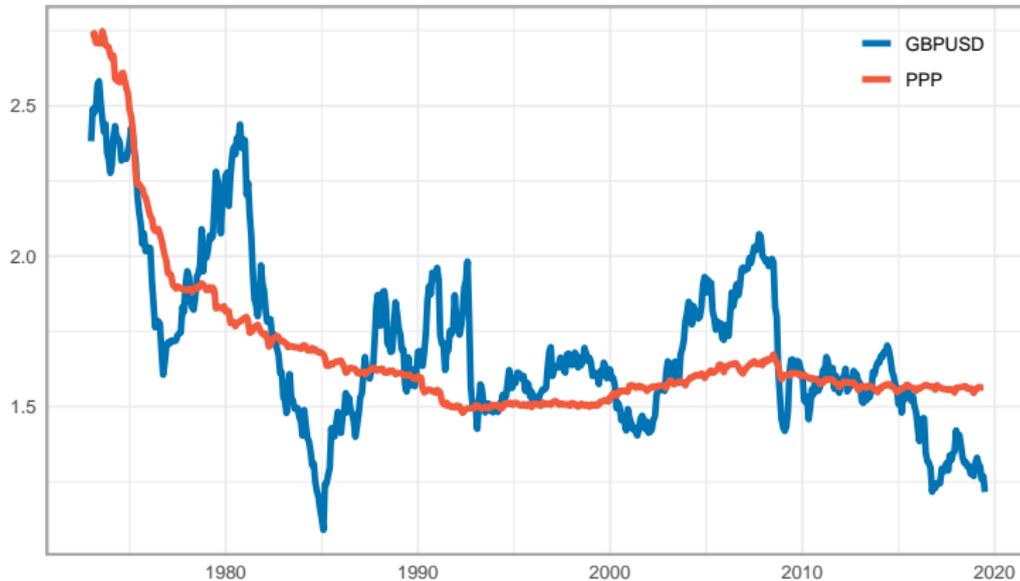
Exchange Rates and Absolute PPPs Using CPI Data

Overvaluations and Undervaluations of Currencies

- The following data spans from January 1973
- Pound and euro exchange rates are quoted directly as the amount of dollars it takes to purchase 1 pound or 1 euro
- Other exchange rates relative to the U.S. dollar are quoted indirectly as the amount of that currency that it takes to purchase 1 dollar
- Since the prices of goods are obtained as consumer price indexes rather than price levels, it is necessary to take a stand on when the actual exchange rate satisfied the PPP relationship
- The data are plotted such that absolute PPP is assumed to have held on average during the decade of the 1980's
- In all the following graphs there are large and persistent deviations of actual exchange rates from the predictions of PPP
- However, there does appear to be some co-movement over the long-term

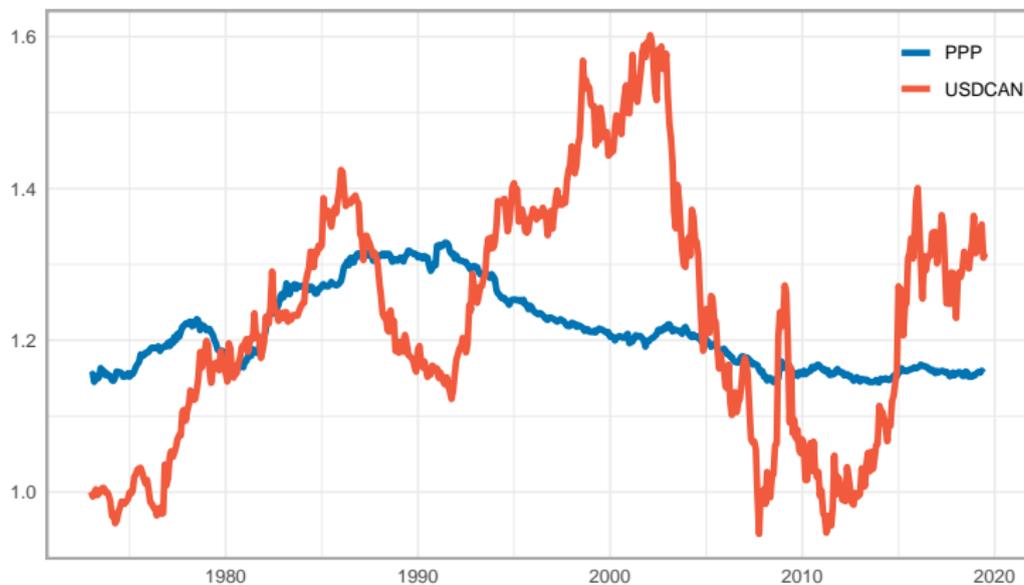
Exchange Rates and Absolute PPPs Using CPI Data

