



unab

VIGILADA MINEDUCACIÓN

Universidad Autónoma de Bucaramanga

UNIVERSIDAD AUTÓNOMA DE BUCARAMANGA UNAB



**“ESTRATEGIA DE ARBITRAJE ENTRE LA COTIZACIÓN DE LOS ADRS DE
LAS EMPRESAS COTIZADAS EN LA BOLSA DE VALORES DE NUEVA YORK
Y SUS PRECIOS LOCALES EN LA BOLSA DE VALORES DE COLOMBIA”**

PROYECTO DE GRADO

JUNIO 2020



**“ESTRATEGIA DE ARBITRAJE ENTRE LA COTIZACIÓN DE LOS ADRS DE
LAS EMPRESAS COTIZADAS EN LA BOLSA DE VALORES DE NUEVA YORK
Y SUS PRECIOS LOCALES EN LA BOLSA DE VALORES DE COLOMBIA”**

**GARCÍA ROJAS DANIEL YESID
FIGUEROA GÓMEZ LUIS DANIEL
MEDINA DUARTE JONATHAN ORLANDO**

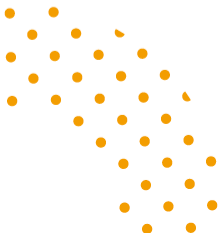
JUNIO 2020





OBJETIVO GENERAL

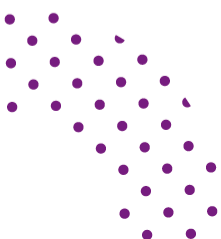
Aplicar una estrategia de arbitraje basada en las diferencias de precios entre las cotizaciones de las acciones de la BVC y sus ADRs equivalentes en la bolsa de valores de Nueva York.





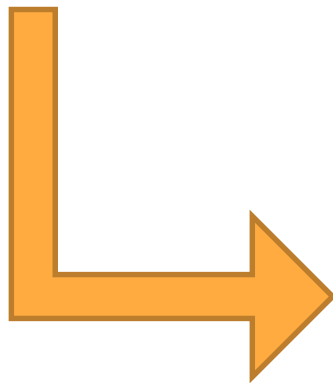
OBJETIVOS ESPECÍFICOS

- 1- Analizar los precios de las acciones de la BVC y sus ADRs en la bolsa de nueva de York en los periodos 2015 – 2019.
- 2- Determinar la correlación entre los cambios de la cotización del Dólar y los precios de las acciones de la Bolsa de Valores de Colombia y sus ADRs en la Bolsa de Nueva de York.
- 3- Diseñar una estrategia de arbitraje en los mercados de Colombia y EEUU en el periodo de tiempo establecido.
- 4- Evaluar la estrategia de arbitraje que mejor se ajuste a la oportunidad que está indicando el mercado, ya sea compra o venta, incluyendo los costos de transacción.

