Economics 304 Fall 2007
Project #10 Due: Friday, 11/30

The data set Proj10.dta can be downloaded from the link at the Project 10 Web page, or at

http://academic.reed.edu/economics/course_pages/304_f07/asgns/Proj10.dta

This is a Stata data set that contains data for 9 countries on the variables shown in Table 1. (Data are taken from the Penn World Table (PWT). See http://pwt.econ.upenn.edu/ for more information.) Save this file on a computer capable of running Stata, which includes all the public Macs and PCs in the IRCs, library, and Public Policy Workshop. Double-clicking on the file icon should open version 10 of Stata.

**Table 1. Variables in data set**

| Variable name | Description | Units |
|---|---|---|
| country | Country name | |
| year | Year | |
| cgdp | Nominal GDP per capita | Current intl $/person |
| rgdpch | Real GDP per capita | 2000 intl $/person |
| xrat | Nominal exchange rate—inverted (1/*E*) | Currency units/dollar |
| ppp | Purchasing-power parity exchange rate | Currency units/dollar |
| p | Real exchange rate (*EP/P**) | Foreign goods/domestic good |
| pop | Population | Thousands of people |
| countrynum | Country number (need to keep) | |
| hi_inf | = 1 if a high-inflation country | |
| med_inf | = 1 if a medium-inflation country | |
| lo_inf | = 1 if a low-inflation country | |

## Data Issues

These variables are drawn directly from the PWT "as is." They will need to be transformed in order to do the analysis. This section describes how the variables are measured and how they relate to the familiar textbook variables. The first thing to keep in mind is that you are looking at the world from the perspective of each individual country. The United States plays the role of the "rest of the world." That means that *P* is the price level in whatever country you are studying and *P** is the U.S. price level.

- **Exchange rate (xrat).** The nominal exchange rate (xrat) is defined inversely to what you are used to. (We talked about this problem in class.) It is measured in units of the country's currency per dollar (remember that the dollar is the foreign currency), so an increase in xrat means that the country's currency has *depreciated*. So you should think of xrat as equal to 1/*E*.

- **Real exchange rate (p).** The variable p is the real exchange rate ε defined in the same terms that we used in class: the value of domestic goods in terms of foreign goods. This is an indication of how much the country's currency is overvalued or undervalued relative to the dollar. (Note: I have divided the original PWT variable by 100 to base it around 1 rather than around 100.)
- **Purchasing-power parity exchange rate (ppp).** This is the nominal exchange rate at which the real exchange rate would be equal to one—where purchasing-power parity would hold. It is defined to be the amount of the domestic currency that would be required to buy the same amount of the country's GDP as one dollar would. In terms of our class model, this is $P/P^*$. If it is equal to xrat ($1/E$), then $\varepsilon = EP/P^* = (P/P^*)/(1/E)$ = ppp/xrat = 1. Note that ppp = p × xrat.
- **Nominal per-capita GDP (cgdp).** Nominal GDP is the value of the country's GDP expressed in terms of current dollars. This variable is expressed on a per-capita basis.
- **Real per-capita GDP (rgdpch).** Real GDP is the value of GDP in Year 2000 dollars. Also a per-capita variable.

Normally, we can construct a price index for a country by dividing nominal GDP by real GDP. However, in this case, both nominal and real GDP are measured in dollars rather than the domestic currency, so the resulting price index is for the dollar, not the domestic currency. Thus, cgpd/rgdpch for any country gives a price index for the United States. (However, this US price index is weighted with the other country's GDP market basket, so it won't be the same for each country.) Since cgdp/rgdpch measures US prices, which are the foreign prices from the perspective of the other country, we can use this as a measure of $P^*$.

Given that cgdp/rgdpch is $P^*$ and the variable ppp is $P/P^*$, we can construct an index of each country's own-currency prices as $P^* \times (P/P^*)$ = (cgdp/rgdpch) × ppp. The percentage change in this variable would be an appropriate measure of the country's internal inflation rate.

