Assignment #3

Econ 102: Introductory Macroeconomics
March 9, 2010

Directions: Turn in the homework to your TA’s box before lecture. Please legibly write your name, TA name, and section number on the front of the homework. Write your name as it appears on your ID. Late homework is not be accepted. Please show your work in a readable and organized way. Good luck!

1 Measuring Output

You are provided with the following information about an economy that produces three final goods: almonds, bicycles, and computers. The currency in use is the US Dollar ($US).

<table>
<thead>
<tr>
<th>Year</th>
<th>Almonds</th>
<th>Bicycles</th>
<th>Computers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price</td>
<td>Quantity</td>
<td>Price</td>
</tr>
<tr>
<td>1980</td>
<td>$1</td>
<td>10,000</td>
<td>$10</td>
</tr>
<tr>
<td>1990</td>
<td>$1.5</td>
<td>15,000</td>
<td>$14</td>
</tr>
<tr>
<td>2000</td>
<td>$2.25</td>
<td>12,500</td>
<td>$22</td>
</tr>
</tbody>
</table>

1.1 Compute nominal GDP in 1980, 1990, and 2000. Do you observe a trend in the data?

Let $i$ index the final goods; $i = 1$ almonds, $i = 2$ bicycles, $i = 3$ computers.

$$NGDP_{1980} = \sum_{i=1}^{3} P_{i,1980}Q_{i,1980}$$

$$= (P_{almonds,1980})(Q_{almonds,1980}) + (P_{bicycles,1980})(Q_{bicycles,1980}) + (P_{computers,1980})(Q_{computers,1980})$$

$$= ($1)(10,000) + ($10)(4,000) + ($700)(130)$$

$$= $10,000 + $40,000 + $91,000$$

$$NGDP_{1980} = $141,000$$

$$NGDP_{1990} = \sum_{i=1}^{3} P_{i,1990}Q_{i,1990}$$

$$= ($1.5)(15,000) + ($14)(3,200) + ($450)(900)$$

$$= $22,500 + $44,800 + $405,000$$

$$NGDP_{1990} = $472,300$$

*Kelly; UW-Madison. TAs Saiah Lee, Hsuan-Chih Lin, Scott Swisher, and Yuan Yuan.*
\[ NGDP_{2000} = \sum_{i=1}^{3} P_{i,2000}Q_{i,2000} \]
\[ = (\$2.25)(12,500) + (\$22)(1,700) + (\$225)(6,000) \]
\[ = 28,125 + 37,400 + 1,350,000 \]
\[ NGDP_{2000} = \$1,415,525 \]

The trend is clearly upward, and the growth looks exponential.


\[
\%\Delta NGDP_{1980-1990} = \frac{NGDP_{1990} - NGDP_{1980}}{NGDP_{1980}} \times 100 \\
\%\Delta NGDP_{1980-1990} = \frac{\$472,300 - \$141,000}{\$141,000} \times 100 \\
\%\Delta NGDP_{1980-1990} = 234.96\% \\
\]

\[
\%\Delta NGDP_{1990-2000} = \frac{NGDP_{2000} - NGDP_{1990}}{NGDP_{1990}} \times 100 \\
\%\Delta NGDP_{1990-2000} = \frac{\$1,415,525 - \$472,300}{\$472,300} \times 100 \\
\%\Delta NGDP_{1990-2000} = 199.71\% \\
\]


\[ RGDP_{1980} = \sum_{i=1}^{3} P_{i,1980}Q_{i,1980} \]
\[ = NGDP_{1980} \]
\[ RGDP_{1980} = \$141,000 \]

\[ RGDP_{1990} = \sum_{i=1}^{3} P_{i,1980}Q_{i,1990} \]
\[ = (\$1)(15,000) + (\$10)(3,200) + (\$700)(900) \]
\[ RGDP_{1990} = \$677,000 \]

\[ RGDP_{2000} = \sum_{i=1}^{3} P_{i,1980}Q_{i,2000} \]
\[ = (\$1)(12,500) + (\$10)(1,700) + (\$700)(6,000) \]
\[ RGDP_{2000} = \$4,229,500 \]

\[ \%\Delta RGDP_{1980-1990} = \frac{\$677,000 - \$141,000}{\$141,000} \times 100 = 380.14\% \]
%ΔRGDP

\[
%ΔRGDP_{1990-2000} = \frac{$4,229,500 - $677,000}{$677,000} (100) = 524.74\%
\]

