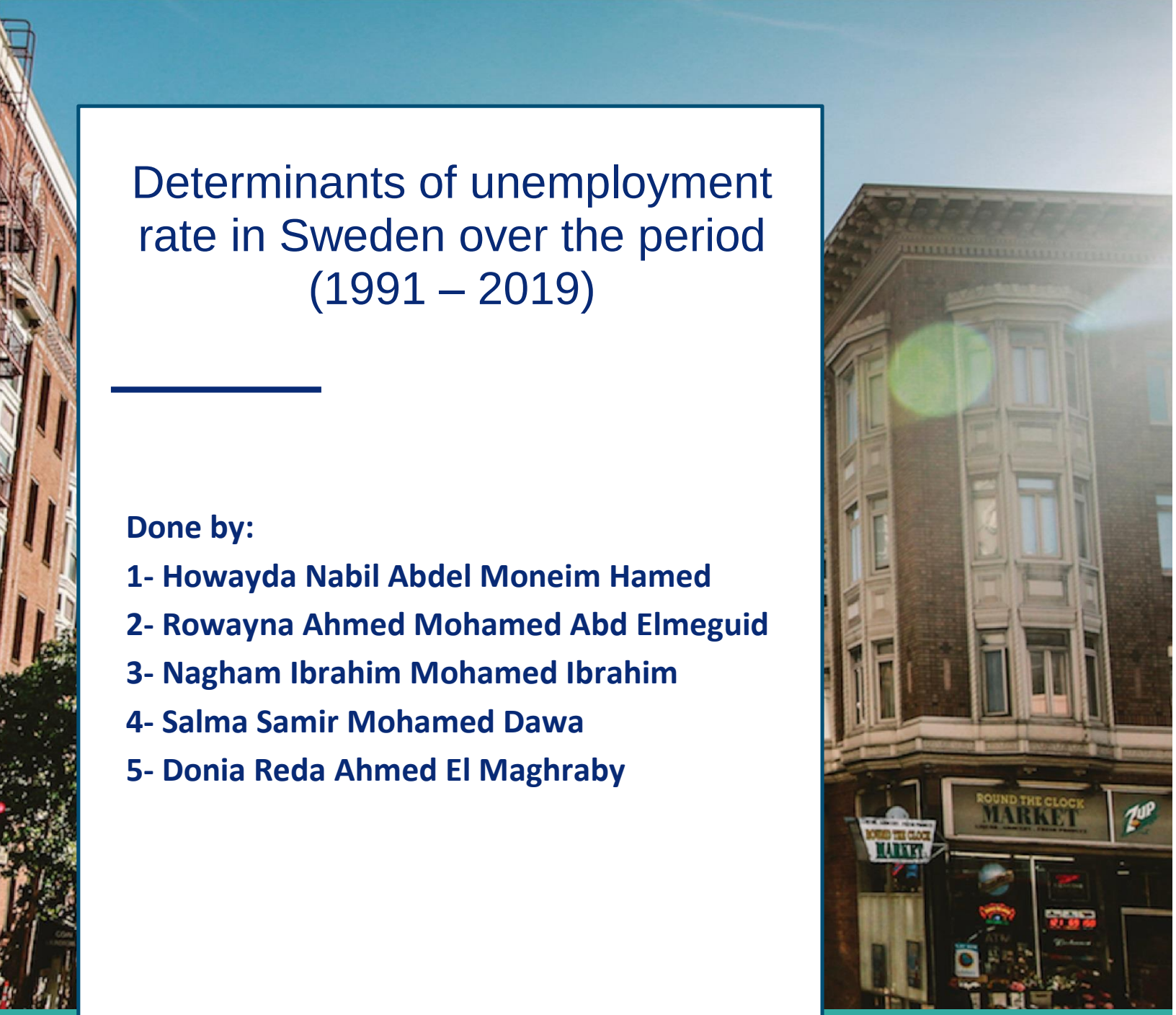


Determinants of unemployment rate in Sweden over the period (1991 – 2019)

Done by:

1- Howayda Nabil Abdel Moneim Hamed

2- Rowayna Ahmed Mohamed Abd Elmeguid

3- Nagham Ibrahim Mohamed Ibrahim

4- Salma Samir Mohamed Dawa

5- Donia Reda Ahmed El Maghraby

Supervised by:

Dr. Shereen Adel

Research Aim

-Our paper aims to determine the determinants of unemployment in Sweden over the period 1991 to 2019, it's a time series data.

-The determinants of unemployment selected are: Inflation rate, economic growth, population growth and trade merchandise (external trade), these are the independent variables.

-Our aim is to find the relationship between unemployment which is the dependent variable and those 4 independent variables, and how the unemployment is affected by them.

Research hypotheses

a) The inflation rate affects negatively the unemployment rate.
b) The GDP affects negatively the unemployment rate.
c) Population growth affects positively the unemployment rate.
d) International trade reduces the unemployment rate of skilled workers and increases the unemployment rate of unskilled workers.

Model Specification

a) Data and Variables:

variables		Proxy	Source of data
Unemployment rate (U_t)	Dependent variable	Annual total % of labor force	World Bank
Economic growth (GDP_t)	Independent variable	GDP (constant LCU)	World Bank
Inflation rate (INF_t)	Independent variable	GDP deflator annual %	World Bank
Population growth (POP_t)	Independent variable	Total population number	World Bank
External trade merchandise (TRD_t)	Independent variable	Exports (Current $)	World Bank

b) Regression Equation:

$$U_t = \alpha + \beta_1 \, GDP_t + \beta_2 \, INF_t + \beta_3 \, TRD_t + \beta_4 \, POP_t + \epsilon_t$$

Where:

- $\mathbf{U_t}$: unemployment rate (dependent variable)
- $\boldsymbol{\alpha}$: the intercept term
- $\mathbf{GDP_t}$: gross domestic product (independent variable)
- $\boldsymbol{\beta_1}$: coefficient of GDP
- $\mathbf{INF_t}$: Inflation rate (independent variable)
- $\boldsymbol{\beta_2}$: coefficient of inflation rate
- $\mathbf{TRD_t}$: External trade merchandise (independent variable)
- $\boldsymbol{\beta_3}$: coefficient of external trade merchandise
- $\mathbf{POP_t}$: population growth (independent variable)
- $\boldsymbol{\beta_4}$: coefficient of population growth
- $\boldsymbol{\epsilon_t}$: the error term

c) Expected results:

Variable	Theory Intuition	Expected Sign
Gross domestic product	According to Okun's law we expect to have a negative relationship between unemployment and GDP.	Negative sign $\beta_1 < 0$
Inflation rate	According to Philip's curve we expect a negative relationship between inflation rate and unemployment	Negative sign $\beta_2 < 0$
Population growth	Population growth is supposed to have a direct relationship with unemployment, because an increase in population means and increase in the labor supply, which will lead to excess supply in the labor market and hence, will increase unemployment.	Positive sign $\beta_3 > 0$
External trade merchandise	In a relatively skill-abundant country, international trade increases the relative price of the skill-intensive products. This reduces the unemployment rate of skilled workers and increases the unemployment rate of unskilled workers.	Negative or positive sign $\beta_4 < 0$ or $\beta_4 > 0$

Empirical Results

a) The Estimated coefficients:

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.795727178							
R Square	0.633181741							
Adjusted R Square	0.572045365							
Standard Error	1.073378477							
Observations	29							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	4	47.73033086	11.93258	10.3568739	5.10291E-05			
Residual	24	27.6513925	1.152141					
Total	28	75.38172336						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
Intercept	-26.03254036	8.948639814	-2.90911	0.007693655	-44.5016252	-7.563455521	-51.06134457	-1.003736152
POP	5.92673E-06	1.32626E-06	4.468745	0.000160367	3.18946E-06	8.664E-06	2.21725E-06	9.63621E-06
TRD	3.36885E-11	8.84854E-12	3.80724	0.000856336	1.5426E-11	5.1951E-11	8.93968E-12	5.84373E-11
GDP	-7.5151E-12	1.40283E-12	-5.35711	1.68718E-05	-1.04104E-11	-4.61981E-12	-1.14387E-11	-3.59148E-12
INF	-0.594846494	0.142353781	-4.17865	0.000335179	-0.888650257	-0.30104273	-0.993001407	-0.19669158

Dependent Variable: U
Method: Least Squares
Date: 05/07/21 Time: 18:17
Sample: 1991 2019
Included observations: 29

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-26.03254	8.948640	-2.909106	0.0077
POP	5.93E-06	1.33E-06	4.468745	0.0002
TRD	3.37E-11	8.85E-12	3.807240	0.0009
GDP	-7.52E-12	1.40E-12	-5.357113	0.0000
INF	-0.594846	0.142354	-4.178649	0.0003

R-squared	0.633182	Mean dependent var	7.265172
Adjusted R-squared	0.572045	S.D. dependent var	1.640794
S.E. of regression	1.073378	Akaike info criterion	3.135085
Sum squared resid	27.65139	Schwarz criterion	3.370826
Log likelihood	-40.45873	Hannan-Quinn criter.	3.208916
F-statistic	10.35687	Durbin-Watson stat	1.526395
Prob(F-statistic)	0.000051		

Regression equation from output:

$$U_t = -26.03254 - (7.5151 \times 10^{-12})\,GDP_t - 0.595\,INF_t - (3.36885 \times 10^{-11})\,TRD_t + (5.92673 \times 10^{-6})\,POP_t + \epsilon_t$$

b) Evaluation of the estimated coefficients:

First: Econometric evaluation:

First Econometric problem: Multicollinearity:

A) Detecting multicollinearity:

- **First method: Method of auxiliary regression and Klein's rule of thumb:**

This is one of the ways of detecting multicollinearity by applying auxiliary regression to each independent variable in the model.

$$U_t = -26.03254 - (7.5151 \times 10^{-12})\,GDP_t - 0.595\,INF_t - (3.36885 \times 10^{-11})\,TRD_t + (5.92673 \times 10^{-6})\,POP_t + \epsilon_t$$

1) Regressing GDP on the other independent variables:

$$GDP_t = (-4.35^{*}10^{12}) - (1.21^{*}10^{10})INF_t + 4.94\,TRD_t + 756754.46\,POP_t + \epsilon_t$$

Regression Statistics								
Multiple R	0.9783609							
R Square	0.95719							
Adjusted R Square	0.9520528							
Standard Error	1.53E+11							
Observations	29							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	1.30903E+25	4.363E+24	186.3253371	3.15596E-17			
Residual	25	5.8546E+23	2.342E+22					
Total	28	1.36758E+25						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
Intercept	-4.35E+12	9.33841E+11	-4.65421	9.13059E-05	-6.26957E+12	-2.423E+12	-6.9493E+12	-1.74327E+12
INF	-1.21E+10	20151646047	-0.59802	0.55520567	-53554188789	2.9452E+10	-6.8223E+10	44120323040
POP	756754.46	113339.2136	6.6768988	5.36776E-07	523327.9763	990180.936	440828.6732	1072680.239
TRD	4.9389543	0.784681618	6.2942143	1.38074E-06	3.322872209	6.5550363	2.751704608	7.126203899

2) Regressing inflation on the other independent variables:

$$\mathrm{INF_t} = -6.27 - (1.17 \times 10^{-12})\ \mathrm{GDP_t} - (7.64 \times 10^{-13})\ \mathrm{TRD_t} + (1.35 \times 10^{-06})\ \mathrm{POP_t} + \epsilon_t$$

Regression Statistics	
Multiple R	0.2357801
R Square	0.0555923
Adjusted R Square	-0.057737
Standard Error	1.5080435
Observations	29

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	3.346744401	1.1155815	0.490539007	0.692014192
Residual	25	56.85488059	2.2741952		
Total	28	60.20162499			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
Intercept	-6.265852	12.50978337	-0.500876	0.620839814	-32.03023281	19.4985294	-41.1360699	28.60436649
POP	1.345E-06	1.84383E-06	0.7292005	0.472655927	-2.45291E-06	5.142E-06	-3.795E-06	6.48407E-06
TRD	-7.64E-13	1.24308E-11	-0.061443	0.951494865	-2.63655E-11	2.4838E-11	-3.5414E-11	3.38863E-11
GDP	-1.17E-12	1.95695E-12	-0.59802	0.55520567	-5.20072E-12	2.8601E-12	-6.6252E-12	4.28459E-12

3) Regressing trade merchandise on the other independent variables:

$$\mathrm{TRD_t} = (1.74 \times 10^{11}) + 0.12\ \mathrm{GDP_t} - (1.98 \times 10^{08})\mathrm{INF_t} - 46759.07\ \mathrm{POP_t} + \epsilon_t$$

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.9449032
R Square	0.8928421
Adjusted R Square	0.8799832
Standard Error	2.426E+10
Observations	29

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1.22606E+23	4.087E+22	69.43353456	2.92556E-12
Residual	25	1.47151E+22	5.886E+20		
Total	28	1.37322E+23			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
Intercept	1.735E+11	1.99265E+11	0.8705176	0.392300023	-2.3693E+11	5.8386E+11	-3.8197E+11	7.28902E+11
GDP	0.1241367	0.019722358	6.2942143	1.38074E-06	0.08351779	0.1647557	0.06916194	0.179111552
INF	-1.98E+08	3217323470	-0.061443	0.951494865	-6823884247	6428519199	-9165765189	8770400141
POP	-46759.07	28480.94023	-1.641767	0.113160059	-105416.6612	11898.5277	-126147.86	32629.72606

4) Regressing population growth on the other independent variables:

$$POP_t = 6625664.1 + (8.47 \times 10^{-07})\ GDP_t + 15489.81\ INF_t - (2.08 \times 10^{-06})\ TRD_t + \epsilon_t$$

Regression Statistics								
Multiple R	0.9477397							
R Square	0.8982106							
Adjusted R Square	0.8859959							
Standard Error	161865.11							
Observations	29							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	5.77992E+12	1.927E+12	73.53505497	1.54306E-12			
Residual	25	6.55008E+11	2.62E+10					
Total	28	6.43493E+12						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
Intercept	6625664.1	255036.097	25.979319	1.3093E-19	6100407.394	7150920.74	5914767.318	7336560.819
TRD	-2.08E-06	1.26776E-06	-1.641767	0.113160059	-4.69238E-06	5.2964E-07	-5.6152E-06	1.45244E-06
GDP	8.467E-07	1.26803E-07	6.6768988	5.36776E-07	5.85495E-07	1.1078E-06	4.93195E-07	1.20011E-06
INF	15489.814	21242.18742	0.7292005	0.472655927	-28259.28957	59238.9183	-43721.4196	74701.04832

The regression of GDP, trade merchandise and population growth have auxiliary R^2s that have (F-statistics > 4) and (Significance < 0.05) which show that R^2 of these regressions is statistically significant suggesting that the explanatory variables of GDP, trade merchandise and population growth are highly collinear with the other explanatory variables. Indicating that the independent variables (GDP, trade merchandise and population growth) in this regression will make multicollinearity.