## Transformations in Stata

You have done some work in Stata in an earlier assignment, so you may recall some of the basics. As before, type browse to look at your dataset. To create a new variable that is a function of existing variables, you use the generate command. This command has the format

```
gen newvar = formula
```

where newvar is a variable name (consists of letters, numbers, and underscores, starts with a letter or underscore, case-sensitive) and formula is a formula constructed according to standard mathematical syntax (+, –, *, /, and ^ for operators and parentheses to define order of operations). For example, to define a new variable $z = \dfrac{4x^2}{3+y}$, you'd type

```
gen z = (4*x^2)/(3+y)
```

You can use lags and differences by prefixing a variable with L. or D. respectively. For example, to get $\Delta z_t \equiv z_t - z_{t-1}$, you could type D.z or z – L.z.

The generate command creates a new variable, so the above command will not work if z already exists. If you want to replace the contents of an existing variable you need to use the replace command, which otherwise has the same syntax.

In order to proceed with the analysis, you need to construct the following variables:

| Variable name | Definition | Formula |
|---|---|---|
| p_US | US price index based on country's GDP basket ($P^*$) | see above |
| p_dom | Domestic price index ($P$) | see above |
| inf_US | US inflation rate ($\pi^*$) | D.p_US / L.p_US |
| inf_dom | Domestic inflation rate ($\pi$) | D.p_dom / L.p_dom |
| ex_app | Rate of currency appreciation ($[E_t - E_{t-1}]/ E_{t-1}$) = minus the rate of currency depreciation | – D.xrat / L.xrat |
| g_gdp | Growth rate of real per-capita GDP | D.rgdpch / L.rgdpch |

## Inflation and Exchange Rates

The data set Proj10.dta contains data for three high-inflation countries (Brazil, Argentina, and Israel), three moderate-inflation countries (Iceland, Jamaica, and Nigeria), and three low-inflation countries (Switzerland, Ethiopia, and Japan).

According to the relative theory of purchasing-power parity, the rate of appreciation of a country's nominal exchange rate should be approximately equal to the difference between the foreign inflation rate and its own inflation rate: $\frac{\Delta E}{E} = \pi^* - \pi$. Construct a variable inf_diff that is the difference between the US inflation rate and the country's domestic-currency inflation rate. All of these rates of change are expressed as pure numbers, not as percentages, so 0.05 = 5% and 2 = 200%.

***Task #1: Create plots of the variation over time in the rate of appreciation of the exchange rate and the inflation differential. Do separate sets of plots for high-inflation, moderate-inflation, and low-inflation countries. Describe the results in detail: do the variables move together as predicted by relative PPP theory? Are there differences between the groups of countries or individual countries within the groups? Why do you think these differences exist?***

In Stata, use the Time-Series Graphs → Line Plots function from the Graphics menu to create a set of plots for the three high-inflation countries. On the Plots tab, create two plots, one for each variable. On the if/in tab, specify hi_inf in the box to pick up only the countries for which hi_inf is 1. On the By tab, click the Draw subgraphs for unique … box and choose country as the variable to select. Once you have all the options set, click the Submit box to draw the graph (but leave the window open for the next one). Copy your graph into your Word report. Repeat the procedure for the medium-inflation and low-inflation countries.

***Task #2: For each group of countries, run a simple regression with exchange-rate appreciation as the dependent variable and the inflation differential as the independent variable: ex_app = $\alpha$ + $\beta$ inf_diff. The relative PPP theory claims that $\alpha$ = 0 and $\beta$ = 1. Are your results consistent with the theory for each group of countries? Explain why there are differences across the country groups.***

STATA In Stata, you can use the reg depvar indvar command to do a simple regression, where depvar is the dependent variable and indvar is the independent variable. To restrict the regression analysis to only countries for which the hi_inf variable is equal to one (the high-inflation countries), you would add if hi_inf to the end of the command. You can also use the Linear models and related → Linear regression selection from the Statistics menu if you prefer the menu-driven interface.

