

**Group Project with Solutions**

Revised: January 17, 2013

*Due Tuesday December 11, 2012, at the start of class***1. Business cycles in various sectors**

Using the employment data provided in the attached excel file you will analyze how different sectors react differently to aggregate business cycles and use this analysis to guide some forecasts and portfolio decisions

a) Compute growth rates of each employment series and as measure of cyclicity use the correlation of each growth rate with the growth rate of total employment. Rank the sectors in terms of cyclicity. Now repeat the exercise above using the level of the series instead of the growth rates. Briefly discuss why the two rankings are quite different. For example why health looks very cyclical in level but not very cyclical in growth rates? And why for durable goods manufacturing the opposite is true? Suppose now that sectoral stock prices are perfectly correlated with employment in that sector and that you are a fund manager that wants to build a portfolio that hedges the risk of the next US recession. Based on the analysis above which sector would you buy (or short)?

b) The data includes the three most recent US recessions. The one which officially started in July 1990, the one which officially started in March 2001 and the one which officially started in December 2007. Using your preferred method of data analysis in each recession select the sectors that were hit the hardest and the ones were hit the least. Briefly propose explanations of why information sector was hit hard in the 2001 recession and the construction sector was hard hit in the 2007/2008 recession?

**Answer** See attached worksheet

**2. Tax policy under two views**

Consider the following simple model of the macroeconomy. Consumption is given by

$$C = C_f + c(Y(1 - \tau))$$

where  $C_f$  is a part of consumption that does not depend on income,  $c$  is a constant equal to 0.8,  $Y$  is before tax income and  $\tau$  is the tax rate equal to 0.2. Assume that the government uses tax revenues  $\tau Y$  to finance public spending  $G$  so that  $\tau Y = G$ .

Define aggregate demand as a function of before tax income  $Y$

**Answer**  $AD = C_f + c(1 - \tau)Y + \tau Y$  Note that aggregate demand includes private consumption and Government consumption

Now consider two different point of views

a) Keynesian economics. Assume that  $C_f$  is fixed and equal to 1 and that in equilibrium pre-tax income  $Y$  will adjust so that aggregate demand is equal to aggregate supply  $Y$ . Solve for the equilibrium level of pre-tax income  $Y$ . Compute what happens to private consumption ( $C_f + c(1 - \tau)Y$ ) when taxes ( $\tau$ ) are raised from 0.2 to 0.3.

**Answer** Equating aggregate demand and income yields  $Y = \frac{C_f}{(1-\tau)(1-c)}$  so that equilibrium GDP is increasing in tax rate. Note also that  $C = C_f + c(1 - \tau)Y = C_f + \frac{cC_f}{(1-c)} = \frac{C_f}{(1-c)}$ , so private consumption is invariant to the tax rate

b) Supply side economics. Assume that  $Y$  is fixed and equal to 6.25 and that  $C_f$  will adjust so that in equilibrium aggregate demand is equal to aggregate supply. Solve for the equilibrium level of  $C_f$ . Compute what happens to total private consumption ( $C_f + c(1 - \tau)Y$ ) when taxes are raised from 0.2 to 0.3

**Answer** Denote the fixed income with  $\bar{Y}$ . We then get that  $C_f = (1 - \tau)(1 - c)\bar{Y}$  and substituting this in the expression for total private consumption we get  $C = (1 - \tau)\bar{Y}$  which is also declining in taxes.

Briefly comment on why you are getting different answers on the effect of taxes in a) and b).

**Answer** In the first case more aggregate demand creates more output. Increasing taxes increases aggregate demand because it transfers resources from the private sector (which only consume 80% of its income) to the government (which consumes 100% of its income). Hence higher taxes generate high income and private consumption does not fall. In the second case income is fixed so taxes transfer from the private sector to the public sector and hence private consumption must fall.

### 3. Connections between monetary and fiscal policy

In the famous article [Some Unpleasant Monetarist Arithmetic](#) economist and Nobel prize winner Thomas Sargent (together with Neil Wallace) stated that “tight money today can lead to high inflation in the future.” Answering this question should help you understand his argument and its relevance for emerging markets.

