**Département des Sciences Commerciales ;**

**Master 1Fiance et Commerce International**

**Module : Analyse des séries temporelles**

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**Exemples d’application du test ADF**

**Exemple 1 : Le Test ADF**

Suivant la stratégie simplifiée des tests de racine unitaire, nous commençons par tester l’hypothèse de l’existence de la tendance, On estimera alors le modèle 3 de ADF.

**Application du modèle 3:** $∆X\_{t}=ρX\_{t-1}-\sum\_{j=2}^{p}Ф\_{j}∆X\_{t-j+1}+c+ β t+ε\_{t}$

L’estimation du modèle 3 du test ADF sur la série EXPO nous donne les résultats suivants :

|  |  |
| --- | --- |
| Null Hypothesis: EXPO has a unit root |  |
| Exogenous: Constant, Linear Trend |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag=9) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic |   Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | -1.961616 |  0.6065 |
| Test critical values: | 1% level |  | -4.165756 |  |
|  | 5% level |  | -3.508508 |  |
|  | 10% level |  | -3.184230 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. |  |
| Augmented Dickey-Fuller Test Equation |  |
| Dependent Variable: D(EXPO) |  |  |
| Method: Least Squares |  |  |
| Date: 02/25/19 Time: 16:27 |  |  |
| Sample (adjusted): 1971 2017 |  |  |
| Included observations: 47 after adjustments |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| EXPO(-1) | -0.175752 | 0.089595 | -1.961616 | 0.0562 |
| C | -1.31E+08 | 2.60E+09 | -0.050274 | 0.9601 |
| @TREND(1970) | 2.16E+08 | 1.53E+08 | **1.408512** | 0.1660 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.082266 |     Mean dependent var | 7.84E+08 |
| Adjusted R-squared | 0.040551 |     S.D. dependent var | 8.51E+09 |
| S.E. of regression | 8.33E+09 |     Akaike info criterion | 48.58631 |
| Sum squared resid | 3.05E+21 |     Schwarz criterion | 48.70440 |
| Log likelihood | -1138.778 |     Hannan-Quinn criter. | 48.63075 |
| F-statistic | 1.972083 |     Durbin-Watson stat | 1.902371 |
| Prob(F-statistic) | 0.151277 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Test du trend:**

H0 :B=0

H1: B≠0

Tb = ǀ1.40ǀ ˃ TADF= **3.18** , on accepte H0 :B=0, la tendance n’est pas significative. On passe à l’estimation du modèle 02

**Modèle 2 :** $∆X\_{t}=ρX\_{t-1}-\sum\_{j=2}^{p}Ф\_{j}∆X\_{t-j+1}+c+ε\_{t}$

|  |  |
| --- | --- |
| Null Hypothesis: EXPO has a unit root |  |
| Exogenous: Constant |  |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag=9) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic |   Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | -1.385033 |  0.5817 |
| Test critical values: | 1% level |  | -3.577723 |  |
|  | 5% level |  | -2.925169 |  |
|  | 10% level |  | -2.600658 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. |  |
| Augmented Dickey-Fuller Test Equation |  |
| Dependent Variable: D(EXPO) |  |  |
| Method: Least Squares |  |  |
| Date: 02/25/19 Time: 16:28 |  |  |
| Sample (adjusted): 1971 2017 |  |  |
| Included observations: 47 after adjustments |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| EXPO(-1) | -0.073453 | 0.053033 | -1.385033 | 0.1729 |
| **C** | 2.56E+09 | 1.78E+09 | **1.442181** | 0.1562 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.040886 |     Mean dependent var | 7.84E+08 |
| Adjusted R-squared | 0.019573 |     S.D. dependent var | 8.51E+09 |
| S.E. of regression | 8.42E+09 |     Akaike info criterion | 48.58786 |
| Sum squared resid | 3.19E+21 |     Schwarz criterion | 48.66659 |
| Log likelihood | -1139.815 |     Hannan-Quinn criter. | 48.61748 |
| F-statistic | 1.918317 |     Durbin-Watson stat | 2.015584 |
| Prob(F-statistic) | 0.172871 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Test de la constante :**

H0 :C=0

H1: C≠0

Tc= ǀ1.44ǀ ˂ TADF= **2.89 ,**  on accepte H0 :C= 0, la constante n’est pas significative. On passe à l’estimation du modèle 01.