The regression of inflation has auxiliary R^2 that has (F-statistics < 4) and (Significance > 0.05) which shows that R^2 of this regression is statistically insignificant suggesting that the explanatory variable of inflation isn't collinear with the other explanatory variables. Indicating that the independent variable (inflation) in this regression will not make multicollinearity.

Since the economic variables are always correlated, we need to use Klein's Rule of Thumb as a more restricted test.

- **Klein's Rule of Thumb:**

To have multicollinearity, the auxiliary regression's R^2 must be higher than the original regression's R^2 which is obtained from regressing unemployment on all the regressors: GDP, inflation, trade merchandise and population growth.
R^2 of the main regression = 0.63
Since that the auxiliary R^2 of the GDP = 0.957, trade merchandise = 0.893 and population growth = 0.898, therefore, these auxiliary R^2s are higher than the original R^2 which means that these variables according to Klein Test have multicollinearity.
Since that the auxiliary R^2 of the inflation = 0.056, therefore, this auxiliary R^2 is lower than the original R^2 which means that this variable according to Klein Test doesn't have multicollinearity.

- **Second method: Variance inflation factor:**
  - $\boldsymbol{VIF = \frac{1}{1-R_x}}$

➢ Variance inflation factor of GDP: $\boldsymbol{VIF = \frac{1}{1-0.957}} = 23.256$

➢ Variance inflation factor of Inflation: $\boldsymbol{VIF = \frac{1}{1-0.056}} = 1.059$

➢ Variance inflation factor of trade merchandise: $\boldsymbol{VIF = \frac{1}{1-0.893}} = \boldsymbol{9.346}$

➢ Variance inflation factor of population growth (X_3): $\boldsymbol{VIF = \frac{1}{1-0.898}} = \boldsymbol{9.804}$

Variance Inflation Factors
Date: 05/07/21 Time: 15:37
Sample: 1991 2019
Included observations: 29

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	80.078154...	2015.6089...	
GDP	1.9679240...	610.07687...	23.359040...
INF	0.0202645...	3.0393105...	1.0588646...
POP	1.7589732...	3771.6107...	9.8242065...
TRD	7.8296612...	65.817315...	9.3320241...

According to the previous calculations and table show that the VIF of the 3 variables inflation, population and trade are 1.05 and 9.82 and 9.33 respectively. Since each VIF is less than 10, therefore, we conclude than the 3 variables will not cause multicollinearity to our main regression. Since the VIF of GDP is 23.35 > 10, therefore, we conclude that this variable will cause multicollinearity.

B) Remedy of multicollinearity:

Since all of our estimated coefficients are significant (t-statistics are all more than 2), therefore we do nothing about the existing multicollinearity of the estimated coefficients.

Second Econometric problem: Autocorrelation

A) Detecting autocorrelation

- **First order autocorrelation: Durbin-Watson test:**

$H_\circ$: No positive autocorrelation

$H_\circ^*$: No negative autocorrelation

Observation	*Predicted U*	*ut*	*ut-1*	*ut-ut-1*
1	4.004868051	-0.764868		
2	8.897306637	-3.1773068	-0.764868	-2.412439
3	8.558454886	0.77154504	-3.1773068	3.9488519
4	8.40890562	1.1710943	0.77154504	0.3995493
5	7.97159144	0.92840818	1.1710943	-0.242686
6	9.613718406	-0.0637182	0.92840818	-0.992126
7	8.725752642	1.63424702	-0.0637182	1.6979652
8	8.4197146	0.52028498	1.63424702	-1.113962
9	7.563198843	0.04680129	0.52028498	-0.473484
10	6.360751269	-0.8907515	0.04680129	-0.937553
11	5.259854082	-0.5298541	-0.8907515	0.3608974
12	5.676151523	-0.7061517	-0.5298541	-0.176298
13	6.062879781	-0.5028798	-0.7061517	0.2032719
14	7.018309275	-0.3283092	-0.5028798	0.1745706
15	6.699362822	0.79063695	-0.3283092	1.1189462
16	5.95731068	1.11268949	0.79063695	0.3220525
17	5.88545964	0.27454021	1.11268949	-0.838149
18	6.876244319	-0.6362445	0.27454021	-0.910785
19	6.925563408	1.42443697	-0.6362445	2.0606815
20	7.693868821	0.91613084	1.42443697	-0.508306
21	8.405465517	-0.6054653	0.91613084	-1.521596
22	8.67266099	-0.692661	-0.6054653	-0.087196
23	8.87321827	-0.8232181	-0.692661	-0.130557
24	8.236279597	-0.2862798	-0.8232181	0.5369383
25	6.212413924	1.2175859	-0.2862798	1.5038657
26	6.606793436	0.38320634	1.2175859	-0.83438
27	6.757727028	-0.0377272	0.38320634	-0.420934
28	7.222121806	-0.8521219	-0.0377272	-0.814395
29	7.124050128	-0.2940502	-0.8521219	0.5580717
		27.6512616		42.206895
		d-calculated	**1.52640032**	

Dependent Variable: U
Method: Least Squares
Date: 05/07/21 Time: 18:17
Sample: 1991 2019
Included observations: 29

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-26.03254	8.948640	-2.909106	0.0077
POP	5.93E-06	1.33E-06	4.468745	0.0002
TRD	3.37E-11	8.85E-12	3.807240	0.0009
GDP	-7.52E-12	1.40E-12	-5.357113	0.0000
INF	-0.594846	0.142354	-4.178649	0.0003

R-squared	0.633182	Mean dependent var	7.265172
Adjusted R-squared	0.572045	S.D. dependent var	1.640794
S.E. of regression	1.073378	Akaike info criterion	3.135085
Sum squared resid	27.65139	Schwarz criterion	3.370826
Log likelihood	-40.45873	Hannan-Quinn criter.	3.208916
F-statistic	10.35687	Durbin-Watson stat	1.526395
Prob(F-statistic)	0.000051		

At k = 4 and n = 29:

dL = 1.124 and dU = 1.743

Since dL $<$ d^* = 1.526 $<$ dU
Therefore, we cannot reject nor accept the null hypothesis of no positive or negative autocorrelation and conclude that according to Durbin-Watson test, we are in the indecision zone. Therefore, we will use LM test to conclude our decision.

