Problem Set #1: Macroeconomic Data

Revised: October 12, 2013

You may do this assignment in a group. Whatever you hand in should be the work of your group and include the names of all of the contributors.

> **Solution:** Brief answers follow, but see also the spreadsheet posted on the course website.

1. *National accounts in Margaritaville (40 points).* Jimmy Buffett has decided to apply for membership in the European Union on behalf of his newly sovereign nation, Margaritaville. As part of his application, he must provide the EU technocrats with a complete set of national accounts. You have been hired as the Chief National Accountant. Your first day on the job, you receive an official Coral Reefer Crew™ t-shirt and the following information about local economic activity:

   - Local Cheeseburger in Paradise™ cafes sold $63,000 worth of cheeseburgers to local consumers. Their expenses were: imported beef and sesame seeds ($10,000), locally produced catsup ($12,000), wages and benefits ($22,000), and rent ($3,000). Hint: you will need to compute the profit earned by the cafes.
   - Local tomato growers sold $8,000 worth of tomatoes to domestic catsup producers and exported another $3,000 to the US. They paid land rent ($1,000) and wages ($9,000).
   - Local producers of the Margaritaville Frozen Concoction Maker™ sold $100,000 worth of blenders; 40% were exported to Europe, the remainder to local consumers. Their expenses were $15,000 worth of imported metal, $20,000 for a new CNC machine imported from Germany, and $70,000 in wages.
   - The domestic catsup industry sold $12,000 worth of product to local cafes. They purchased $8,000 worth of tomatoes from domestic growers and paid $4,000 in wages.
   - The newly-formed government collected $10,000 in taxes from its citizens and paid $10,000 to government regulators, who oversee food and beverage safety.

   You mission is to use this raw data to construct national income and product accounts for Magaritaville. Specifically:

   (a) Compute the value-added of each production unit. What is GDP? (10 points)

   (b) Compute GDP and its expenditure components (consumption, investment, government purchases of goods and services, exports, and imports). (10 points)

   (c) What are saving and investment? Why are they different? Where does the difference go? (10 points)

   (d) Jimmy looks over your calculation in (a) and is worried that you made a mistake. Over a couple Land Shark Lagers™ you explain to him that GDP can be computed

three different ways: the sum of value-added across production units (Gross Domestic Product), the sum of expenditure components (Gross Domestic Expenditure), and the sum of payments to labor and capital (Gross Domestic Income). You do the remaining one, payments to labor and capital, and show him that you get the same answer. He buys you a margarita to show his appreciation. (10 points)

Solution: It's easiest to do the whole thing on a spreadsheet — see the link on the course website. The idea is to calculate value added, income, and final sales, as we did in class. It includes government production, which is valued at cost (income = value added), investment, which is not counted as an expense, and imports.

(a) Here's a quick overview of value added by producer:

- Cafes: Value added comes from sales of 63 minus intermediate goods of 22, which gives you value-added of 41. On the income side this corresponds to 22 to labor, 3 in rent, and 16 of profit to the owner.
- Tomatoes: Value added is 11, which equals income of 11 (9 to labor, 1 to rent, 1 of profit).
- MFCM: Value added is sales of 100 minus the 15 of metal, for a total of 85. By convention, we do not include the 20 of new machines as an expense, because it's an investment in new plant and equipment. On the income side, that consists of wages of 70 and profit of 15.
- Catsup: Revenue of 12 minus intermediate inputs of 8 gives us value-added of 4, which is paid as wages.
- Government. Wages of 10 count (by convention) as value added of 10, all of it income to government workers.