Assume that the government of Bocconia is around for two periods. In period 2 it has to pay all its obligations and cannot raise debt. In each period, if no new money is printed, inflation is 0%. In the first period government spending is 30 billions of pesos, nominal GDP is 100 billions and government tax revenues are 20% of nominal GDP. The government can also raise revenues by printing money. Each extra billion of money that is printed raises government revenues by 1 billion (Government can use newly printed money to pay its obligations)

but causes inflation in period 1 ( $\pi_1$ ) to go up by 1%. Finally the government in the first period can issue bonds (at a 25% nominal interest rate) that need to be paid back in the second period. In the second period government spending is  $30 \cdot (1 + \pi_1)$  billion pesos, nominal GDP is  $100 \cdot (1 + \pi_1)$  billions (for example if the inflation rate in the first period is 10% then government spending is 33 billions and nominal GDP is 110 billions), tax revenues are 30% of nominal GDP, the government needs to pay off 10 billions of outstanding zero coupon debt (assume that this debt was issued before period 1) plus any bonds (capital plus interest) issued in period 1. Any government obligation that is not covered by tax revenues needs to be covered by money printing. In period 2 (as in period 1) each extra billion of money that is printed raises government revenues by 1 billion but also causes inflation in period 2 ( $\pi_2$ ) to go up by 1%.

Consider the following two policies:

- (a) Tight money: in the first period the government does not print any new money. Compute:
  - a) Inflation rate in the first period
  - b) The amount of debt the government needs to issue in the first period
  - c) The inflation rate in the second period.
- (b) Money printing: In the first period the government prints 10bln pesos of new money. Compute:
  - d) Inflation in the first period,
  - e) The amount of debt the government needs to issue in the first period
  - f) The inflation rate in the second period.

g) Suppose you live and spend in Bocconia. Before period 1 you purchased a zero coupon bond maturing in period 2 you are holding it until maturity, that is you receive your money at the end of period 2. What is your preferred policy? Why?

h) Show that if the government can control government spending then zero inflation in period 1 and 2 can be achieved. Does this mean that inflation is controlled by fiscal policy?

### Answers

a) By assumption if no new money is printed inflation rate in the first period will be 0%. b) The government the debt needs to issue can be solved from the government budget constraint  $b = 30 - 20 = 10$  c) To solve for inflation rate in the second period we need to solve for the amount of money the government needs to print  $M = 10 + 10 \cdot (1.25) = 22.5$  This gives an inflation rate of 22.5%

d) By assumption if the government prints 10 blns inflation rate will be 10%. e) If the government prints 10 blns of money its revenues will increase by 10 billions and using its budget constraint we get that  $b = 0$ . f) To solve for inflation rate in the second period we need to solve for the amount of money the government

needs to print  $M=30*1.1+10-1.1*0.3*100*1.1=10$ . This gives an inflation rate of 10%

g) If am holding zero coupon bonds until maturity what is relevant for me is the inflation rate in the two periods. Under tight money policy the inflation rate is 22.5% while under the money printing policy inflation is 10% in each period so that compounded inflation is 21%. So the money printing policy is better for the holders of the zero coupon.

h) Yes, in the sense that if the government can control spending it will not need to resort to inflation tax.

#### 4. Mexico: A country study

This question asks you to analyze the performance of the Mexican economy in the past and to forecast its performance for the next 50 years, using the basic tools of growth theory. Throughout this question assume that the aggregate production function is given by  $Y_t = A_t K_{t-1}^\alpha (L_t H_t)^{1-\alpha}$  where  $Y_t$  is GDP in year  $t$ ,  $A_t$  is total factor productivity (TFP) in period  $t$ ,  $K_{t-1}$  is the capital stock at the end of year  $t-1$ ,  $L_t$  is the labor force and  $H_t$  is the per-capita stock of human capital (education). Assume that the per capita stock of human capital in the country ( $H$ ) is equal to the average years of education of the workforce in the country and that  $\alpha = 0.33$ .

a) The capital stock series for Mexico is incomplete as it starts in 1965 and ends in 1990. Fortunately, we have investment data. Using the information you have for investment during the year  $t$   $I_t$  and the capital stock at the end of years  $t-1$  and  $t$ ,  $K_{t-1}$  and  $K_t$  plus the law of motion for capital stock ( $K_t = (1-\delta)K_{t-1} + I_t$ ) compute the capital stock for Mexico in the period 60-65 (assuming an annual depreciation of 20%) and in the period 91-09 (assuming an annual depreciation of 10%)

#### Answer

To compute capital stock in the the 1960-65 period use

$$K_{t-1} = \frac{K_t - I_{t-1}}{1 - \delta}$$

while for the 1991-2004 period use

$$K_{t+1} = (1 - \delta)K_t + I_t$$

The complete series for the capital stock is in the the excel worksheet attached.

b) Decompose the growth of real GDP per capita over the periods 1960-1976, 1977-1994, 1995-2009 into the components due to per capita capital accumulation, total factor productivity growth, labor force/population growth and human capital growth. What can you say about the impact of NAFTA (Mexico

entered NAFTA in 1994) on the Mexican economy?