Again, the trend in real GDP is upward with exponential growth.


\[
RGDP_{1980} = \sum_{i=1}^{3} P_{i,2000}Q_{i,1980}
\]

\[
= ($2.25)(10,000) + ($22)(4,000) + ($225)(130)
\]

\[
RGDP_{1980} = $139,750
\]

\[
RGDP_{1990} = \sum_{i=1}^{3} P_{i,2000}Q_{i,1990}
\]

\[
= ($2.25)(15,000) + ($22)(3,200) + ($225)(900)
\]

\[
RGDP_{1990} = $306,650
\]

\[
RGDP_{2000} = \sum_{i=1}^{3} P_{i,2000}Q_{i,2000}
\]

\[
= NGDP_{2000}
\]

\[
RGDP_{2000} = $1,415,525
\]

\[
%ΔRGDP_{1980-1990} = \frac{$306,650 - $139,750}{$139,750} (100) = 119.43\%
\]

\[
%ΔRGDP_{1990-2000} = \frac{$1,415,525 - $306,650}{$306,650} (100) = 361.61\%
\]

The estimated growth rates do not agree. Real GDP growth rates depend on the specification of the base year because the base year determines relative prices, which are used to weight the quantities.


\[
(GDP\ deflator)_{1980} = \frac{NGDP_{1980}}{RGDP_{1980}} (100) = \frac{$141,000}{$141,000} (100) = 100
\]

\[
(GDP\ deflator)_{1990} = \frac{NGDP_{1990}}{RGDP_{1990}} (100) = \frac{$472,300}{$677,000} (100) = 69.76
\]

\[
(GDP\ deflator)_{2000} = \frac{NGDP_{2000}}{RGDP_{2000}} (100) = \frac{$1,415,525}{$4,229,500} (100) = 33.47
\]

\[
%Δ(GDP\ deflator)_{1980-1990} = \pi_{1980-1990} = \frac{69.76 - 100}{100} (100) = -30.24\%
\]
\[
\%\Delta (GDP \text{ deflator})_{1990-2000} = \pi_{1990-2000} = \frac{33.47 - 69.76}{69.76} (100) = -52.03\%
\]

Deflation is occurring from 1980-2000. The growth rate of the GDP deflator is interpreted as the inflation rate, \(\pi\). \(\pi < 0 \Rightarrow \text{deflation.}\)


\[
(GDP \text{ deflator})_{1980} = \frac{NGDP_{1980}}{RGDP_{1980}} (100) = \frac{141,000}{139,750} (100) = 100.89
\]

\[
(GDP \text{ deflator})_{1990} = \frac{NGDP_{1990}}{RGDP_{1990}} (100) = \frac{472,300}{306,650} (100) = 154.02
\]

\[
(GDP \text{ deflator})_{2000} = \frac{NGDP_{2000}}{RGDP_{2000}} (100) = \frac{1,415,525}{1,415,525} (100) = 100
\]

\[
\%\Delta (GDP \text{ deflator})_{1980-1990} = \pi_{1980-1990} = \frac{154.02 - 100.89}{100.89} (100) = 52.65\%
\]

\[
\%\Delta (GDP \text{ deflator})_{1990-2000} = \pi_{1990-2000} = \frac{100 - 154.02}{154.02} (100) = -35.07\%
\]

The estimated inflation rates do not agree. Since real GDP depends on the base year, so does the GDP deflator; this implies that the inflation rates will differ.

1.7 Briefly discuss how real GDP (as a measure of output) depends on the base year. Does the base year matter?

Relative prices in the base year are used as weights on the quantities for all years that real GDP is calculated. Because relative prices vary from year to year, we expect that real GDP will change as the base year changes. For example, let's assume that housing prices are very high in the base year we choose (such as the peak of the real estate bubble in 2007). If this is the case, real GDP puts high weight on housing and relatively lower weight on all other goods, which increases the importance of the housing market in calculating output. It is best to choose an average or “representative” year as the base year for computing real GDP.
2 Building a Price Index

Table 2 lists the average prices faced by consumers (from 1980-2000) across five categories of household expenditure: housing, clothing, fuel, food, and entertainment.