Adding it all up gives us GDP from the production side:

$$\text{Value added} \quad = \quad 41 + 11 + 85 + 4 + 10 \quad = \quad 151.$$

(b) Expenditures are

- Cafes: All of the sales revenue is final sales to consumers. How do we handle the input of imported beef and seeds? We put a 10 in imports, which therefore makes a negative contribution to expenditures on (our) GDP.
- Tomatoes: Only the exports of 3 counts as final sales, the rest is an input to the catsup producer.
- MFCM: Finals sales includes consumption of 60, exports of 40, imports of 35, and investment of 20. Note that the investment of 20 makes no contribution to GDP: the entries under investment and imports net to zero.
- Catsup: None of it counts as final sales, since it's sold to cafes and used by them as an intermediate product (an input).

- Government. Government purchases are 10: by convention, it "purchases" what it produces.

Adding it all up gives us GDP from the expenditure identity:

$$Y(\text{GDP} = 151) \quad = \quad C(123) + I(20) + G(10) + NX(43 - 45).$$

(c) From above, saving is $S = Y - C - G = 18$ and investment is $I = 20$. Net exports of f$NX = -2$ accounts for the difference: $S = I + NX$. In this case, it means we are borrowing 2 in foreign capital markets: domestic saving is less than we need to finance domestic investment, so we make up the difference by raising money from foreign investors.

(d) We've calculated GDP from value-added of producers and expenditures. The only one we're missing is income, which (of course) is the same as value added. Summing again across production units in order of appearance:

$$\text{Gross Domestic Income} \quad = \quad 41 + 11 + 85 + 4 + 10 \quad = \quad 151.$$

This breaks down into wages (115), rent (4), and profit (32). Thus we have three ways to get the same number: value added, expenditures, and income. The numbers are all the same, so we can drink our margarita in peace.

2. *Inputs and outputs (20 points).* Specify the most likely direct impact of each of the following on the components of the production function. Don't make this more complicated than it is: we're concerned only with the impact on the components of the production function.

(a) A "ghost city" in China, complete with new office and apartment buildings, but with no people. (5 points)

(b) A reduction in the employer tax on workers that leads firms to hire more people. (5 points)

(c) An improvement in education that increases the skill and effectiveness of workers. (5 points)

(d) A reduction in tariffs in Brazil on imported computer equipment. (5 points)

Solution: You may recall that the production function links output Y to inputs of capital K and labor L and productivity A:

$$Y \quad = \quad AK^{1/3}L^{2/3}.$$

(a) This is an increase in capital, but since it's not used, it generates no additional output. To make this work in the production function, we need productivity to fall.

(b) An increase in labor, which should raise output.

(c) This raises the quality-adjusted amount of labor, therefore output goes up. If labor is measured without quality adjustment, then it shows up as an increase in productivity. As usual, productivity absorbs anything that's not accounted for explicitly.

(d) This makes computer equipment cheaper, which should increase the capital stock and thus output. It could also raise productivity by giving Brazilian firms cheaper/better access to the best computer technology.

From a paper by Cole, Ohanian, Riascos, and Schmitz ("Latin America in the rearview mirror") (rough paraphrase):

> In 1977, Brazil embarked on a zero-quota policy that meant that only PCs and minicomputers produced by Brazilian-owned firms could be sold in Brazil. Moreover, the black market was not a practical choice for large firms. The policy insulated Brazilian computer producers from foreign competition and featured entry barriers to new Brazilian producers through a maze of bureaucratic requirements.
>
> When the quota was lifted by President Collor in 1992, productivity in Brazil's computer industry rose dramatically and 6 of the top 10 firms selling in Brazil in the mid-1990s were Brazilian. Productivity of computer users also increased, as firms got access to better equipment at lower prices.

3. *The stock of residential property in the US (40 points).* Estimating the stock of capital is more art than science. Let's try our hand at applying the perpetual inventory method to estimate the stock of real residential capital (i.e., houses) in the United States.

   The first thing we'll need is a starting point, which we will assume is 8 trillion (2009 dollars) at the beginning of 1999. You can download annual real private residential real investment for the years 1999 to 2012 from FRED (series PRFICA). Also, don't forget to account for the fact that houses depreciate at a rate of 3.5 percent per annum.