**Modèle 1 :** $∆X\_{t}=ρX\_{t-1}-\sum\_{j=2}^{p}Ф\_{j}∆X\_{t-j+1}+ε\_{t}$

|  |  |
| --- | --- |
| Null Hypothesis: EXPO has a unit root |  |
| Exogenous: None |  |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag=9) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic |   Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | -0.490171 |  0.4984 |
| Test critical values: | 1% level |  | -2.615093 |  |
|  | 5% level |  | **-1.94**7975 |  |
|  | 10% level |  | -1.612408 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller Test Equation |  |
| Dependent Variable: D(EXPO) |  |  |
| Method: Least Squares |  |  |
| Date: 02/25/19 Time: 16:28 |  |  |
| Sample (adjusted): 1971 2017 |  |  |
| Included observations: 47 after adjustments |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| **EXPO(-1)** | -0.018176 | 0.037081 | **-0.490171** | 0.6263 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | -0.003444 |     Mean dependent var | 7.84E+08 |
| Adjusted R-squared | -0.003444 |     S.D. dependent var | 8.51E+09 |
| S.E. of regression | 8.52E+09 |     Akaike info criterion | 48.59049 |
| Sum squared resid | 3.34E+21 |     Schwarz criterion | 48.62985 |
| Log likelihood | -1140.876 |     Hannan-Quinn criter. | 48.60530 |
| Durbin-Watson stat | 2.035727 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Test de**$ ρ$**:**

H0 :$ρ$ =1

H1: $ρ$ ˂ 1

T $ρ$ = - 0.49 ˃ TADF (5%) = - 1.94. On accepte H0 $ρ$ =1, le processus est  **non stationnaire**

Le processus de cette série est un processus **« DS sans dérive »**

**La stationnarisation de la série et récupération de l’ordre d’intégration :**

|  |  |
| --- | --- |
| Null Hypothesis: D(EXPO) has a unit root |  |
| Exogenous: None |  |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag=9) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic |   Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | -6.921577 |  0.0000 |
| Test critical values: | 1% level |  | -2.616203 |  |
|  | 5% level |  | **-1.948140** |  |
|  | 10% level |  | -1.612320 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller Test Equation |  |
| Dependent Variable: D(EXPO,2) |  |  |
| Method: Least Squares |  |  |
| Date: 02/25/19 Time: 16:29 |  |  |
| Sample (adjusted): 1972 2017 |  |  |
| Included observations: 46 after adjustments |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| **D(EXPO(-1))** | -1.034365 | 0.149441 | **-6.921577** | 0.0000 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.515618 |     Mean dependent var | 1.01E+08 |
| Adjusted R-squared | 0.515618 |     S.D. dependent var | 1.24E+10 |
| S.E. of regression | 8.63E+09 |     Akaike info criterion | 48.61695 |
| Sum squared resid | 3.35E+21 |     Schwarz criterion | 48.65670 |
| Log likelihood | -1117.190 |     Hannan-Quinn criter. | 48.63184 |
| Durbin-Watson stat | 1.997989 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Test du ϕ:**

H0 : $ρ$ =1

H1: $ρ$ ˂ 1

T$ ρ$ = - 6.92 ˂ TADF (5%) = - 1.94. On accepte H1$ ρ$˂ 1, le processus est  **stationnaire**

Le processus EXPO est devenu stationnaire avec une seule différenciation. Donc **EXPO→I(1)**