<table>
<thead>
<tr>
<th>Year</th>
<th>Housing</th>
<th>Clothing</th>
<th>Fuel</th>
<th>Food</th>
<th>Entertainment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>$100,000</td>
<td>$40</td>
<td>$5</td>
<td>$250</td>
<td>$10</td>
</tr>
<tr>
<td>1990</td>
<td>$125,000</td>
<td>$50</td>
<td>$2.2</td>
<td>$325</td>
<td>$17</td>
</tr>
<tr>
<td>2000</td>
<td>$300,000</td>
<td>$35</td>
<td>$3.5</td>
<td>$500</td>
<td>$53</td>
</tr>
</tbody>
</table>

When calculating market basket expenditure, the Bureau of Labor Statistics wants you to use the following weights (fixed quantities) for each category of expenditure given in Table 3. The weights do not change over time. Given market basket expenditure in each year, you can compute the Consumer Price Index (CPI).

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>0.1</td>
</tr>
<tr>
<td>Clothing</td>
<td>0.1</td>
</tr>
<tr>
<td>Fuel</td>
<td>0.15</td>
</tr>
<tr>
<td>Food</td>
<td>0.55</td>
</tr>
<tr>
<td>Entertainment</td>
<td>0.1</td>
</tr>
</tbody>
</table>


\[
Expenditure_{1980} = (0.1)($100,000) + (0.1)($40) + (0.15)($5) + (0.55)($250) + (0.1)($10) = $10,143.3
\]
\[
Expenditure_{1990} = (0.1)($125,000) + (0.1)($50) + (0.15)($2.2) + (0.55)($325) + (0.1)($17) = $12,685.8
\]
\[
Expenditure_{2000} = (0.1)($300,000) + (0.1)($35) + (0.15)($3.5) + (0.55)($500) + (0.1)($53) = $30,284.3
\]


\[
CPI_{1980} = \frac{Expenditure_{1980}}{Expenditure_{1980}} \times 100 = \frac{Expenditure_{1980}}{Expenditure_{1980}} = \frac{10,143.3}{10,143.3} (100) = 100
\]
\[
CPI_{1990} = \frac{Expenditure_{1990}}{Expenditure_{1980}} \times 100 = \frac{12,685.8}{10,143.3} (100) = 125.07
\]
\[
CPI_{2000} = \frac{Expenditure_{2000}}{Expenditure_{1980}} \times 100 = \frac{30,284.3}{10,143.3} (100) = 298.57
\]
\[
\% \Delta CPI_{1980–1990} = \pi_{1980–1990} = \frac{CPI_{1990} - CPI_{1980}}{CPI_{1980}} \times 100 = \frac{125.07 - 100}{100} (100) = 25.07\%
\]
\[
\% \Delta CPI_{1990–2000} = \pi_{1990–2000} = \frac{298.57 - 125.07}{125.07} (100) = 138.72\%
\]
The growth rate of the CPI is interpreted as the inflation rate, \( \pi \). The growth rate of the CPI does not necessarily equal the growth rate of the GDP deflator.


\[
CPI_{1980} = \frac{Expenditure_{1980}}{Expenditure_{base}}(100) = \frac{Expenditure_{1980}}{Expenditure_{1990}}(100) = \frac{10,143.3}{12,685.8}(100) = 79.96
\]

\[
CPI_{1990} = \frac{Expenditure_{1990}}{Expenditure_{1990}}(100) = \frac{12,685.8}{12,685.8}(100) = 100
\]

\[
CPI_{2000} = \frac{Expenditure_{2000}}{Expenditure_{1990}}(100) = \frac{30,284.3}{12,685.8}(100) = 238.72
\]

\[
%\Delta CPI_{1980-1990} = \pi_{1980-1990} = \frac{CPI_{1990} - CPI_{1980}}{CPI_{1980}}(100) = \frac{100 - 79.96}{79.96}(100) = 25.07\%
\]

\[
%\Delta CPI_{1990-2000} = \pi_{1990-2000} = \frac{238.72 - 100}{100}(100) = 138.72\%
\]

The inflation rate estimates using 1990 as the base year agree with those from the previous part. The base year does not matter when computing inflation rates from the CPI.