In your output table, you should look at several reported statistics. Your estimated $\alpha$ is in the row labeled _cons (constant term) in the table; $\beta$ is in the inf_diff row. The estimated coefficient values are in the column headed Coef. To test whether $\alpha = 0$, you'd look at the columns headed t and P>|t|. If the t value is greater than 2 (in absolute value) then we can usually reject the hypothesis that $\alpha = 0$. The p-value adjacent gives the probability of observing such a strong deviation from $\alpha = 0$ if in fact $\alpha$ is zero. We reject $\alpha = 0$ if the p value is less than 0.05. If we can't reject $\alpha = 0$, then we conclude that the data provide no evidence against that part of the PPP hypothesis.

The t statistic and p value test the hypothesis that the corresponding coefficient is zero. In the case of $\beta$, the hypothesis of interest is $\beta = 1$. The easiest way to test this from your regression table is to look at the two right-most columns, giving a 95% confidence interval for the coefficients. This is (loosely) a range of values that we are 95% confident contains the true value. If this range includes our hypothetical value ($\beta = 1$), then we cannot reject the hypothesis. So if one falls inside your estimated confidence interval for $\beta$, then your results are consistent with that aspect of relative PPP, if not then your data have rejected the hypothesis.

Finally, you may want to look at the R-squared statistic in the upper-right list of statistics. R-squared measures the fraction of the variation in the dependent variable (exchange rate movements) that is explained by changes in the independent variable(s) (inflation differentials). If R-squared is close to one, then the relationship between the variables is very close: inflation differentials explain almost all of the variation in exchange rates. If R-squared is near zero, then there is very little relationship between the variables: most of the movements in exchange rates are due to something other than inflation differentials. How do your R-squared values vary across the three groups of countries? How do you interpret this result?

## Inflation, Exchange Rates, and Output Fluctuations

The traditional Phillips curve suggests that output booms should coincide with periods of high inflation and recessions should occur when inflation is low. The modern theory refines this to replace "high (low) inflation" with "higher (lower) than expected

inflation." We now look at the association among inflation, output, and exchange rates for our groups of economies.

> ***Task #3: Working again with each of the three groups of countries separately, plot time-series line plots of domestic-price inflation on the same graph with growth in per-capita real output. Do periods of high inflation correspond with output booms or with recessions in the high-inflation countries, the moderate-inflation countries, and/or the low-inflation countries? What do regressions of inflation on output growth tell you for each group of countries? How do you interpret these results with respect to the original Phillips curve?***

STATA You can use the same Stata commands you used before to produce plots of the two series inf_dom and g_gdp. Because the inflation variable has extreme values for some countries, you may wish to use separate scales for the two variables. To do this in the Stata line plot dialog box, when you create or edit Plot 2, click the box next to the variable name that is labeled "Add a second y axis on right." As before, use the "if" and "by" tabs to generate separate plots for each country, grouped by inflation category. To do the regressions, you will again use the reg command either from the command line or the dialog box. Make inflation the dependent variable and growth the independent variable.

> ***Task #4: Examine the periods of recession in your countries, defined for our purposes as anytime that per-capita real GDP declines. Is there any consistent pattern to what happens to inflation and to real exchange rates in recessions? How would you explain this result using macroeconomic theory?***

You now have a library of Stata commands at your disposal including regressions, lag functions, and graphical analyses. Another simple command is summarize varlist, which calculates basic statistics such as the mean for the variables in varlist. Any Stata command can be restricted to a subset of observations by appending an if clause. For example, to calculate the mean of both domestic inflation and the change in the real exchange rate during recessions in only high-inflation countries, you could type summarize inf_dom D.p if g_gdp < 0 & hi_inf. Remember that the D. prefix takes the difference and that the PWT variable p measures the real exchange rate, so D.p is the change in the real exchange rate from the previous period.

If you want to do more sophisticated analyses and can't figure out how to do something, send me an email and I'll help you figure out how to do it. This one's intended to be a bit more open-ended than previous assignments.