- **Higher order autocorrelation: LM test:**

H_0 : No higher order autocorrelation

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

F-statistic	0.727216	Prob. F(4,20)	0.5838
Obs*R-squared	3.682288	Prob. Chi-Square(4)	0.4507

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 05/24/21 Time: 13:47
Sample: 1991 2019
Included observations: 29
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.317463	9.229164	-0.142750	0.8879
GDP	-2.09E-13	1.45E-12	-0.143477	0.8873
INF	-0.013310	0.148255	-0.089777	0.9294
POP	2.06E-07	1.37E-06	0.150617	0.8818
TRD	1.03E-12	9.43E-12	0.109568	0.9138
RESID(-1)	0.249867	0.227678	1.097456	0.2855
RESID(-2)	-0.221556	0.237736	-0.931944	0.3625
RESID(-3)	-0.137218	0.235950	-0.581554	0.5674
RESID(-4)	0.018919	0.228489	0.082802	0.9348

R-squared	0.126975	Mean dependent var	-2.40E-15
Adjusted R-squared	-0.222234	S.D. dependent var	0.993755
S.E. of regression	1.098643	Akaike info criterion	3.275155
Sum squared resid	24.14034	Schwarz criterion	3.699489
Log likelihood	-38.48975	Hannan-Quinn criter.	3.408051
F-statistic	0.363608	Durbin-Watson stat	2.005467
Prob(F-statistic)	0.927678		

RESIDUAL OUTPUT										
Observation	*Predicted U*	*ut*	POP	TRD	GDP	INF	ut-1	ut-2	ut-3	ut-4
1	4.004863	-0.764863042	8617375	7.16E+10	2.47E+12	8.246788915				
2	8.897297	-3.17729675	8668067	7.38E+10	2.44E+12	1.015341243	-0.764863			
3	8.558457	0.771543275	8718561	6.48E+10	2.39E+12	2.212271092	-3.177297	-0.76486		
4	8.408879	1.171121207	8780745	7.7E+10	2.48E+12	2.588042316	0.7715433	-3.1773	-0.76486	
		ut	**POP**	**TRD**	**GDP**	**INF**	**ut-1**	**ut-2**	**ut-3**	**ut-4**
5	7.97163	0.928370006	8826939	9.92E+10	2.58E+12	3.811391398	1.1711212	0.771543	-3.1773	-0.76486
6	9.613705	-0.063704823	8840998	1.05E+11	2.62E+12	1.009058606	0.92837	1.171121	0.771543	-3.1773
7	8.725731	1.63426872	8846062	1.05E+11	2.7E+12	1.525517958	-0.063705	0.92837	1.171121	0.771543
8	8.419723	0.520276658	8850974	1.08E+11	2.82E+12	0.812959691	1.6342687	-0.0637	0.92837	1.171121
9	7.563215	0.046785233	8857874	1.1E+11	2.94E+12	0.897864616	0.5202767	1.634269	-0.0637	0.92837
10	6.36076	-0.890760347	8872109	1.14E+11	3.08E+12	1.505770482	0.0467852	0.520277	1.634269	-0.0637
11	5.259878	-0.529878416	8895960	1.04E+11	3.12E+12	2.483522966	-0.89076	0.046785	0.520277	1.634269
12	5.676191	-0.706191173	8924958	1.1E+11	3.19E+12	1.547639398	-0.529878	-0.89076	0.046785	0.520277
13	6.062845	-0.502845099	8958229	1.35E+11	3.26E+12	1.700239435	-0.706191	-0.52988	-0.89076	0.046785
14	7.018292	-0.328291843	8993531	1.64E+11	3.41E+12	0.333021898	-0.502845	-0.70619	-0.52988	-0.89076
15	6.699374	0.790625414	9029572	1.77E+11	3.5E+12	0.686383051	-0.328292	-0.50285	-0.70619	-0.52988
16	5.957293	1.112707371	9080505	2.01E+11	3.67E+12	1.757413691	0.7906254	-0.32829	-0.50285	-0.70619
17	5.885464	0.274535971	9148092	2.34E+11	3.79E+12	2.825893231	1.1127074	0.790625	-0.32829	-0.50285
18	6.876234	-0.636233877	9219637	2.54E+11	3.78E+12	3.23523528	0.274536	1.112707	0.790625	-0.32829
19	6.925549	1.424451169	9298515	1.9E+11	3.61E+12	2.358905101	-0.636234	0.274536	1.112707	0.790625
20	7.693899	0.916101013	9378126	2.22E+11	3.83E+12	0.947565419	1.4244512	-0.63623	0.274536	1.112707
21	8.405491	-0.605490549	9449213	2.6E+11	3.95E+12	1.0883594	0.916101	1.424451	-0.63623	0.274536
22	8.672663	-0.692662876	9519374	2.49E+11	3.93E+12	1.001422023	-0.605491	0.916101	1.424451	-0.63623
23	8.87321	-0.823209376	9600379	2.5E+11	3.97E+12	0.927395691	-0.692663	-0.60549	0.916101	1.424451
24	8.236258	-0.286258133	9696110	2.52E+11	4.08E+12	1.744531292	-0.823209	-0.69266	-0.60549	0.916101
25	6.212387	1.2176128	9799186	2.21E+11	4.26E+12	2.121180245	-0.286258	-0.82321	-0.69266	-0.60549
26	6.606787	0.383212719	9923085	2.2E+11	4.35E+12	1.525609914	1.2176128	-0.28626	-0.82321	-0.69266
27	6.757731	-0.037731307	10057698	2.37E+11	4.46E+12	2.135151825	0.3832127	1.217613	-0.28626	-0.82321
28	7.222141	-0.852141475	10175214	2.54E+11	4.55E+12	2.396920335	-0.037731	0.383213	1.217613	-0.28626
29	7.124052	-0.294052471	10285453	2.5E+11	4.6E+12	2.701777288	-0.852141	-0.03773	0.383213	1.217613

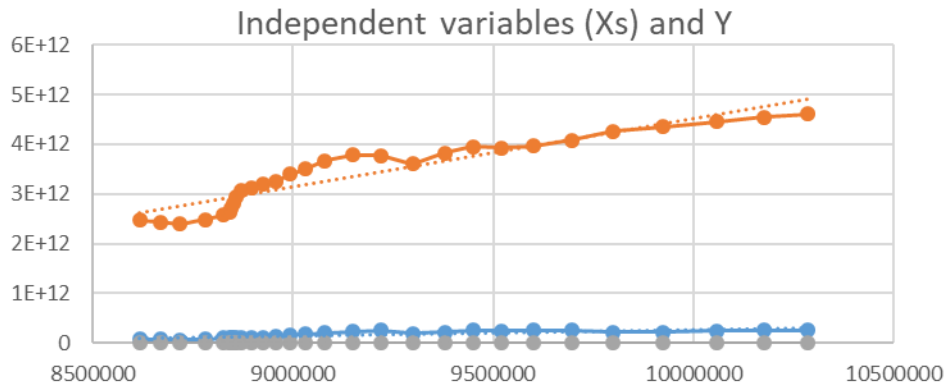
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.476148							
R Square	0.226717		calculated CHI2	6.5748				
Adjusted R Square	-0.15992		tabulated CHI2	9.487729				
Standard Error	0.847015							
Observations	25							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	8	3.365490471	0.420686309	0.586376	0.775111			
Residual	16	11.47894875	0.717434297					
Total	24	14.84443922						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-2.40943	7.78416745	-0.309529652	0.760913	-18.9111	14.09226718	-18.91112847	14.09226718
POP	5.03E-07	1.21491E-06	0.414043623	0.684339	-2.1E-06	3.07852E-06	-2.07247E-06	3.07852E-06
TRD	1.2E-12	7.75685E-12	0.154426923	0.879204	-1.5E-11	1.76417E-11	-1.52459E-11	1.76417E-11
GDP	-7.2E-13	1.38541E-12	-0.521646293	0.609063	-3.7E-12	2.21425E-12	-3.65964E-12	2.21425E-12
INF	0.119449	0.229080501	0.521426413	0.609212	-0.36618	0.605077592	-0.366180344	0.605077592
ut-1	0.351633	0.248993947	1.412216255	0.17704	-0.17621	0.879476886	-0.176210288	0.879476886
ut-2	-0.28214	0.288174006	-0.979060517	0.342123	-0.89304	0.328761811	-0.893041394	0.328761811
ut-3	-0.08021	0.197188799	-0.406773892	0.689564	-0.49823	0.337810325	-0.498232836	0.337810325
ut-4	0.029396	0.179864945	0.163431071	0.872226	-0.3519	0.410692171	-0.351901129	0.410692171

Since calculated CHI squared = 6.574 in Excel results and CHI squared = 3.68 in E-views results which both are < tabulated CHI squared = 9.4877

We cannot reject the null hypothesis of no higher order autocorrelation. Therefore, we conclude that our model doesn't have autocorrelation.