\[
CPI_{1980} = \frac{Expenditure_{1980}}{Expenditure_{base}}(100) = \frac{Expenditure_{1980}}{Expenditure_{2000}}(100) = \frac{10,143.3}{30,284.3}(100) = 33.49
\]

\[
CPI_{1990} = \frac{Expenditure_{1990}}{Expenditure_{2000}}(100) = \frac{12,685.8}{30,284.3}(100) = 41.8
\]

\[
CPI_{2000} = \frac{Expenditure_{2000}}{Expenditure_{2000}}(100) = \frac{30,284.3}{30,284.3}(100) = 100
\]

\[
%\Delta CPI_{1980-1990} = \pi_{1980-1990} = \frac{CPI_{1990} - CPI_{1980}}{CPI_{1980}}(100) = \frac{41.8 - 33.49}{33.49}(100) = 25.07\%
\]

\[
%\Delta CPI_{1990-2000} = \pi_{1990-2000} = \frac{100 - 41.8}{41.8}(100) = 138.72\%
\]

The inflation rate estimates using 2000 as the base year agree with those from the previous parts. Again, the base year does not matter when computing inflation rates from the CPI.

2.5 Briefly discuss how the growth rate of the CPI depends on the base year. Does the base year matter?

The growth rate of the CPI does not depend on the choice of base year. The CPI growth rate depends only on the relative market basket expenditure levels in each year, and those relative expenditure levels do not change when the base year changes. In other words, the base year does not matter when computing inflation rates based on the CPI.
3 Labor Market Outcomes

The following data on the labor market have been provided to you by the US Bureau of Labor Statistics. Due to an error in the transfer, the database has been corrupted and some entries are missing.

Table 4: US Labor Force

<table>
<thead>
<tr>
<th>Adult Population (N)</th>
<th>200</th>
<th>N, % Female 52%</th>
<th>N, % Male 48%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor Force (LF)</td>
<td>155</td>
<td>LF, % Female 40%</td>
<td>LF, % Male 60%</td>
</tr>
<tr>
<td>Employed (E)</td>
<td>130</td>
<td>E, % Female 45%</td>
<td>E, % Male 55%</td>
</tr>
<tr>
<td>Unemployed (U)</td>
<td>25</td>
<td>U, % Female 14%</td>
<td>U, % Male 86%</td>
</tr>
</tbody>
</table>

3.1 Complete Table 4.

\[ U = LF - E = 155 - 130 = 25 \]
\[ N_{male} = 100\% - 52\% = 48\% \]
\[ LF_{female} = 100\% - 60\% = 40\% \]
\[ E_{male} = 100\% - 45\% = 55\% \]

\( (0.52)(200) = 104 \) females, \( (0.4)(155) = 62 \) females in the labor force, \( (0.45)(130) = 58.5 \) employed females
\Rightarrow 62 - 58.5 = 3.5 unemployed females.

\[ U_{female} = \frac{3.5}{25} (100) = 14\% \]
\[ U_{male} = 100\% - 14\% = 86\% \]

<table>
<thead>
<tr>
<th>Adult Population (N)</th>
<th>200</th>
<th>N, % Female 52%</th>
<th>N, % Male 48%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor Force (LF)</td>
<td>155</td>
<td>LF, % Female 40%</td>
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<tr>
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<td>130</td>
<td>E, % Female 45%</td>
<td>E, % Male 55%</td>
</tr>
<tr>
<td>Unemployed (U)</td>
<td>25</td>
<td>U, % Female 14%</td>
<td>U, % Male 86%</td>
</tr>
</tbody>
</table>

3.2 What is the US unemployment rate? What is the unemployment rate for females? What is the unemployment rate for males?

\[ UR = \frac{U}{LF}(100) = \frac{25}{155}(100) = 16.13\% \]
\[ UR_{female} = \frac{U_{female}}{LF_{female}}(100) = \frac{(0.14)(25)}{(0.4)(155)}(100) = \frac{3.5}{62}(100) = 5.64\% \]
\[ UR_{male} = \frac{U_{male}}{LF_{male}}(100) = \frac{(0.86)(25)}{(0.6)(155)}(100) = \frac{21.5}{93}(100) = 23.12\% \]
3.3 What is the US labor force participation rate? What is the labor force participation rate for females? What is the labor force participation rate for males?

\[
LFPR = \frac{LF}{N} (100) = \frac{155}{200} (100) = 77.5\%
\]

\[
LFPR_{female} = \frac{LF_{female}}{N_{female}} (100) = \frac{(0.4)(155)}{(0.52)(200)} (100) = \frac{62}{104} (100) = 59.61\%
\]

\[
LFPR_{male} = \frac{LF_{male}}{N_{male}} (100) = \frac{(0.6)(155)}{(0.48)(200)} (100) = \frac{93}{96} (100) = 96.87\%
\]
4 Historical US Unemployment

The following table lists the US unemployment rate from 1933-1945.

