1) 

a) 

\[ H_0: \beta_2 = 0 \]

\[ H_1: \beta_2 > 0 \]

\[ t = \frac{\hat{\beta}_2 - \beta_2}{\sigma_{\beta_2}} = \frac{3-0}{4^{1/2}} = 1.5 \]

but \( t_{0.05,63-3} = t_{0.05,60} = 1.671 \)

as \( t_{\text{calculated}} < t_{\text{table}} \) we fail to reject \( H_0 \)

b) 

\[ H_0: \beta_1 + 2\beta_2 = 5 \]

\[ H_1: \beta_1 + 2\beta_2 > 5 \]

\[ t = \frac{\hat{\beta}_1 + 2\hat{\beta}_2 - 5}{\sigma_{\beta_1+2\beta_2}} = \frac{2+6-5}{11^{1/2}} = 0.9045 \]

where \( \sigma_{\beta_1+2\beta_2} = (\text{Var}(\beta_1 + 2\beta_2))^{1/2} = (V(\beta_1) + 4V(\beta_2) + (2 \times 2) \text{Cov}(\beta_1, \beta_2))^{1/2} \)

\[ \sigma_{\beta_1+2\beta_2} = (3+4.4+4(-2))^{1/2} = (11)^{1/2} = 3.31662 \]

but \( t_{0.05,63-3} = t_{0.05,60} = 1.671 \)

as \( t_{\text{calculated}} < t_{\text{table}} \) we fail to reject \( H_0 \)

c) 

\[ H_0: \beta_1 - \beta_2 + \beta_3 = 4 \]

\[ H_1: \beta_1 - \beta_2 + \beta_3 < 4 \]

\[ t = \frac{\hat{\beta}_1 - \hat{\beta}_2 + \hat{\beta}_3 - 4}{\sigma_{\beta_1-\beta_2+\beta_3}} = \frac{(2-3-1)-4}{20^{1/2}} = -1.34 \]
where \( \sigma_{\beta_1-\beta_2+\beta_3}^2 = (\text{Var}(\beta_1 - \beta_2 + \beta_3))^{1/2} \)
\[
= (V(\beta_1) + V(\beta_2) + V(\beta_3) - 2 \text{Cov}(\beta_1, \beta_2) + 2 \text{Cov}(\beta_1, \beta_3) - 2 \text{Cov}(\beta_2, \beta_3))^{1/2}
\]
\[
\sigma_{\beta_1-\beta_2+\beta_3}^2 = (3 + 4 + 3 - 2(-2) + 2(3) - 2(0))^{1/2} = (20)^{1/2} = 4.47213
\]

but \( t_{0.05,63-3} = t_{0.05,60} = 1.671 \)
as \( t_{\text{calculated}} < t_{\text{table}} \) we fail to reject \( H_0 \)

2.

\[
F = \frac{\text{SSE}_R - \text{SSE}_U}{/k - 1} = \left( \frac{\text{SSE}_R - \text{SSE}_U}{\text{SSE}_U} \right) \left( \frac{T-k}{k-1} \right)
\]

where \( T \): total number of observations
\( k \): total number of independent variables including the constant

\[
\text{SSE}_R = \sum_{t=1}^{T} (\tilde{y}_t - \bar{y})^2 = \frac{1}{T-1} \sum_{t=1}^{T} (\tilde{y}_t - \bar{y})^2 = \text{Var}(\tilde{y}_t)(T-1)
\]

\[
\text{SSE}_R = (4.326)(99) = 428.274
\]

also,

\[
[S.E. \text{ of regression}]^2 = \frac{\text{SSE}_U}{T-k}
\]

\[
\Rightarrow \text{SSE}_U = [S.E. \text{ of regression}]^2 (T-k)
\]

\[
= (2.5321)(100-4)
\]

\[
\text{SSE}_U = 243.0816
\]

\[
\Rightarrow F = \frac{(428.274 - 243.0816)(96)}{(243.0816)(3)} = 24.3792
\]

but \( F_{k_1=5,k_2=4} = 2.68 \)
as \( F_{\text{calculated}} > F_{\text{table}} \) we reject \( H_0 \).
3) 