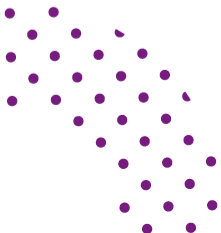




MARCO TEÓRICO

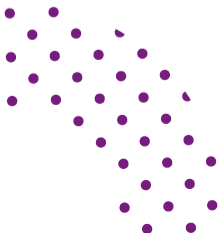


ANTECEDENTES



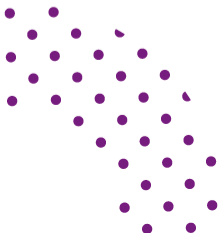


ECOPETROL

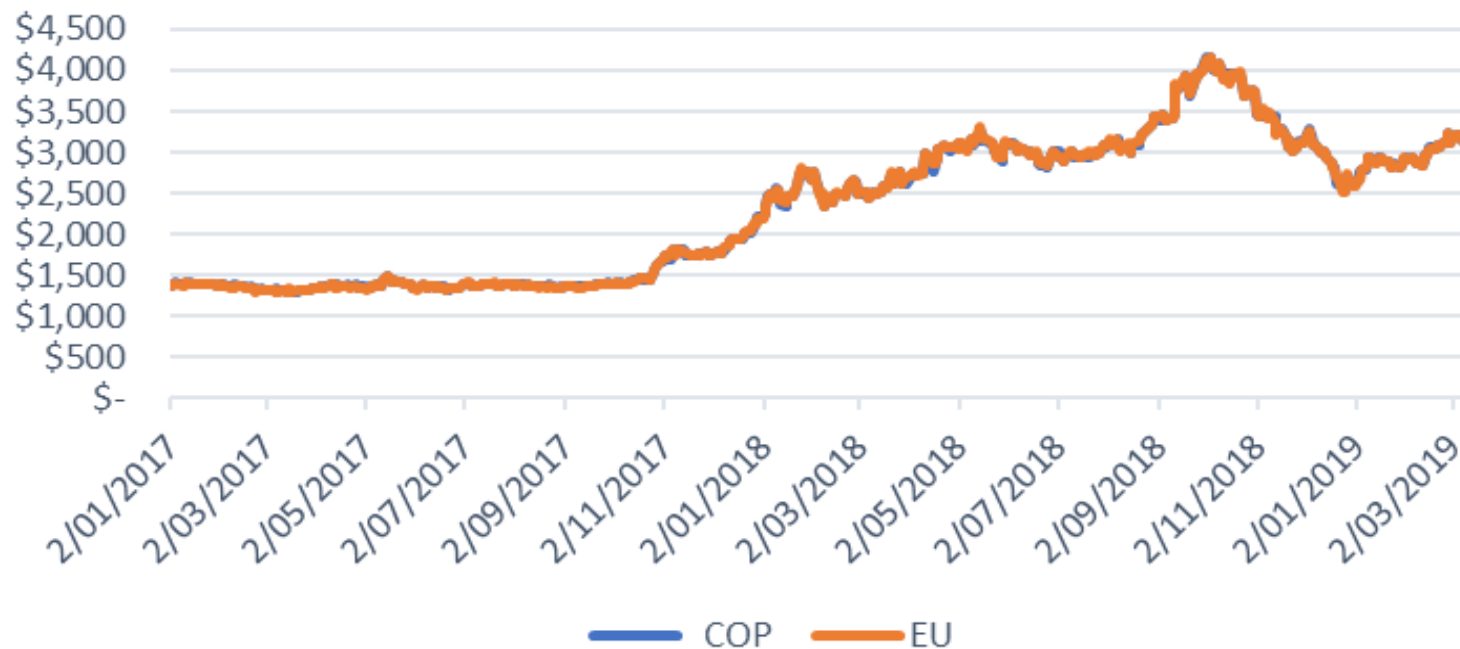




ANALISIS DEL COMPORTAMIENTO DE LA ACCION DE ECOPETROL Y SU ADR COTIZADO EN LA NYSE



Comportamiento de lo precios de COP y EU



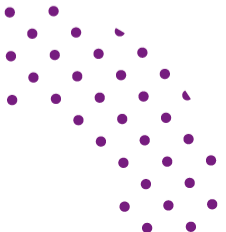
Nota. Fuente: elaboración propia a partir de datos obtenidos de Bloomberg