Actual USD/GBP and PPP Exchange Rates



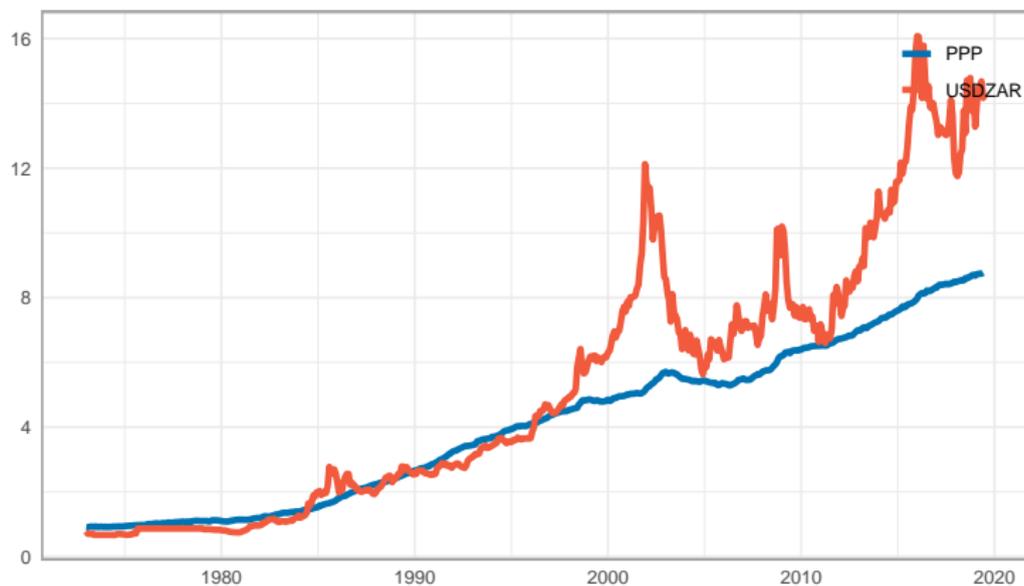
Exchange Rates and Absolute PPPs Using CPI Data

Actual CAN/USD and PPP Exchange Rates



Exchange Rates and Absolute PPPs Using CPI Data

Actual ZAR/USD and PPP Exchange Rates



Explaining the Failure of Absolute PPP

- Previous figures show large and persistent deviations of actual exchange rates from the predictions of absolute PPP
- Since PPP is ultimately based on the law of one price, we know that anything that causes deviations from it can also cause deviations from PPP
- Factors causing deviations from the law of one price are quite numerous, including tariffs, quotas, and transaction costs
- There are also other factors that cause deviations from absolute PPP

Explaining the Failure of Absolute PPP

Changes in Relative Prices

- Changes in the relative prices of goods can cause deviations from PPP if price indices do not have the same weights across countries
- Suppose all goods are traded and assume that the prices of all goods satisfy the law of one price
- Assume that tastes differ across countries so expenditure shares on goods differ and let the price levels reflect differences in consumption bundles
- Residents consume a larger share of the goods and services produced in that country than of imported goods and services
- Hence, price indexes of each country will have a larger weight on goods produced at home
- Changes in the relative prices will then lead to deviations from PPP

Explaining the Failure of Absolute PPP

Non-Traded Goods

- Similar problems with absolute PPP arise when there are changes in the relative prices of traded and non-traded goods
- Since these goods are also included in the consumption bundles of individuals in the different countries, the prices of non-traded goods affect the price levels of the countries
- Changes in the relative prices of traded and non-traded goods in two countries will cause deviations from absolute PPP that do not represent arbitrage opportunities
- Changes to house prices would affect PPP but not the exchange rate
- If technology increases faster in traded goods industries than in non-traded goods industries we would expect that the relative price of non-traded goods would rise over time
 - This is known as the Harrod-Balassa-Samuelson effect

Explaining the Failure of Absolute PPP

PPP Deviations and the Balance of Payments

- Balance of payments represents the amounts of goods that are bought and sold between residents in a country and the ROW
- Hence, when a currency is overvalued relative to a PPP calculation, the external purchasing power of that currency increases
- This shifts the nation's expenditures from domestic to foreign goods
- This weakens the competitive position of domestic firms relative to foreign firms

Comparing Incomes Across Countries

- PPP data can be used to compare nominal incomes across countries
- Let's consider an extended example:
 - New York job offer for \$100,000 per year
 - Tokyo job offer for ¥15,000,000 per year
 - You are indifferent between living in New York or Tokyo
 - Exchange rate is ¥100/\$
- Given the exchange rate, the Tokyo offer sounds better as you earn the equivalent of \$150,000 per year
- But what about the cost of living in these two cities?