Table 5: US Unemployment Rate (% of LF)

<table>
<thead>
<tr>
<th>Year</th>
<th>UR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1933</td>
<td>24.9</td>
</tr>
<tr>
<td>1934</td>
<td>21.7</td>
</tr>
<tr>
<td>1935</td>
<td>20.1</td>
</tr>
<tr>
<td>1936</td>
<td>16.9</td>
</tr>
<tr>
<td>1937</td>
<td>14.3</td>
</tr>
<tr>
<td>1938</td>
<td>19.0</td>
</tr>
<tr>
<td>1939</td>
<td>17.2</td>
</tr>
<tr>
<td>1940</td>
<td>14.6</td>
</tr>
<tr>
<td>1941</td>
<td>9.9</td>
</tr>
<tr>
<td>1942</td>
<td>4.7</td>
</tr>
<tr>
<td>1943</td>
<td>1.9</td>
</tr>
<tr>
<td>1944</td>
<td>1.2</td>
</tr>
<tr>
<td>1945</td>
<td>1.9</td>
</tr>
</tbody>
</table>

4.1 The unemployment rate before 1941 is much higher than the rate from 1941-1945. What do you think is the main component of unemployment from 1933 to 1940 (frictional, structural, cyclical, etc.)?

*Cyclical unemployment due to the Great Depression. The persistent US (aggregate) unemployment spell ended due to entry into World War II and the wartime economy.*

4.2 Is it possible to maintain a zero unemployment rate after 1945? Why or why not?

*Zero unemployment is not currently attainable; frictional unemployment will always exist with the present labor market matching technology that pairs idle workers with hiring firms (search process).*

4.3 Assume that the US adult population over this period is constant at 100 million and the labor force participation rate is fixed at 80%. Calculate the number of unemployed persons in the US from 1933-1945.

\[ LF = LFPR(N) = (0.8)(100 \text{ million}) = 80 \text{ million} \]

\[ U_t = UR_t(LF) = UR_t(80 \text{ million}) \]
<table>
<thead>
<tr>
<th>Year</th>
<th>UR (%)</th>
<th>U (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1933</td>
<td>24.9</td>
<td>19.92</td>
</tr>
<tr>
<td>1934</td>
<td>21.7</td>
<td>17.36</td>
</tr>
<tr>
<td>1935</td>
<td>20.1</td>
<td>16.08</td>
</tr>
<tr>
<td>1936</td>
<td>16.9</td>
<td>13.52</td>
</tr>
<tr>
<td>1937</td>
<td>14.3</td>
<td>11.44</td>
</tr>
<tr>
<td>1938</td>
<td>19</td>
<td>15.2</td>
</tr>
<tr>
<td>1939</td>
<td>17.2</td>
<td>13.76</td>
</tr>
<tr>
<td>1940</td>
<td>14.6</td>
<td>11.68</td>
</tr>
<tr>
<td>1941</td>
<td>9.9</td>
<td>7.92</td>
</tr>
<tr>
<td>1942</td>
<td>4.7</td>
<td>3.76</td>
</tr>
<tr>
<td>1943</td>
<td>1.9</td>
<td>1.52</td>
</tr>
<tr>
<td>1944</td>
<td>1.2</td>
<td>0.96</td>
</tr>
<tr>
<td>1945</td>
<td>1.9</td>
<td>1.52</td>
</tr>
</tbody>
</table>

4.4 After 1945, suppose that the government implements a preferential tax scheme for women that encourages entry into the labor force. Briefly discuss the possible effects on the unemployment rate and the labor force participation rate.

*Provided that more females are entering the labor force, both the unemployment rate and the labor force participation rate will increase (holding the rates of job creation/destruction constant).*