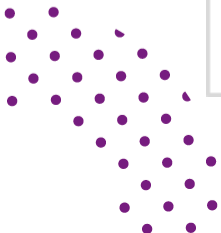
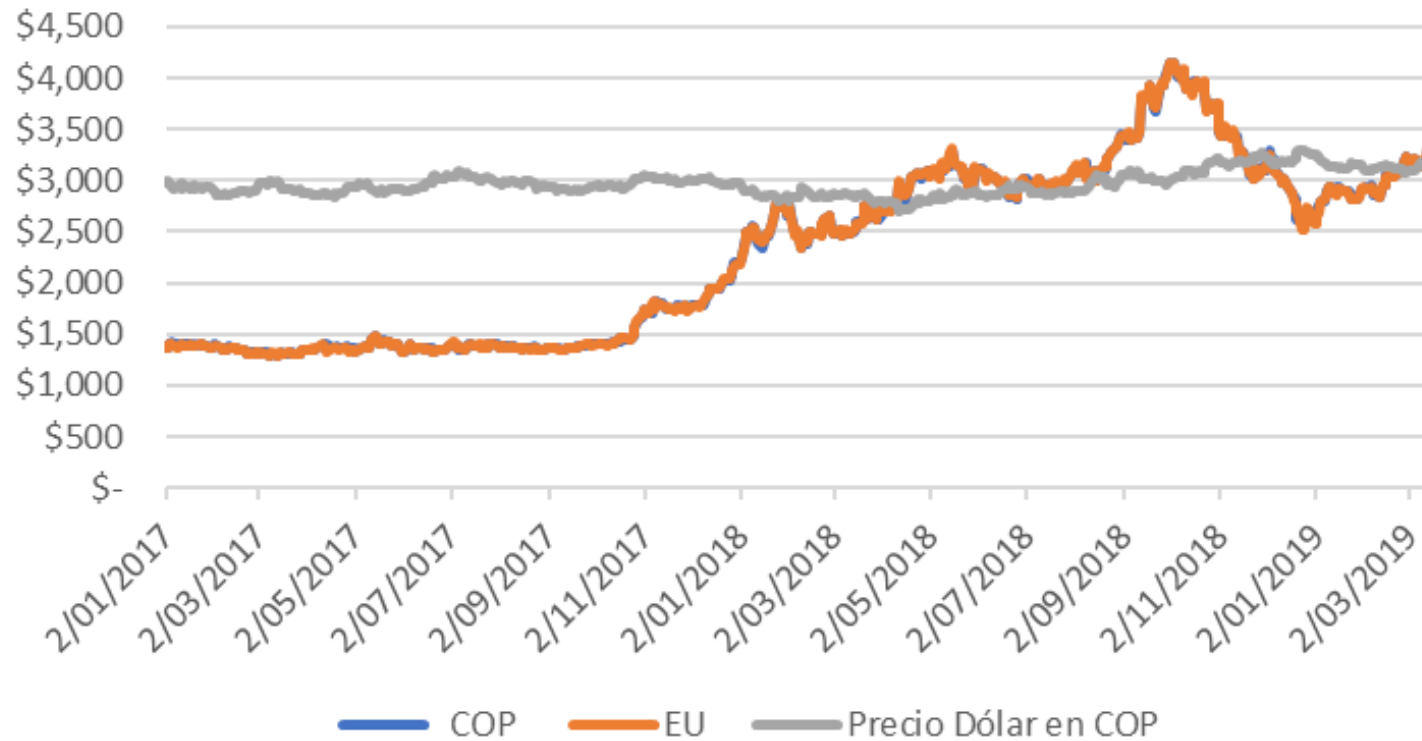
unab



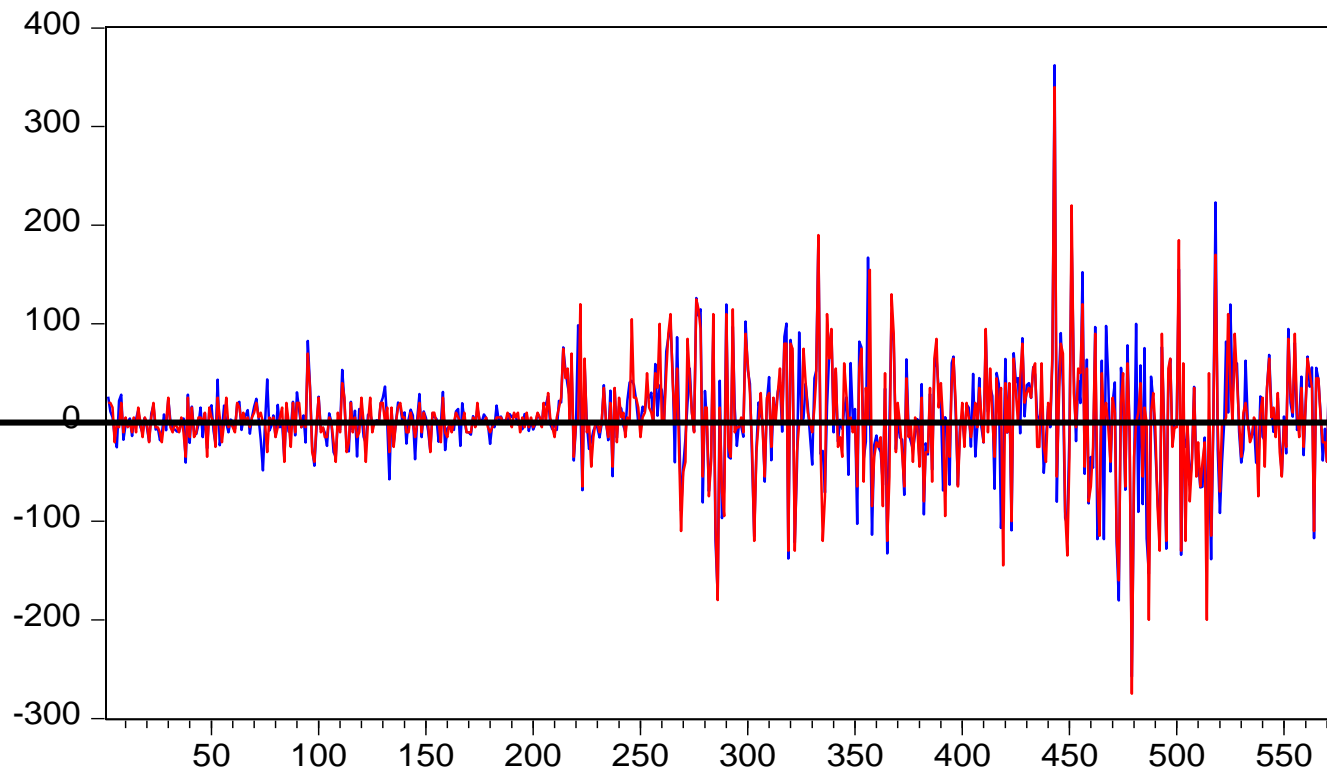
CORRELACION ENTRE LOS CAMBIOS DE LA COTIZACION DEL DÓLAR, EL PRECIO DE LA ACCION Y SU ADR