Comparing Incomes Across Countries

Job offers in New York and Tokyo

- Suppose the PPP exchange rate is ¥160/\$
- To achieve the same purchasing power in Japan as you would have in the United States, you need a salary of

$$(\text{¥}160/\text{\$}) \times \$100,000 = \text{¥}16,000,000$$

- But your offer is only ¥15,000,000
- Given these conditions you should turn down the offer to work in Japan or demand a higher yen salary
- Note that exchange rate fluctuations relative to PPP could provide you with quite different results over time

Comparing Incomes Across Countries

Comparing GDPs Using PPP Exchange Rates

- Can also use PPP to compare GDP per capita of different countries
- Following table compares OECD countries measured in U.S. dollars using a 3-year average of current exchange rates in the first column and PPP exchange rates in the second column
- When the currency of a country is stronger in foreign exchange markets than its PPP exchange rate
- The dollar value of the country's GDP per capita when measured by current exchange rates is larger than when measured by PPP exchange rates
- Note that the dollar value of Japan's GDP falls from \$38,456 per capita in the first column to \$34,132 in the second column
- May be used to suggest that PPP exchange rates are the appropriate ones to use when comparing standards of living across countries

Comparing Incomes Across Countries

Comparing GDPs Using PPP Exchange Rates

OECD Country	In U.S. Dollars, Based on Market Exchange Rates	In U.S. Dollars, Based on PPP Exchange Rates
Australia	48,569	39,056
Austria	49,527	37,858
Belgium	47,151	35,288
Canada	44,995	39,014
Czech Republic	20,719	24,631
Denmark	62,054	36,808
Finland	50,775	35,809
France	44,450	33,098
Germany	44,519	35,432
Greece	31,174	28,896
Hungary	15,363	19,732
Iceland	52,610	36,994
Ireland	59,944	41,493
Italy	38,384	31,195
Japan	38,456	34,132
Korea	19,115	27,658
Luxembourg	117,967	84,713
Mexico	10,194	14,517
Netherlands	53,094	41,063
New Zealand	30,142	27,444
Norway	94,572	58,599
Poland	13,861	17,294
Portugal	22,951	23,283
Slovak Republic	17,537	22,141
Spain	34,971	31,455
Sweden	51,709	36,790
Switzerland	64,885	42,783
Turkey	10,275	13,959
United Kingdom	42,378	35,620
United States	47,186	47,186

Relative Purchasing Power Parity

- Another form of PPP, called relative purchasing power parity, takes market imperfections into account
- It acknowledges that because of these imperfections, a consumption bundle will not necessarily have the same value from country to country
- However, according to the theory of relative PPP, exchange rates adjust in response to differences in inflation rates across countries to leave the differences in purchasing power unchanged over time
- If the percentage change in the exchange rate just offsets the differential rates of inflation, economists say that relative PPP is satisfied

Relative Purchasing Power Parity

- For example, if S.A. inflation is 6% p.a. and U.K. inflation is 4% p.a.
- The pound is losing purchasing power over goods and services due to U.K. inflation of 4% per year
- The rand is losing purchasing power over goods and services due to S.A. inflation of 6% per year
- Hence, a 1.92% appreciation of the pound relative to the rand is therefore required to make the loss of the pound's external purchasing power equal to the loss of its internal purchasing power

Relative Purchasing Power Parity

General Expression for Relative PPP

- Let $s_{t+1,DC/FC}$ denote the percentage rate of change of the domestic currency (denoted DC) per unit of foreign currency (denoted FC) from time t to $t + 1$,
- Let $\pi_{t+1,DC}$ and $\pi_{t+1,FC}$ represent the corresponding rates of domestic and foreign inflation
- Then relative PPP requires that

$$1 + s_{t+1,DC/FC} = \frac{1 + \pi_{t+1,DC}}{1 + \pi_{t+1,FC}}$$

- If we subtract 1 from each side and place terms over a common denominator

$$s_{t+1,DC/FC} = \frac{\pi_{t+1,DC} - \pi_{t+1,FC}}{1 + \pi_{t+1,FC}}$$

- States that the rate of appreciation of the foreign currency relative to the domestic currency is equal to the difference between the domestic rate of inflation and the foreign rate of inflation divided by 1 plus the foreign rate of inflation