It's important to note that E-views assumes that lag of the residuals = 0, therefore this caused the small change in our calculated CHI squared.

Third Econometric problem: Heteroscedasticity



A) Detecting Heteroscedasticity:

- **First test: Park Test:**

Null Hypothesis:

H_0 : No Heteroscedasticity

$H_0 : \beta_1 = 0$, $H_0 : \beta_2 = 0$, $H_0 : \beta_3 = 0$, $H_0 : \beta_4 = 0$

Observation	*Y hat*	*ut*	*ut^2*	*ln ut^2*	POP	*ln POP*	TRD	*ln TRD*	GDP	*ln GDP*	INF	*ln INF*
1	4.004863	-0.76486	0.585015	-0.5361	8617375	15.96929	7.16E+10	24.993792	2.5E+12	28.53407	8.2468	2.1098239
2	8.897297	-3.1773	10.09521	2.31206	8668067	15.97516	7.38E+10	25.024664	2.4E+12	28.52242	1.0153	0.01522476
3	8.558457	0.771543	0.595279	-0.5187	8718561	15.98096	6.48E+10	24.893948	2.4E+12	28.50154	2.2123	0.79401963
4	8.408879	1.171121	1.371525	0.31592	8780745	15.98807	7.7E+10	25.06644	2.5E+12	28.54009	2.588	0.95090173
5	7.97163	0.92837	0.861871	-0.1486	8826939	15.99332	9.92E+10	25.320754	2.6E+12	28.57869	3.8114	1.33799432
6	9.613705	-0.0637	0.004058	-5.507	8840998	15.99491	1.05E+11	25.378292	2.6E+12	28.59436	1.0091	0.00901782
7	8.725731	1.634269	2.670834	0.98239	8846062	15.99548	1.05E+11	25.376568	2.7E+12	28.6246	1.5255	0.422334
8	8.419723	0.520277	0.270688	-1.3068	8850974	15.99604	1.08E+11	25.408914	2.8E+12	28.66682	0.813	-0.2070738
9	7.563215	0.046785	0.002189	-6.1244	8857874	15.99682	1.1E+11	25.423149	2.9E+12	28.70841	0.8979	-0.107736
10	6.36076	-0.89076	0.793454	-0.2314	8872109	15.99842	1.14E+11	25.456817	3.1E+12	28.75497	1.5058	0.40930472
11	5.259878	-0.52988	0.280771	-1.2702	8895960	16.00111	1.04E+11	25.368023	3.1E+12	28.76937	2.4835	0.9096781
12	5.676191	-0.70619	0.498706	-0.6957	8924958	16.00436	1.1E+11	25.424359	3.2E+12	28.7911	1.5476	0.4367308
13	6.062845	-0.50285	0.252853	-1.3749	8958229	16.00808	1.35E+11	25.627235	3.3E+12	28.81393	1.7002	0.53076909
14	7.018292	-0.32829	0.107776	-2.2277	8993531	16.01202	1.64E+11	25.825625	3.4E+12	28.85639	0.333	-1.099547
15	6.699374	0.790625	0.625089	-0.4699	9029572	16.01602	1.77E+11	25.89692	3.5E+12	28.88457	0.6864	-0.3763194
16	5.957293	1.112707	1.238118	0.21359	9080505	16.02164	2.01E+11	26.026154	3.7E+12	28.93015	1.7574	0.56384323
17	5.885464	0.274536	0.07537	-2.5853	9148092	16.02906	2.34E+11	26.178102	3.8E+12	28.96396	2.8259	1.0388245
18	6.876234	-0.63623	0.404794	-0.9044	9219637	16.03685	2.54E+11	26.261096	3.8E+12	28.95945	3.2352	1.17410165
19	6.925549	1.424451	2.029061	0.70757	9298515	16.04537	1.9E+11	25.968671	3.6E+12	28.91508	2.3589	0.85819757
20	7.693899	0.916101	0.839241	-0.1753	9378126	16.05389	2.22E+11	26.123794	3.8E+12	28.97289	0.9476	-0.0538593
21	8.405491	-0.60549	0.366619	-1.0034	9449213	16.06144	2.6E+11	26.28356	3.9E+12	29.00435	1.0884	0.08467143
22	8.672663	-0.69266	0.479782	-0.7344	9519374	16.06884	2.49E+11	26.239794	3.9E+12	28.99845	1.0014	0.00142101
23	8.87321	-0.82321	0.677674	-0.3891	9600379	16.07731	2.5E+11	26.242986	4E+12	29.01026	0.9274	-0.075375
24	8.236258	-0.28626	0.081944	-2.5017	9696110	16.08724	2.52E+11	26.251875	4.1E+12	29.03649	1.7445	0.55648592
25	6.212387	1.217613	1.482581	0.39378	9799186	16.09781	2.21E+11	26.121734	4.3E+12	29.0804	2.1212	0.75197265
26	6.606787	0.383213	0.146852	-1.9183	9923085	16.11037	2.2E+11	26.117532	4.3E+12	29.1009	1.5256	0.42239427
27	6.757731	-0.03773	0.001424	-6.5545	1E+07	16.12385	2.37E+11	26.189692	4.5E+12	29.12625	2.1352	0.75853776
28	7.222141	-0.85214	0.726145	-0.32	1E+07	16.13547	2.54E+11	26.259612	4.5E+12	29.14556	2.3969	0.87418472
29	7.124052	-0.29405	0.086467	-2.448	1E+07	16.14624	2.5E+11	26.243196	4.6E+12	29.15809	2.7018	0.99390981

ln(ut2)	ln(POP)	ln(TRD)	ln(GDP)	ln(INF)
-0.53611698	15.9692911	24.99379238	28.53407	2.1098239
2.312061513	15.9751564	25.02466419	28.522416	0.01522476
-0.51872503	15.9809648	24.89394805	28.501544	0.79401963
0.315923173	15.9880718	25.06643989	28.540091	0.95090173
-0.14864982	15.9933189	25.32075375	28.578688	1.33799432
-5.50699	15.9949103	25.37829218	28.59436	0.00901782
0.982390877	15.9954829	25.37656796	28.624603	0.422334
-1.30678915	15.9960381	25.40891386	28.666817	-0.2070738
-6.1243753	15.9968173	25.42314858	28.708412	-0.107736
-0.23135972	15.9984231	25.45681662	28.754975	0.40930472
-1.2702154	16.0011078	25.36802307	28.769366	0.9096781
-0.69573859	16.0043622	25.42435941	28.791097	0.4367308
-1.37494622	16.0080831	25.62723486	28.813932	0.53076909
-2.2277046	16.0120161	25.8256253	28.856387	-1.099547
-0.46986197	16.0160155	25.89692013	28.884574	-0.3763194
0.213592238	16.0216404	26.02615381	28.930147	0.56384323
-2.58534597	16.0290559	26.17810238	28.963961	1.0388245
-0.90437811	16.0368462	26.26109612	28.959445	1.17410165
0.70757319	16.0453653	25.96867124	28.915078	0.85819757
-0.17525729	16.0538905	26.1237939	28.972895	-0.0538593
-1.00343265	16.061442	26.28355987	29.004348	0.08467143
-0.73442374	16.0688396	26.23979361	28.998448	0.00142101
-0.38908941	16.0773131	26.24298565	29.010255	-0.075375
-2.50172262	16.0872353	26.2518751	29.036486	0.55648592
0.393784442	16.0978099	26.12173436	29.080401	0.75197265
-1.91833008	16.1103744	26.11753228	29.100895	0.42239427
-6.55453023	16.1238489	26.18969193	29.12625	0.75853776
-0.32000543	16.1354653	26.2596115	29.145563	0.87418472
-2.44799411	16.1462411	26.24319623	29.158094	0.99390981