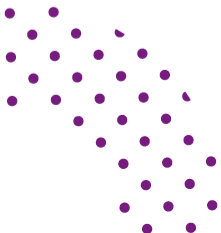
COMPORTAMIENTO COP, EU Y DOLAR



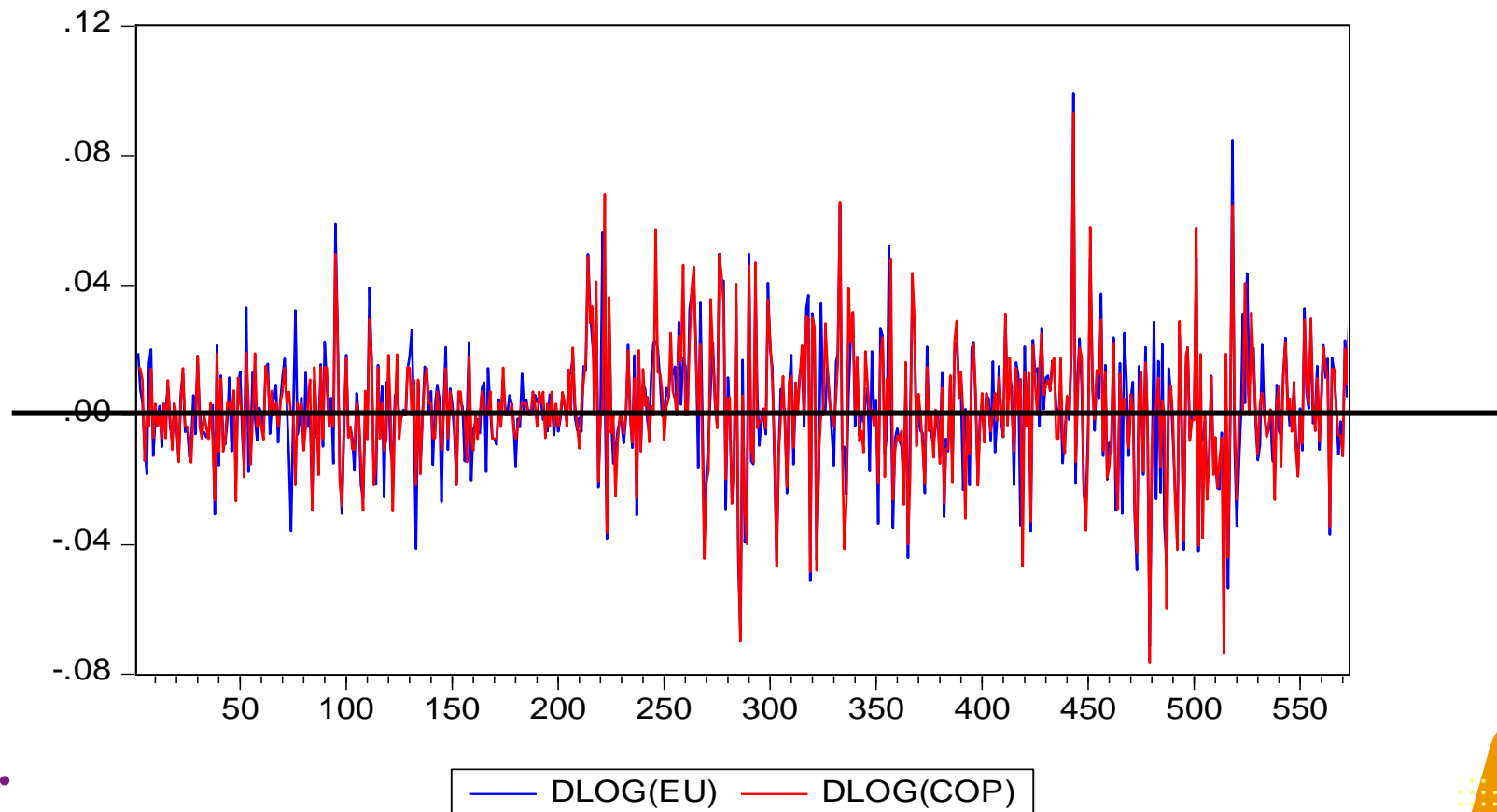
PRIMERAS DIFERENCIAS DE LOS PRECIO DE EU Y COP



— D(EU) — D(COP)



LOGARITMO PRIMERAS DIFERENCIAS DE LOS PRECIO DE EU Y COP

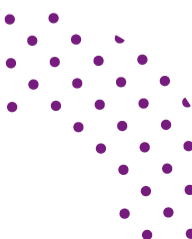


TEST DE RAÍCES UNITARIAS EU



Null Hypothesis: LOG(EU) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob *
Augmented Dickey-Fuller test statistic		1.907671	0.9868	
Test critical values:	1% level	-2.569011		
	5% level	-1.941378		
	10% level	-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LOG(EU))				
Method: Least Squares				
Date: 05/28/20 Time: 14:32				
Sample (adjusted): 2 573				
Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(EU(-1))	0.000201	0.000105	1.907671	0.0569
R-squared	-0.000241	Mean dependent var		0.001570
Adjusted R-squared	-0.000241	S.D. dependent var		0.019320
S.E. of regression	0.019322	Akaike info criterion		-5.053361
Sum squared resid	0.213185	Schwarz criterion		-5.045758
Log likelihood	1446.261	Hannan-Quinn criter.		-5.050395
Durbin-Watson stat	1.992256			

Null Hypothesis: D(LOG(EU)) has a unit root				
Exogenous: None				
Lag Length: 2 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob *
Augmented Dickey-Fuller test statistic		-13.23042	0.0000	
Test critical values:	1% level	-2.569032		
	5% level	-1.941381		
	10% level	-1.616325		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LOG(EU),2)				
Method: Least Squares				
Date: 05/28/20 Time: 14:43				
Sample (adjusted): 5 573				
Included observations: 569 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(EU(-1)))	-0.994802	0.075191	-13.23042	0.0000
D(LOG(EU(-1)),2)	0.017176	0.058770	0.292252	0.7702
D(LOG(EU(-2)),2)	-0.114046	0.041890	-2.722552	0.0067
R-squared	0.510605	Mean dependent var		4.89E-05
Adjusted R-squared	0.508876	S.D. dependent var		0.027338
S.E. of regression	0.019158	Akaike info criterion		-5.066911
Sum squared resid	0.207743	Schwarz criterion		-5.044009
Log likelihood	1444.536	Hannan-Quinn criter.		-5.057975
Durbin-Watson stat	2.002934			



TEST DE RAÍCES UNITARIAS COP



Null Hypothesis: LOG(COP) has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=18)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.937743	0.9878
Test critical values: 1% level	-2.569011	
5% level	-1.941378	
10% level	-1.616327	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(LOG(COP))
 Method: Least Squares
 Date: 05/28/20 Time: 14:29
 Sample (adjusted): 2 573
 Included observations: 572 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP(-1))	0.000200	0.000103	1.937743	0.0531