**Exemple 2 : Une serie comportant une tendance**

L’Application du test ADF, modèle 3, sur la série Y donne les résultats de l’estimation sous eviews, sont consignés dans le tableau suivant :

|  |  |
| --- | --- |
| Null Hypothesis: Y has a unit root |  |
| Exogenous: Constant, Linear Trend |  |
| Lag Length: 6 (Automatic - based on SIC, maxlag=9) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic |   Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | -5.041157 |  0.0016 |
| Test critical values: | 1% level |  | -4.284580 |  |
|  | 5% level |  | -3.562882 |  |
|  | 10% level |  | -3.215267 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. |  |
| Augmented Dickey-Fuller Test Equation |  |
| Dependent Variable: D(Y) |  |  |
| Method: Least Squares |  |  |
| Date: 04/27/19 Time: 19:13 |  |  |
| Sample (adjusted): 1987 2017 |  |  |
| Included observations: 31 after adjustments |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| Y(-1) | -0.534336 | 0.105995 | -5.041157 | 0.0000 |
| D(Y(-1)) | 0.430805 | 0.145076 | 2.969523 | 0.0071 |
| D(Y(-2)) | -0.031805 | 0.169304 | -0.187860 | 0.8527 |
| D(Y(-3)) | 0.557266 | 0.206000 | 2.705175 | 0.0129 |
| D(Y(-4)) | 0.331010 | 0.244879 | 1.351729 | 0.1902 |
| D(Y(-5)) | 0.402116 | 0.215548 | 1.865552 | 0.0755 |
| D(Y(-6)) | 0.674157 | 0.232865 | 2.895058 | 0.0084 |
| C | -9.686533 | 2.969369 | -3.262152 | 0.0036 |
| @TREND("1980") | 1.692245 | 0.340462 | **4.970432** | 0.0001 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.650021 |     Mean dependent var | 3.428087 |
| Adjusted R-squared | 0.522755 |     S.D. dependent var | 5.468270 |
| S.E. of regression | 3.777639 |     Akaike info criterion | 5.733776 |
| Sum squared resid | 313.9523 |     Schwarz criterion | 6.150095 |
| Log likelihood | -79.87353 |     Hannan-Quinn criter. | 5.869486 |
| F-statistic | 5.107604 |     Durbin-Watson stat | 2.155190 |
| Prob(F-statistic) | 0.001106 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Test du trend:**

H0 :B=0

H1: B≠0

Tb = ǀ4.97ǀ ˂ TADF= 3.18 , on rejette H0 :B=0, la tendance est significative.

On passe au test de$ ρ$

**Test du** $ρ$**:**

H0 :$ρ$ =1

H1: $ρ$ ˂ 1

T $ρ$ = - 5.04 ˂ TADF (5%) = - 3.65 ; on rejette H0  $ρ$ =1, le processus est un TS**.** Il convient de le stationnariser en retranchant la tendance de la serie Y par la methode des MCO :

L’estimation de l’équation de la tendance ( par les (MCO) ,

Les résultats de l’estimation sont donnés dans le tableau ci-apres :

|  |  |  |
| --- | --- | --- |
| Dependent Variable: T |  |  |
| Method: Least Squares |  |  |
| Date: 04/27/19 Time: 19:45 |  |  |
| Sample: 1980 2017 |  |  |
| Included observations: 38 |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| @TREND(1980) | 0.241394 | 0.036592 | 6.596920 | 0.0000 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | -1.043790 |     Mean dependent var | 6.217105 |
| Adjusted R-squared | -1.043790 |     S.D. dependent var | 3.393242 |
| S.E. of regression | 4.851019 |     Akaike info criterion | 6.022218 |
| Sum squared resid | 870.6983 |     Schwarz criterion | 6.065312 |
| Log likelihood | -113.4221 |     Hannan-Quinn criter. | 6.037551 |
| Durbin-Watson stat | 0.059825 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**- Tester la stationnarité des résidus en menant le test ADF avec le premier modèle.**