   (a) Is "private residential real investment" a measure of value added, income or expenditure? How big was it relative to real GDP in 2012? (10 points)

   (b) Using the law of motion for capital that we discussed in class, what is our estimate of the real stock of residential property at the end of 2012? (15 points)

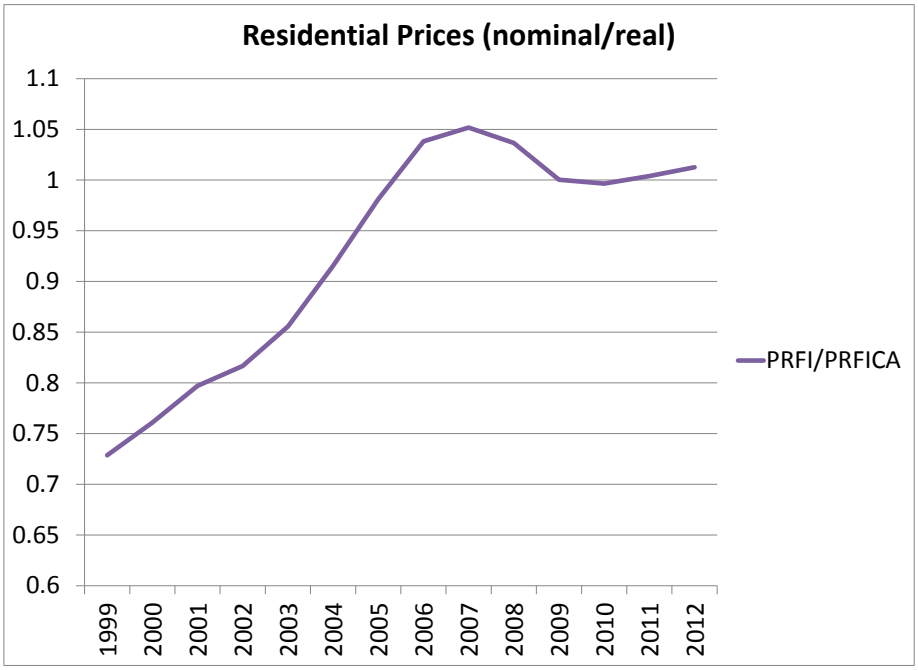
   (c) Now try the same calculation using the nominal values for private residential investment (series PRFI, converted to annual frequency). How does the estimate compare to when we used real investment? What does this tell us about house prices over this period? (15 points)

Solution:

(a) Private residential investment is a measure of the final expenditures on residential property (houses) stated in units of constant dollars (quantity). To get a sense of how big this is and how it has evolved over time, we can download real residential investment (PRFICA) and real GDP (GDPC1) in comparable units - the default on FRED will give you 2009 USD in billions, and then you would just need to convert the GDP figure into annual units instead of quarterly to match the series for PRFICA. Doing so gives you two numbers that you can compare on an apples to apples basis - we find that private residential investment was about 2.8 percent of GDP in 2012, down from a high of 6.1 percent in 2005. All figures used to answer this question can be found on the spreadsheet posted to the course website.

(b) We apply our formula for the evolution of capital to a base of 8,000 at the end of 1998 by adding our value for PRFICA and the subtracting depreciation (i.e., 0.03*Kt) in each subsequent year. The resulting value in 2012 using this perpetual inventory method is 12.1 trillion 2009 dollars.

(c) When we apply the nominal investment values, we get a smaller number for the level of residential capital stock by about a half trillion dollars: 11.7 trillion dollars.



Why? The difference reflects what is going on with house prices over that period. The nominal values for investment are much lower than the real values in the early 2000s, implying that the general price level was lower at that time. That explains why our measure of capital stock using nominals is lower. To illustrate this point, recall that when we take a nominal value and divide it by a real value it gives us a rough measure of price. In the graph above, we see that prices rose briskly in the 2000s up to the financial crisis; they they retraced to their 2005 level and have remained roughly the same since.