R-squared	-0.000243	Mean dependent var	0.001566
Adjusted R-squared	-0.000243	S.D. dependent var	0.018974
S.E. of regression	0.018976	Akaike info criterion	-5.089550
Sum squared resid	0.205608	Schwarz criterion	-5.081947
Log likelihood	1456.611	Hannan-Quinn criter.	-5.086584
Durbin-Watson stat	1.997510		

Null Hypothesis: D(LOG(COP)) has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=18)

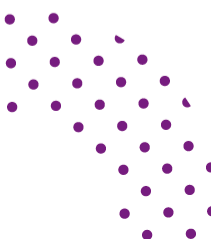
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-23.70893	0.0000
Test critical values: 1% level	-2.569018	
5% level	-1.941379	
10% level	-1.616327	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(LOG(COP),2)
 Method: Least Squares
 Date: 05/28/20 Time: 14:30
 Sample (adjusted): 3 573
 Included observations: 571 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(COP(-1)))	-0.994769	0.041958	-23.70893	0.0000

R-squared	0.496516	Mean dependent var	2.78E-05
Adjusted R-squared	0.496516	S.D. dependent var	0.026840
S.E. of regression	0.019045	Akaike info criterion	-5.082298
Sum squared resid	0.206741	Schwarz criterion	-5.074684
Log likelihood	1451.996	Hannan-Quinn criter.	-5.079327
Durbin-Watson stat	1.996070		

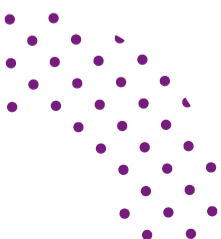


REGRESION LINEAL DE EU Y COP



Dependent Variable: LOG(EU)				
Method: Least Squares				
Date: 05/28/20 Time: 14:34				
Sample: 1 573				
Included observations: 573				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP)	0.999941	4.75E-05	21069.60	0.0000
R-squared	0.999492	Mean dependent var	7.675905	
Adjusted R-squared	0.999492	S.D. dependent var	0.387225	
S.E. of regression	0.008732	Akaike info criterion	-6.641959	
Sum squared resid	0.043611	Schwarz criterion	-6.634365	
Log likelihood	1903.921	Hannan-Quinn criter.	-6.638997	
Durbin-Watson stat	1.464507			

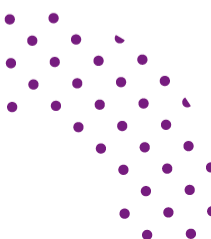
BETA DE COINTEGRACIÓN



TEST DE RAÍCES UNITARIAS ERRORES

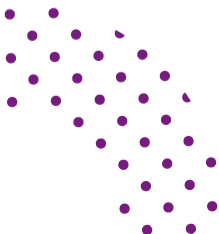
Null Hypothesis: ERROR has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic				
			-18.16052	0.0000
Test critical values:				
	1% level		-2.569011	
	5% level		-1.941378	
	10% level		-1.616327	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(ERROR)				
Method: Least Squares				
Date: 05/28/20 Time: 14:36				
Sample (adjusted): 2 573				
Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERROR(-1)	-0.732279	0.040323	-18.16052	0.0000
R-squared	0.366122	Mean dependent var	4.63E-06	
Adjusted R-squared	0.366122	S.D. dependent var	0.010576	
S.E. of regression	0.008420	Akaike info criterion	-6.714586	
Sum squared resid	0.040485	Schwarz criterion	-6.706983	
Log likelihood	1921.372	Hannan-Quinn criter.	-6.711620	
Durbin-Watson stat	2.015822			