\[ R^2 = 1 - \frac{SSE}{SST}, \quad \bar{R}^2 = 1 - \frac{SSE / T - k}{SST / T - 1} \]

substitute \( R^2 \) in the right hand side of the expression that we need to solve for:

\[
R^2 - \frac{k - 1}{T - k} (1 - R^2) = \left[ 1 - \frac{SSE}{SST} \right] - \left( \frac{k - 1}{T - k} \right) \left[ 1 - \left( 1 - \frac{SSE}{SST} \right) \right]
\]

\[
= 1 - \frac{SSE}{SST} - \left( \frac{k - 1}{T - k} \right) \left( \frac{SSE}{SST} \right)
\]

\[
= 1 - \frac{SSE}{SST} \left( 1 + \frac{k - 1}{T - k} \right)
\]

\[
= 1 - \frac{SSE}{SST} \left( \frac{T - k + k - 1}{T - k} \right)
\]

\[
= 1 - \frac{SSE}{SST} \left( \frac{T - 1}{T - k} \right)
\]

\[
= 1 - \frac{SSE}{SST} \left( \frac{T - k}{T - 1} \right)
\]

\[ = \bar{R}^2 \]

**EViews Exercise:**

I) **An analysis if the effect of rigidities on unemployment:**

Let’s start with a general (unrestricted) model, which aims to explain the factors that could have an impact on unemployment:

1)  

Dependent Variable: LOG_UNEMP8396  
Method: Least Squares  
Sample(adjusted): 1 19  
Included observations: 19 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.414309</td>
<td>1.608546</td>
<td>-0.257567</td>
<td>0.8032</td>
</tr>
<tr>
<td>ACTIVE_LABOR_POL</td>
<td>0.020152</td>
<td>0.014025</td>
<td>1.436907</td>
<td>0.1887</td>
</tr>
<tr>
<td>ANNUAL_HRS</td>
<td>0.004347</td>
<td>0.000841</td>
<td>5.170573</td>
<td>0.0009</td>
</tr>
<tr>
<td>BENEFIT_DURATION</td>
<td>-0.005681</td>
<td>0.089892</td>
<td>-0.063193</td>
<td>0.9512</td>
</tr>
<tr>
<td>BENEFIT_REPLACEM</td>
<td>-0.002878</td>
<td>0.006840</td>
<td>-0.420737</td>
<td>0.6850</td>
</tr>
<tr>
<td>EMP_PROTECTION</td>
<td>-0.029925</td>
<td>0.023803</td>
<td>-1.257216</td>
<td>0.2441</td>
</tr>
<tr>
<td>LABOR_STD</td>
<td>-0.093003</td>
<td>0.075217</td>
<td>-1.236461</td>
<td>0.2514</td>
</tr>
<tr>
<td>OVERALL_LABOR</td>
<td>-0.108010</td>
<td>0.023883</td>
<td>-4.522407</td>
<td>0.0019</td>
</tr>
<tr>
<td>PAYROLL_TAX</td>
<td>-0.084882</td>
<td>0.035966</td>
<td>-2.360087</td>
<td>0.0460</td>
</tr>
<tr>
<td>TOTAL_TAX_RATE</td>
<td>0.077974</td>
<td>0.029456</td>
<td>2.647110</td>
<td>0.0294</td>
</tr>
</tbody>
</table>
It is clear that not all variables are statistically significant in explaining unemployment. In particular, Active Labor Policies, Benefit Duration, Benefit Replacement, Employment Protection, Labor Standards and Union Density are the variables with insignificant p-values. We know that this could be either due to the fact that those variables are in fact irrelevant in explaining unemployment or they might be highly correlated with the other variables in the regression equation. If this is the case, the information that these variables carry in explaining unemployment is already reflected into the regression by those other variables (multicolinearity).

Note that the dependent variable is the logarithm of unemployment as suggested in the article (footnote 5).