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.26935385					
R Square	0.0725515					
Adjusted R Square	-0.0820233					
Standard Error	2.08404994					
Observations	29					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	4	8.154250908	2.0385627	0.4693619	0.757639747	
Residual	24	104.23834	4.3432642			
Total	28	112.3925909				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	191.362146	204.9340354	0.9337743	0.35972056	-231.6009153	614.325206
ln(POP)	-11.617648	21.24590239	-0.5468183	0.58955216	-55.46703514	32.2317396
ln(TRD)	0.85800635	3.07057743	0.2794283	0.7823101	-5.479353992	7.19536669
ln(GDP)	-0.9925483	9.386959791	-0.1057369	0.91666989	-20.36628107	18.3811846
ln(INF)	0.52282042	0.665911307	0.7851202	0.44006515	-0.851552972	1.89719381

Since all of our estimated coefficients are insignificant at the 5% level of significance, therefore. we cannot reject the null hypothesis of no heteroscedasticity. Therefore, we conclude that our model doesn't have heteroscedasticity, we have homoscedasticity.

- **Second test: White test:**

Null Hypothesis: H_0 : No Heteroscedasticity

Since $\rho = 5$, therefore we expect 15 estimated coefficient

$$Y_t = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 {X_4}^2 + \beta_5 {X_1}^2 + \beta_6 {X_2}^2 + \beta_7 {X_3}^2 + \beta_8 {X_4}^2 + \beta_9 X_1 X_2 + \beta_{10} X_1 X_3 + \beta_{11} X_1 X_4 + \beta_{12} X_2 X_3 + \beta_{13} X_2 X_4 + \beta_{14} X_4 X_3 + \epsilon_t$$

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.594977	Prob. F(14,14)	0.1965
Obs*R-squared	17.82457	Prob. Chi-Square(14)	0.2149
Scaled explained SS	22.59755	Prob. Chi-Square(14)	0.0671

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/19/21 Time: 11:00
Sample: 1991 2019
Included observations: 29

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3031.843	1102.068	-2.751049	0.0156
POP^2	-7.43E-11	2.71E-11	-2.739559	0.0160
POP*TRD	2.21E-16	2.35E-16	0.941049	0.3626
POP*GDP	9.21E-17	5.07E-17	1.817566	0.0906
POP*INF	2.56E-07	4.07E-06	0.062974	0.9507
POP	0.000981	0.000348	2.816613	0.0137
TRD^2	-8.06E-22	7.94E-22	-1.015207	0.3272
TRD*GDP	-6.31E-23	2.64E-22	-0.239129	0.8145
TRD*INF	-1.68E-11	2.54E-11	-0.660820	0.5195
TRD	-1.42E-09	1.57E-09	-0.905193	0.3807
GDP^2	-1.65E-23	2.64E-23	-0.624696	0.5422
GDP*INF	2.07E-12	3.05E-12	0.678894	0.5083
GDP	-7.19E-10	3.39E-10	-2.118740	0.0525
INF^2	-0.315042	0.260485	-1.209444	0.2465
INF	-4.421416	32.89134	-0.134425	0.8950

R-squared	0.614640	Mean dependent var	0.953496
Adjusted R-squared	0.229280	S.D. dependent var	1.867076
S.E. of regression	1.639118	Akaike info criterion	4.132438
Sum squared resid	37.61390	Schwarz criterion	4.839660
Log likelihood	-44.92035	Hannan-Quinn criter.	4.353931
F-statistic	1.594977	Durbin-Watson stat	2.350759
Prob(F-statistic)	0.196500		