Null Hypothesis: D(ERROR) has a unit root				
Exogenous: None				
Lag Length: 9 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic				
			-13.15548	0.0000
Test critical values:				
	1% level		-2.569083	
	5% level		-1.941388	
	10% level		-1.616321	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(ERROR,2)				
Method: Least Squares				
Date: 05/28/20 Time: 14:36				
Sample (adjusted): 12 573				
Included observations: 562 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ERROR(-1))	-5.105649	0.388101	-13.15548	0.0000
D(ERROR(-1),2)	3.409023	0.368954	9.239707	0.0000
D(ERROR(-2),2)	2.760806	0.339593	8.129759	0.0000
D(ERROR(-3),2)	2.204778	0.303338	7.268399	0.0000
D(ERROR(-4),2)	1.743288	0.261677	6.661979	0.0000
D(ERROR(-5),2)	1.266899	0.217458	5.825939	0.0000
D(ERROR(-6),2)	0.877391	0.172547	5.084949	0.0000
D(ERROR(-7),2)	0.575211	0.126574	4.544467	0.0000
D(ERROR(-8),2)	0.296207	0.082186	3.604118	0.0003
D(ERROR(-9),2)	0.118922	0.041982	2.832691	0.0048
R-squared	0.765921	Mean dependent var	-3.02E-06	
Adjusted R-squared	0.762105	S.D. dependent var	0.017630	
S.E. of regression	0.008599	Akaike info criterion	-6.656665	
Sum squared resid	0.040818	Schwarz criterion	-6.579592	
Log likelihood	1880.523	Hannan-Quinn criter.	-6.626574	
Durbin-Watson stat	2.018951			





ESTRATEGIA DE ABRITRAJE





OPERACIÓN

VENDER X

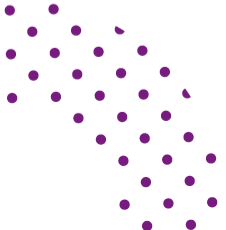
COMPRAR Y



COMPRAR X

VENDER Y

$$(VENDER X - COMPRAR X) + (-COMPRAR Y + VENDER Y) = GANANCIAS$$



DETERMINACIÓN DESVIACIÓN ESTANDAR (LÍMITES)

Modified: 1 573 //
error=resid

Workfile: UNTITLED
Series: ERROR Workfile: UNTITLED::Untitled

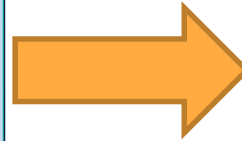
Range: 1 1341 -- 1341 obs
Sample: 1 1341 -- 1341 obs

View Proc Object Properties Print Name Freeze Default Sort Edit+/- Smp

ERROR

Last updated: 05/30/20 - 10:06
Imported from 'D:\USUARIO\Desktop\PROYECTO DE GRADO.xlsx'

1	-0.000625
2	-0.008209
3	0.000496
4	0.000275
5	-0.003231
6	-0.000681
7	-0.002557
8	-0.003677
9	0.003152
10	0.003586
11	0.001076
12	0.000632
13	-0.002511
14	-0.000352
15	-0.000352

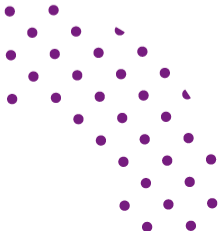


Fecha	ERROR
2/01/2017	-0.0007
3/01/2017	0.0038
4/01/2017	-0.0027
5/01/2017	-0.0096
6/01/2017	-0.0053
9/01/2017	-0.0235
10/01/2017	-0.0038
11/01/2017	0.0022
12/01/2017	-0.0033
13/01/2017	-0.0085
.	.
.	.
.	.
28/02/2019	-0.0005
1/03/2019	0.0028
4/03/2019	0.0023
5/03/2019	0.0033
6/03/2019	-0.0025
7/03/2019	0.0018
8/03/2019	0.0018
11/03/2019	0.0044
12/03/2019	0.0008
13/03/2019	0.0019
Desv Est	0.0087