Let’s proceed by gradually dropping those variables with highest p-values until we reach a model with all significant regressors:

2) 

Dependent Variable: LOG_UNEMP8396
Method: Least Squares
Sample(adjusted): 1 19
Included observations: 19 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-1.235041</td>
<td>1.527345</td>
<td>-0.808620</td>
<td>0.4323</td>
</tr>
<tr>
<td>ANNUAL_HRS</td>
<td>0.003646</td>
<td>0.000775</td>
<td>4.703199</td>
<td>0.0003</td>
</tr>
<tr>
<td>OVERALL_LABOR</td>
<td>-0.076114</td>
<td>0.013085</td>
<td>-5.816687</td>
<td>0.0000</td>
</tr>
<tr>
<td>PAYROLL_TAX</td>
<td>-0.055380</td>
<td>0.016339</td>
<td>-3.389501</td>
<td>0.0044</td>
</tr>
<tr>
<td>TOTAL_TAX_RATE</td>
<td>0.045595</td>
<td>0.017062</td>
<td>2.672263</td>
<td>0.0182</td>
</tr>
</tbody>
</table>

R-squared          0.730178  Mean dependent var  1.947838
Adjusted R-squared 0.653086  S.D. dependent var  0.584326
S.E. of regression 0.344165  Akaike info criterion 0.925540
Sum squared resid   0.045595  Schwarz criterion  1.174077

Here, we observe that all independent variables are significant in explaining unemployment for the period 1983-1996.

- Contrary to Nickell’s findings, an increase in the annual hours worked leads to an increase in the unemployment rate. This finding seems to be in line with the
advocates of the view that there is some exogenously given level of work to be done. Hence, by increasing the hours of work, less job opportunities will be left for rest of the people, increasing unemployment.

- Overall labor supply is negatively related to unemployment. At first glance, this finding seems to be in contradiction with our first result. In particular, this result suggests that the amount of work to be done tends to increase more than proportionally with the available supply of labor. That is, as more people enter into the labor force, even more jobs will be created, decreasing the equilibrium unemployment rate. A possible explanation might be that changes in the overall labor supply require a longer time span (in contrast to changes in annual hours) which makes it possible to expand new areas of employment.

- An increase in payroll tax leads to a decrease in unemployment. This is a counter-intuitive finding and requires some further analysis. A natural inclination would be to expect a positive relationship between payroll taxes and unemployment. This is simply because payroll taxes contribute as an important cost of labor for the employer. Therefore, an increase in cost of hiring more employees would lead the employer to hire fewer workers. Then, what could be going on? One possibility is that whenever payroll taxes are adjusted, other tax rates may also be adjusted. By not including those tax rates, our regression equation may not be able to filter out pure effects of payroll taxes. For example, it may be possible that an increase in payroll taxes might be associated with a decrease in income or consumption taxes. As a result, even though the demand for labor goes down, supply of labor may increase more than proportionally, leading to an increase in the equilibrium amount of employment.

- An increase in total tax rate tends to increase unemployment. This is an intuitive finding and supports our story for payroll taxes. By looking at the overall tax rate as a whole (rather than just focusing on the payroll taxes) we are able to get the big picture. An overall increase in taxes will lead the employers hire less workers, with no corresponding increase in labor supply. Hence equilibrium unemployment will go up.

**Hypothesis Tests:**

Given that the p-values associated with the two tax variables (payroll tax and the total-tax-rate) are relatively larger, compared to other regressors, let’s check whether these two variables are jointly significant or not:

**Wald Test:**

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(4)=0</td>
<td>5.907803</td>
<td>0.013795</td>
</tr>
<tr>
<td>C(5)=0</td>
<td>11.81561</td>
<td>0.002718</td>
</tr>
</tbody>
</table>

As the p-value is less than 0.05, we reject the null hypothesis at 95% confidence level. This indicates that the tax variables are jointly significant.

Let’s also test whether the estimated sign for the payroll tax is statistically significant or not. In particular, let’s test the possibility of a positive coefficient (such as 0.05):
Wald Test:
Equation: EQ01

Null Hypothesis:
C(4) = 0.05

F-statistic | 41.59885 | Probability | 0.000015
Chi-square  | 41.59885 | Probability | 0.000000

We strongly reject the null hypothesis. This suggests that the negative sign associated with that coefficient is pretty accurate. Therefore, it should be the presence of all other factors that we failed to filter out (as we have discussed above) that might be causing a negative coefficient.