### Answer

See the table and the figure in the attached worksheet. Note that 1994, the year in which Mexico joined NAFTA also coincides with the year of the Tequila crisis which you can see in the large drop in Mexican TFP. After the Tequila crisis though you can see few years of sustained TFP growth, which is a fairly rare occurrence in Mexican history. It is conceivable that the increase in competition brought by NAFTA is partly responsible for the TFP growth in those years.

c) Compute the TFP level (A) for Mexico in 2009

### Answer

See the attached worksheet

d) In 2009 the ratio between GDP per capita in Mexico and in US is around 5.5. Assume that US GDP per capita grows at 2% per year until 2050. Compute the path of GDP per capita in Mexico until 2050 and compute its ratio to US GDP in 2050.

To do so you will need the following assumptions:

- Capital stock in Mexico will evolve according to  $K_t = (1 - \delta)K_{t-1} + sY_t$  where  $s$  is a constant investment to output ratio. Compute  $s$  using the investment output ratio in Mexico in the last 10 years (1999-2009) and assume  $\delta = 0.1$ .

- The stock of human capital in Mexico from 2009 to 2050 will grow at the same rate at which it has grown in the last 10 years (2000-2009).

- The population is going to grow according to the forecasts reported by the Census Bureau and labor force as a fraction of the population is going to increase at a decreasing rate so that in 2050 the ratio is equal to 0.5 (as it is for US now).

- Total factor productivity (A) growth between year  $t$  and year  $t+1$  is given by  $1.3\% - 1.5\% * \ln\left(\frac{\text{GDP per capita Mexico in year } t}{\text{GDP per capita US in year } t}\right)$

(This assumption is also used in the GS piece Dreaming with the BRICS).

### Answer

See the attached worksheet. Using this methodology, which is the one used by GS in the BRIC article, Mexico GDP per capita would be 75% of the one in US.

e) Looking back at your answers in parts b and d which of the assumptions of part d seems less plausible? How would you modify it? Assess the impact of your proposed modification on forecasted Mexican GDP per capita in 2050.

### Answer

The most questionable assumption is the one regarding the growth of TFP. Figure 2 shows how the forecasted path of TFP is dramatically different from

the actual path. In particular the forecasted path assumes a base rate of TFP growth of 1.3% plus a catch-up factor which depends on the ratio between Mexican and US GDP. If, for example, Mexican GDP per capita is 1/5 the GDP per capita in the US the additional growth would be 2.4% ( $-0.015 \cdot \ln(0.2)$ ). Unfortunately Mexico's TFP, over the period 1960-2004 not only has not displayed any catch up but has also failed to display base growth (i.e. Mexican TFP has displayed negative growth). So unless there is evidence of important structural change in Mexico (and unfortunately there is not much of it) the assumption of productivity growth seems overly optimistic. If one makes the, still optimistic compared to the the 60-05 experience, hypothesis of 1% TFP growth, Mexico in 2050 would reach a GDP per capita which is 25% of the US.

### 5. The past and the future of the Euro

Go to the [OECD i-library national Accounts Statistics](#) and get data for quarterly GDP (in constant PPP dollars) and for total employment for Germany, France, Italy and Spain (the 4 major countries in the Euro area) for the period 1996.1-2012.2. (No need to print the data and attach them to the project).

(a) Compute the levels of GDP per worker in 1996.1 and 2012.2 and assess whether over this period there has been convergence in the Euro Area.  
**Answer** See the attached graph. Notice three main patterns. Germany and France, the richest countries in the the EU have experienced very similar patterns with steady growth in productivity throughout the period (except the Great Recession). Spain and Italy have experienced very different patterns. Spain has displayed constant productivity in the early years, but has experienced strong growth in productivity after the GR, due the massive reduction in employment. Italy on the other had has experienced a steady decline in productivity, which has continued throughout the Great Recession.

(b) Prepare a table that includes for each country and for the following subperiods: 1996.1-2006.1, 2006.2-2012.2 growth rates of real GDP, employment and labor productivity for all the 4 countries.

**Answer** See Attached worksheet

(c) Suppose you have just been hired by a Chinese company who wants a brief report (max 1 page typed) on what macro developments in the Euro area can tell about the future of the common currency. Use the data above (and other data if you wish, but stick to the one page limit) to write the report.

**Answer** In the report I would highlight two main facts. The core of the Euro (i.e. France and Germany) has had very similar Macroeconomic conditions, hence a common monetary policy is certainly possible. The two periphery countries (Italy and Spain) though have had very different

macroeconomic experiences, raising doubts on whether they will stick to the Euro.