u^2	POP	TRD	GDP	INF	POP^2	TRD^2	GDP^2	INF^2	POP x TRD	POP x GDP	POP x INF	TRD x GDP	TRD x INF	GDP x INF
0.585	9E+06	7E+10	2E+12	8.2468	7.4E+13	5.1E+21	6.1E+24	68.0095	6.167E+17	2.126E+19	71065673	1.765E+23	5.901E+11	2.035E+13
10.1	9E+06	7E+10	2E+12	1.0153	7.5E+13	5.4E+21	5.9E+24	1.03092	6.397E+17	2.1137E+19	8801045.9	1.8E+23	7.494E+10	2.476E+12
0.595	9E+06	6E+10	2E+12	2.2123	7.6E+13	4.2E+21	5.7E+24	4.89414	5.646E+17	2.0821E+19	19287820	1.547E+23	1.433E+11	5.283E+12
1.372	9E+06	8E+10	2E+12	2.588	7.7E+13	5.9E+21	6.2E+24	6.69796	6.757E+17	2.1794E+19	22724940	1.91E+23	1.992E+11	6.424E+12
0.862	9E+06	1E+11	3E+12	3.8114	7.8E+13	9.8E+21	6.7E+24	14.5267	8.759E+17	2.2771E+19	33642919	2.56E+23	3.782E+11	9.832E+12
0.004	9E+06	1E+11	3E+12	1.0091	7.8E+13	1.1E+22	6.9E+24	1.0182	9.293E+17	2.3167E+19	8921085.1	2.754E+23	1.061E+11	2.644E+12
2.671	9E+06	1E+11	3E+12	1.5255	7.8E+13	1.1E+22	7.3E+24	2.32721	9.282E+17	2.3892E+19	13494826	2.834E+23	1.601E+11	4.12E+12
0.271	9E+06	1E+11	3E+12	0.813	7.8E+13	1.2E+22	7.9E+24	0.6609	9.593E+17	2.4936E+19	7195485.1	3.053E+23	8.811E+10	2.29E+12
0.002	9E+06	1E+11	3E+12	0.8979	7.8E+13	1.2E+22	8.6E+24	0.80616	9.738E+17	2.6016E+19	7953171.6	3.229E+23	9.871E+10	2.637E+12
0.793	9E+06	1E+11	3E+12	1.5058	7.9E+13	1.3E+22	9.5E+24	2.26734	1.009E+18	2.7299E+19	13359360	3.498E+23	1.712E+11	4.633E+12
0.281	9E+06	1E+11	3E+12	2.4835	7.9E+13	1.1E+22	9.7E+24	6.16789	9.255E+17	2.777E+19	22093321	3.248E+23	2.584E+11	7.753E+12
0.499	9E+06	1E+11	3E+12	1.5476	8E+13	1.2E+22	1E+25	2.39519	9.823E+17	2.8472E+19	13812617	3.511E+23	1.703E+11	4.937E+12
0.253	9E+06	1E+11	3E+12	1.7002	8E+13	1.8E+22	1.1E+25	2.89081	1.208E+18	2.9238E+19	15231134	4.4E+23	2.292E+11	5.549E+12
0.108	9E+06	2E+11	3E+12	0.333	8.1E+13	2.7E+22	1.2E+25	0.1109	1.479E+18	3.0627E+19	2995042.8	5.599E+23	5.475E+10	1.134E+12
0.625	9E+06	2E+11	4E+12	0.6864	8.2E+13	3.1E+22	1.2E+25	0.47112	1.594E+18	3.1628E+19	6197745.2	6.184E+23	1.212E+11	2.404E+12
1.238	9E+06	2E+11	4E+12	1.7574	8.2E+13	4E+22	1.3E+25	3.0885	1.824E+18	3.329E+19	15958204	7.366E+23	3.531E+11	6.443E+12
0.075	9E+06	2E+11	4E+12	2.8259	8.4E+13	5.5E+22	1.4E+25	7.98567	2.14E+18	3.4691E+19	25851531	8.869E+23	6.609E+11	1.072E+13
0.405	9E+06	3E+11	4E+12	3.2352	8.5E+13	6.5E+22	1.4E+25	10.4667	2.343E+18	3.4805E+19	29827695	9.593E+23	8.222E+11	1.221E+13
2.029	9E+06	2E+11	4E+12	2.3589	8.6E+13	3.6E+22	1.3E+25	5.56443	1.764E+18	3.3579E+19	21934314	6.85E+23	4.475E+11	8.519E+12
0.839	9E+06	2E+11	4E+12	0.9476	8.8E+13	4.9E+22	1.5E+25	0.89788	2.077E+18	3.5883E+19	8886387.9	8.476E+23	2.099E+11	3.626E+12
0.367	9E+06	3E+11	4E+12	1.0884	8.9E+13	6.8E+22	1.6E+25	1.18453	2.456E+18	3.731E+19	10284140	1.026E+24	2.829E+11	4.297E+12
0.48	1E+07	2E+11	4E+12	1.0014	9.1E+13	6.2E+22	1.5E+25	1.00285	2.368E+18	3.7366E+19	9532910.8	9.765E+23	2.491E+11	3.931E+12
0.678	1E+07	2E+11	4E+12	0.9274	9.2E+13	6.2E+22	1.6E+25	0.86006	2.396E+18	3.8131E+19	8903350.1	9.912E+23	2.314E+11	3.683E+12
0.082	1E+07	3E+11	4E+12	1.7445	9.4E+13	6.3E+22	1.7E+25	3.04339	2.441E+18	3.9535E+19	16915167	1.027E+24	4.393E+11	7.113E+12
1.483	1E+07	2E+11	4E+12	2.1212	9.6E+13	4.9E+22	1.8E+25	4.49941	2.166E+18	4.1749E+19	20785840	9.419E+23	4.689E+11	9.037E+12
0.147	1E+07	2E+11	4E+12	1.5256	9.8E+13	4.8E+22	1.9E+25	2.32749	2.184E+18	4.3152E+19	15138757	9.573E+23	3.358E+11	6.634E+12
0.001	1E+07	2E+11	4E+12	2.1352	1E+14	5.6E+22	2E+25	4.55887	2.38E+18	4.4861E+19	21474712	1.055E+24	5.052E+11	9.524E+12
0.726	1E+07	3E+11	5E+12	2.3969	1E+14	6.4E+22	2.1E+25	5.74523	2.582E+18	4.627E+19	24389177	1.154E+24	6.082E+11	1.09E+13
0.086	1E+07	2E+11	5E+12	2.7018	1.1E+14	6.2E+22	2.1E+25	7.2996	2.567E+18	4.7361E+19	27789003	1.149E+24	6.744E+11	1.244E+13

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.783989917		**Calculated Chi**	17.8245655				
R Square	0.61464019		**Tabulated Chi**	23.6847913				
Adjusted R Square	0.22928038		**P-value**	0.21488821				
Standard Error	1.639117842							
Observations	29							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	14	59.99332412	4.285237437	1.5949774	0.196499552			
Residual	14	37.61390221	2.6867073					
Total	28	97.60722632						
	Coefficients	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-3031.84336	1102.067934	-2.751049429	0.01561278	-5395.544	-668.142726	-5395.544	-668.142726
POP	0.000980967	0.000348279	2.816612469	0.013724	0.000233983	0.00172795	0.00023398	0.001727951
TRD	-1.4229E-09	1.57192E-09	-0.905192817	0.38067741	-4.7943E-09	1.9485E-09	-4.794E-09	1.94854E-09
GDP	-7.1853E-10	3.3913E-10	-2.118740123	0.05247933	-1.4459E-09	8.8332E-12	-1.446E-09	8.83316E-12
INF	-4.42141515	32.891343	-0.13442489	0.89498	-74.9663298	66.1234995	-74.96633	66.12349946
POP2	-7.4313E-11	2.7126E-11	-2.739558605	0.01596896	-1.3249E-10	-1.6134E-11	-1.325E-10	-1.6134E-11
TRD2	-8.0579E-22	7.93721E-22	-1.015206472	0.32723204	-2.5082E-21	8.9657E-22	-2.508E-21	8.96572E-22
GDP2	-1.6465E-23	2.63564E-23	-0.624695908	0.54221843	-7.2994E-23	4.0064E-23	-7.299E-23	4.00641E-23
INF2	-0.31504236	0.260485405	-1.20944344	0.24652066	-0.87372799	0.24364326	-0.873728	0.243643265
POP*TRD	2.21135E-16	2.34987E-16	0.941049314	0.36263484	-2.8286E-16	7.2513E-16	-2.829E-16	7.25132E-16
POP*GDP	9.21261E-17	5.06865E-17	1.817565751	0.09059049	-1.6586E-17	2.0084E-16	-1.659E-17	2.00838E-16
POP*INF	2.56279E-07	4.06963E-06	0.062973492	0.95067788	-8.4722E-06	8.9848E-06	-8.472E-06	8.98476E-06
TRD*GDP	-6.312E-23	2.63957E-22	-0.239129497	0.81447038	-6.2925E-22	5.0301E-22	-6.293E-22	5.03011E-22
TRD*INF	-1.6777E-11	2.53886E-11	-0.660820236	0.51945437	-7.123E-11	3.7676E-11	-7.123E-11	3.76758E-11
GDP*INF	2.06955E-12	3.04842E-12	0.678894149	0.5082733	-4.4687E-12	8.6078E-12	-4.469E-12	8.60775E-12

Since calculated CHI squared = 17.824 < tabulated CHI squared = 23.68 and P-value = 0.272 > 0.05 Therefore, we cannot reject the null hypothesis of no heteroscedasticity. Therefore, we conclude that our model doesn't have heteroscedasticity, we have homoscedasticity.

Since our model has no econometric problems, we can now proceed with our statistical and theoretical evaluation with our current data.

Second: Statistical and theoretical evaluation:

1) The intercept:

Hypothesis Testing at 5% level of significance:

Null Hypothesis: $H_\circ : \alpha = 0$; Alternative Hypothesis: $H_1 : \alpha \neq 0$

- Statistical evaluation using P-Value and T-Test:

Since that the P – Value of α is 0.00769 < 0.05 and the absolute value of t – stat (α) = 2.9 > t – tabulated = 2 (As a rule of thumb). Therefore, we can reject the null hypothesis of $\boldsymbol{\alpha = 0}$ and accept the alternative hypothesis of $\boldsymbol{\alpha \neq 0}$. So, we conclude that α is statistically significant at the 5% level of significance, which means that α is statistically different from zero and there is a relation between intercept and unemployment rate.

- Theoretical evaluation: This result is consistent with the economic theory.