II) An analysis if the effect of rigidities on labor force participation:

In order to analyze the variables that affect labor force participation, we proceed in the same way as in part I, and start with the most general model. After we drop the insignificant variables, we obtain the following final forms:

1) Dependent Variable: OVERALL_LABOR
   Method: Least Squares, Sample: 1 20, Included observations: 20

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>28.94670</td>
<td>12.88418</td>
<td>2.246686</td>
<td>0.0401</td>
</tr>
<tr>
<td>ACTIVE_LABOR_POL</td>
<td>0.204250</td>
<td>0.093336</td>
<td>2.188315</td>
<td>0.0449</td>
</tr>
<tr>
<td>ANNUAL_HRS</td>
<td>0.021893</td>
<td>0.006763</td>
<td>3.237397</td>
<td>0.0055</td>
</tr>
<tr>
<td>BENEFIT_DURATION</td>
<td>-1.810496</td>
<td>0.716495</td>
<td>-2.526880</td>
<td>0.0232</td>
</tr>
<tr>
<td>LABOR_STD</td>
<td>-2.627397</td>
<td>0.528372</td>
<td>-4.972625</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

R-squared | 0.809759 | Mean dependent var | 54.34000
Adjusted R-squared | 0.759027 | S.D. dependent var | 8.605286
S.E. of regression | 4.224245 | Akaike info criterion | 5.931876
Sum squared resid | 267.6637 | Schwarz criterion | 6.180809

- An improvement in active labor policies increases the overall labor supply. This is an expected result, indicating that policies that encourage the unemployed back to work are rather effective.
- An increase in annual hours worked tends to increase labor supply. This might be picking up the case of part-time job opportunities. Certain people (e.g. students, married women) might only consider part-time jobs to begin with. By extending the opportunities of part-time jobs, it may be possible to attract those groups into labor force.
- An increase in benefit duration tends to decrease labor supply. As indicated by Nickell, generous benefit systems reduce the fear of unemployment and hence make
employees more choosy. A longer span for benefit duration would work in this way to reduce labor supply.

- An increase in labor standards decreases labor participation. Intuitively, a high value for the labor standards index refers to the strength of the legislation governing various aspects of the labor market such as employment protection, minimum wages, employee’s rights, etc. Therefore, as the laws raise the cost of employment adjustment, they will make firms more cautious about hiring, it may discourage people to get into the labor force.

2) Now let’s see the relative share of male participation in the overall labor supply. In order to analyze this issue, we will add the employment-population ratio for males into above regression.

Dependent Variable: OVERALL_LABOR
Method: Least Squares Sample: 1 20, Included observations: 20

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-58.25858</td>
<td>29.00949</td>
<td>-2.008260</td>
<td>0.0618</td>
</tr>
<tr>
<td>ANNUAL_HRS</td>
<td>0.020808</td>
<td>0.006730</td>
<td>3.091916</td>
<td>0.0070</td>
</tr>
<tr>
<td>LABOR_STD</td>
<td>-1.588605</td>
<td>0.535326</td>
<td>-2.967549</td>
<td>0.0091</td>
</tr>
<tr>
<td>EPRATIO_MALE</td>
<td>0.957499</td>
<td>0.287914</td>
<td>3.325638</td>
<td>0.0043</td>
</tr>
</tbody>
</table>

R-squared       | 0.782575    | Mean dependent var | 54.340000
Adjusted R-squared | 0.741808   | S.D. dependent var  | 8.605286
S.E. of regression | 4.372569    | Akaike info criterion | 5.965435
Sum squared resid  | 305.9097    | Schwarz criterion    | 6.164581

We observe that, once we include the employment-population ratio for male participants, variables such as active labor market policies or benefit duration turn out to be insignificant. This might be due to the fact that these factors are also two major determinants of male participation. Therefore, information carried by those variables in labor force participation is already summarized by employment population ratio for males.

Finally, let’s test the overall significance of the independent variables from our last regression:
Wald Test: Equation: EQ02

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(2)=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C(3)=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C(4)=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F-statistic | 19.19622 | Probability | 0.000015
Chi-square | 57.58867 | Probability | 0.000000

The p-value indicates that we reject the null hypothesis. The regressors are jointly significant.