|  |  |
| --- | --- |
| Null Hypothesis: RESID01Y has a unit root |  |
| Exogenous: None |  |  |
| Lag Length: 3 (Automatic - based on SIC, maxlag=9) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic |   Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | -2.762418 |  0.0072 |
| Test critical values: | 1% level |  | -2.634731 |  |
|  | 5% level |  | -1.951000 |  |
|  | 10% level |  | -1.610907 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller Test Equation |  |
| Dependent Variable: D(RESID01Y) |  |
| Method: Least Squares |  |  |
| Date: 04/27/19 Time: 20:53 |  |  |
| Sample (adjusted): 1984 2017 |  |  |
| Included observations: 34 after adjustments |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| RESID01Y(-1) | -0.201467 | 0.072931 | -2.762418 | 0.0097 |
| D(RESID01Y(-1)) | 0.466225 | 0.155104 | 3.005886 | 0.0053 |
| D(RESID01Y(-2)) | -0.124718 | 0.168120 | -0.741838 | 0.4640 |
| D(RESID01Y(-3)) | 0.584671 | 0.196173 | 2.980377 | 0.0057 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.381199 |     Mean dependent var | 0.375246 |
| Adjusted R-squared | 0.319319 |     S.D. dependent var | 5.308341 |
| S.E. of regression | 4.379561 |     Akaike info criterion | 5.901905 |
| Sum squared resid | 575.4166 |     Schwarz criterion | 6.081477 |
| Log likelihood | -96.33238 |     Hannan-Quinn criter. | 5.963144 |
| Durbin-Watson stat | 2.060358 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Donc, le processus **resid01y**→I(0), par contre la série T est intégré d’ordre 1.

**Exemple 3**: **Une serie comportant une contante**

Apres avoir testé la tendance, nous l’avons trouvé non significative, nous avons ainsi passe à l’estimation du modèle 2. Le résultat de l’estimation de ce modèle est donné dont le tableau suivant :

|  |  |
| --- | --- |
| Null Hypothesis: M has a unit root |  |
| Exogenous: Constant |  |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag=9) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  | t-Statistic |   Prob.\* |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller test statistic | -4.899478 |  0.0003 |
| Test critical values: | 1% level |  | -3.621023 |  |
|  | 5% level |  | -2.943427 |  |
|  | 10% level |  | -2.610263 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*MacKinnon (1996) one-sided p-values. |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Augmented Dickey-Fuller Test Equation |  |
| Dependent Variable: D(M) |  |  |
| Method: Least Squares |  |  |
| Date: 04/27/19 Time: 20:13 |  |  |
| Sample (adjusted): 1981 2017 |  |  |
| Included observations: 37 after adjustments |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| M(-1) | -0.820393 | 0.167445 | -4.899478 | 0.0000 |
| C | 12.30044 | 2.990904 | 4.112615 | 0.0002 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.406829 |     Mean dependent var | -0.246343 |
| Adjusted R-squared | 0.389881 |     S.D. dependent var | 12.03302 |
| S.E. of regression | 9.399008 |     Akaike info criterion | 7.371624 |
| Sum squared resid | 3091.947 |     Schwarz criterion | 7.458700 |
| Log likelihood | -134.3750 |     Hannan-Quinn criter. | 7.402322 |
| F-statistic | 24.00489 |     Durbin-Watson stat | 1.977555 |
| Prob(F-statistic) | 0.000022 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Test de la constante :**

H0 :C=0

H1: C≠0

Tc= ǀ4.11ǀ ˃ TADF, donc on accepte H1 :C≠0, la constante est significative. On passe au test de $ρ$

**Test de**$ ρ$ **:**

H0 : $ρ$ =1

H1: ϕ ˂ 1

T$ ρ$ = -4.899478 ˂ TADF (5%) = - 2.96 on rejette H0  $ρ$ =1, le processus est  **stationnaire**

Le processus M est intégré d’ordre 0 ; Donc, M→I(0)