2) Coefficient of GDP: $\boldsymbol{\beta_1}$

Hypothesis Testing at 5% level of significance:

Null Hypothesis: $H_\circ : \beta_\circ = 0$; Alternative Hypothesis: $H_1 : \beta_\circ \neq 0$

- Statistical evaluation using P-Value and T-Test:

Since that the P – Value of α is 1.69×10^{-6} < 0.05 and the absolute value of t – stat ($\beta_\circ$) = 5.357 > t – tabulated = 2 (As a rule of thumb). Therefore, we can reject the null hypothesis of $\beta_\circ = 0$ and accept the alternative hypothesis of $\beta_\circ \neq 0$. So, we conclude that $\beta_\circ$ is statistically significant at the 5% level of significance, which means that $\beta_\circ$ is statistically different from zero and there is a relation between GDP and unemployment rate.

- Theoretical evaluation: This result is consistent with the economic theory.

3) Coefficient of inflation rate: $\boldsymbol{\beta_2}$

Hypothesis Testing at 5% level of significance:

Null Hypothesis: $H_\circ : \beta_1 = 0$; Alternative Hypothesis: $H_1 : \beta_1 \neq 0$

- Statistical evaluation using P-Value and T-Test:

Since that the P – Value of α is 0.0003 < 0.05 and the absolute value of t – stat (β_1) = 4.178 > t – tabulated = 2 (As a rule of thumb). Therefore, we can reject the null hypothesis of $\beta_1 = 0$ and accept the alternative hypothesis of $\beta_1 \neq 0$. So, we conclude that β_1 is statistically significant at the 5% level of significance, which means that β_1 is statistically different from zero and there is a relation between inflation rate and unemployment rate.

- Theoretical evaluation: This result is consistent with the economic theory.

4) Coefficient of population growth: $\boldsymbol{\beta_3}$

Hypothesis Testing at 5% level of significance:

Null Hypothesis: $H_\circ : \beta_2 = 0$; Alternative Hypothesis: $H_1 : \beta_2 \neq 0$

- Statistical evaluation using P-Value and T-Test:

Since that the P – Value of α is 0.0001 < 0.05 and the absolute value of t – stat (β_2) = 4.468 > t – tabulated = 2 (As a rule of thumb). Therefore, we reject the null hypothesis of $\beta_2 = 0$ and accept the alternative hypothesis of $\beta_2 \neq 0$. So, we conclude that β_2 is statistically significant at

the 5% level of significance, which means that β_2 is statistically different from zero and there is a relation between external trade merchandise and unemployment rate.

- Theoretical evaluation: This result is consistent with the economic theory.

5) Coefficient of external trade merchandise: β_4

Hypothesis Testing at 5% level of significance:

Null Hypothesis: $H_\circ : \beta_3 = 0$; Alternative Hypothesis: $H_1 : \beta_3 \neq 0$

- Statistical evaluation using P-Value and T-Test:

Since that the P – Value of α is $0.0008 < 0.05$ and t – stat (β_3) = 3.8 > t – tabulated = 2 (As a rule of thumb). Therefore, we can reject the null hypothesis of $\beta_3 = 0$ and accept the alternative hypothesis of $\beta_3 \neq 0$. So, we conclude that β_3 is statistically significant at the 5% level of significance, which means that β_3 is statistically different from zero and there is a relation between population growth and unemployment rate.

- Theoretical evaluation: This result is consistent with the economic theory.

6) R^2

Hypothesis Testing of R at 5% level of significance:

Null Hypothesis: $H_\circ : R^2 = 0$; Alternative Hypothesis: $H_1 : R^2 \neq 0$

- Significance F and F-Test:

Since that the Significance F of R^2 is $5.102 \times 10^{-11} < 0.05$ and F – stat (R^2) = 10.356 > F – tabulated = 4 (As a rule of thumb). Therefore, we can reject the null hypothesis of $R^2 = 0$ and accept the alternative hypothesis of $R^2 \neq 0$. So, we conclude that R^2 is statistically significant at the 5% level of significance, which means that R^2 is statistically different from zero and that the explanatory variables together provide significant explanatory power.

c) Interpretation of the estimated coefficients:

The intercept

α : = -26.03 which means that if GDP, inflation, external trade merchandise and population growth were zero, the unemployment rate would be about -26.03 % Accordingly this means that if there is no GDP, inflation, external trade merchandise or population growth there will be employment rate by 26.03 % and this is economically insignificant.

β_1 : The coefficient of GDP

It means that if GDP increases by 1 trillion dollars, unemployment rate decreases by 7.515 % (assuming that other variables are constant).
N.B: $\beta_\circ$ of value -7.515×10^{-12} is multiplied by 1 trillion = 7.515

β_2 : The coefficient of inflation rate

It means that if inflation rate increases by 1%, unemployment rate decreases by 0. 59 % (assuming that other variables are constant).

β_3 : The coefficient of external trade merchandise

It means that if external trade merchandise increases by 1 billion dollars, unemployment rate increases by 33.3688 % (assuming that other variables are constant).
N.B: β_2 of value 3.3688×10^{-11} is multiplied by 1 billion = 33.3688

β_4 : The coefficient of population growth

It means that if population growth increases by 1 million persons, unemployment rate increases by 5.926 % (assuming that other variables are constant).
N.B: β_3 of value 5.926×10^{-6} is multiplies by 1 million = 5.926

R^2

Value of about 0.633 means that 63.3% of the variation in the dependent variable which is the unemployment rate is explained by the variation in all the explanatory variables GDP, inflation rate, external trade merchandise and population growth jointly and 36.7% of the variation in unemployment rate is unexplained by the variation in all the explanatory variables GDP, inflation rate, external trade merchandise and population growth jointly, which indicates a strong explanatory power of the independent variables the dependent variable unemployment rate.

Results & Conclusion

It is important to mention that:

Our first model was Determinants of unemployment in United Kingdom over the period 1980 - 2010 which showed severe econometric issues such as the following:

1) Severe multicollinearity problems between GDP, trade merchandise, and population which caused insignificance of the estimated coefficient of trade that wasn't solved with remedial measures.

2) Autocorrelation problem via employing LM test which wasn't solvable even after using the three remedial measures of autocorrelation using difference equation –First difference transformation, obtaining ρ from durbin Watson, and obtaining ρ from residuals–

3) Results of autocorrelation didn't allow us to apply Park test.

Since the remedies didn't solve our econometric problems and R^2 decreased significantly throughout these trials, our best choice was to change the model to find a more suitable and convenient model.

Therefore, our new model is determinants of unemployment in Sweden over the period 1991 – 2019.

Conclusion:

The objective of this study is to explore the determinants of unemployment in Sweden. The study examines the relationship between unemployment and the variables of GDP, inflation, population growth, and the external trade. It is hypothesized that these variables exert an impact on unemployment in the Sweden over the period 1991 – 2019.

Via employing OLS analysis, results showed that all of the mentioned variables are the main determinants of unemployment. It is found that population growth and trade impacted unemployment significantly with a positive effect, while inflation and GDP impacted unemployment significantly with a negative effect.

One of the most important variables was inflation rate as it has the highest impact on unemployment rate followed by population growth. All our estimated coefficients were significant.

Our model was a multiple linear regression form based on our literature review which was also in a linear form. The linear model form successfully explained the mentioned theory and the effect of the variables on unemployment as all the estimated coefficients were consistent with our economic theory.

Our model showed no severe multicollinearity problem, no autocorrelation and no heteroscedasticity problems. Therefore, our model is also econometrically convenient as well as it is statistically and theoretically convenient.

References

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