Real Exchange Rate

- The real exchange rate for the rand relative to the euro is $RS_{t,R/euro}$
- Defined to be the nominal exchange rate multiplied by the ratio of the price levels

$$RS_{t,R/euro} = \frac{S_{t,R/euro} \times P_{t,euro}}{P_{t,R}}$$

- Notice that the real exchange rate would be 1 if absolute PPP held because the nominal exchange rate, $S_{t,R/euro}$ would equal the ratio of the two price levels, $P_{t,R}/P_{t,euro}$

Real Exchange Rate

Constant Real Exchange Rate

- Consider initial S.A. price level of R150,000/ S.A. cons. bundle
- Europe price level is initially €11,000/ European cons. bundle
- Nominal exchange rate equal to R13.00/€
- Real exchange rate equals

$$RS_{t,R/\text{€}} = \frac{\text{R}13.00/\text{€} \times \text{€}11,000}{\text{R}150,000} = 0.9533$$

- Over the next year, there is 8% inflation in South Africa and 3% inflation in Europe
- Suppose the nominal exchange rate changes so that relative PPP is satisfied
- Then the new nominal exchange rate that satisfies this condition is

$$S_{t,R/\text{€}} = \frac{\text{R}13.00/\text{€} \times 1.08}{1.03} = \text{R}13.63/\text{€}$$

Real Exchange Rate

Constant Real Exchange Rate

- Hence the euro should strengthen by 4.89%
- With 8% S.A. inflation the new S.A. price level is R162,000
- With 3% European inflation the new European price level is €11,330
- The new real exchange rate is the same since

$$RS_{t+1,R/\text{€}} = \frac{R13.63/\text{€} \times \text{€}11,330}{R162,000} = 0.9533$$

Real Exchange Rate

Real Appreciations and Real Depreciations

- Concepts of real appreciations and real depreciations are useful and may help us describe real exchange risk
- When the percentage change in nominal exchange rate $S_{t,R/\pounds}$ was positive, we called it a nominal appreciation of the pound
- To work out the percentage change in the real exchange rate we use the expression

$$rs_{t+1,R/\pounds} = \frac{RS_{t+1,R/\pounds} - RS_{t,R/\pounds}}{RS_{t,R/\pounds}}$$

- When the right-hand side is positive, we have a real depreciation of the rand

Real Exchange Rate

Real Appreciations and Real Depreciations

- To consider how the various nominal factors affect the real exchange rate we substitute in the real exchange rate and simplify:

$$\begin{aligned} [1 + rs_{t+1,R/\pounds}] &= \frac{RS_{t+1,R/\pounds}}{RS_{t,R/\pounds}} \\ &= \frac{[S_{t+1,R/\pounds} \times P_{t+1,\pounds}/P_{t+1,R}]}{[S_{t,R/\pounds} \times P_{t,\pounds}/P_{t,R}]} \\ &= \frac{[S_{t+1,R/\pounds}/S_{t,R/\pounds}] \times [P_{t+1,\pounds}/P_{t,\pounds}]}{[P_{t+1,R}/P_{t,R}]} \\ &= \frac{[1 + s_{t+1,R/\pounds}] \times [1 + \pi_{t+1,\pounds}]}{[1 + \pi_{t+1,R}]} \end{aligned}$$

Real Exchange Rate

Real Appreciations and Real Depreciations

- Many combinations of changes lead to a real depreciation of the rand
- Three basic movements include:
 - Increase in the nominal exchange rate, R/\pounds , that is a nominal appreciation of the pound, holding the rand prices and pound prices of goods constant
 - Increase in the pound prices of goods, holding the exchange rate and the rand prices of goods constant
 - Decrease in the rand prices of S.A goods, holding the exchange rate and the pound prices of goods constant
- The percentage rate of change of the rand-pound exchange rate that leaves the real exchange rate unchanged is then

$$[1 + s_{t+1,R/\pounds}] = \frac{[1 + \pi_{t+1,R}]}{[1 + \pi_{t+1,\pounds}]}$$

Real Exchange Rate

Real Appreciations and Real Depreciations

- Many governments calculate a trade-weighted real exchange rate
- Currencies rarely strengthen or weaken relative to all foreign currencies by the same amount
- These measures consider currency movement relative to the proportion of trade conducted with each foreign country
- May be used to describe how the depreciation of the domestic currency would affect a country's trade balance
- Termed the relative exchange rate or real effective exchange rate

Conclusion

- Considered the concept of purchasing power parity and measurement of real exchange rate
- This included the concepts of absolute and relative purchasing power parity
- Discussed the differences between the internal and external value of a currency
- As well as the similarities between the law of one price and purchasing power parity
- Suggested that PPP could be used to describe a currency as overvalued or undervalued
- Also noted that measures of the real exchange rate could be used to identify different elements of risk