PISO
-0.0087

TECHO
0.0087

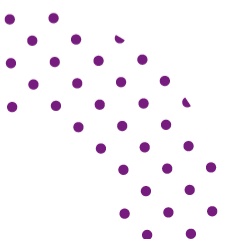


DETERMINACION DEL ERROR A LOS DATOS A APLICAR LA ESTRATEGIA DE ABRITRAJE

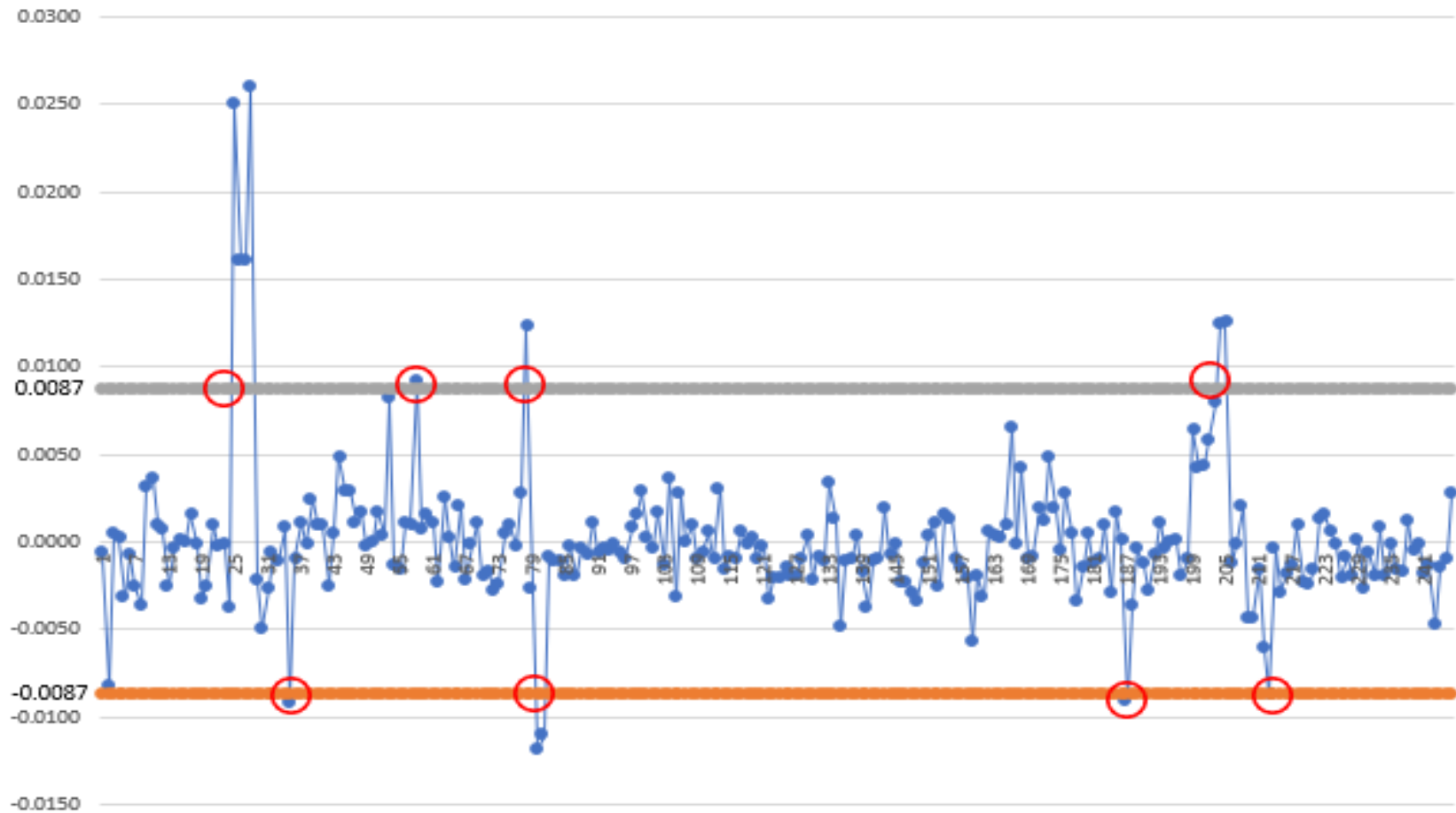
Dependent Variable: LOG(EU)
 Method: Least Squares
 Date: 05/28/20 Time: 14:34
 Sample: 1 573
 Included observations: 573

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP)	0.999941	4.75E-05	21069.60	0.0000
R-squared	0.999492	Mean dependent var	7.675905	
Adjusted R-squared	0.999492	S.D. dependent var	0.387225	
S.E. of regression	0.008732	Akaike info criterion	-6.641959	
Sum squared resid	0.043611	Schwarz criterion	-6.634365	
Log likelihood	1903.921	Hannan-Quinn criter.	-6.638997	
Durbin-Watson stat	1.464507			

FECHA	COP	EU	ERROR
14/03/2019	\$ 3,320	\$ 3,314	-0.0006
15/03/2019	\$ 3,400	\$ 3,335	-0.0082
18/03/2019	\$ 3,445	\$ 3,447	0.0005
19/03/2019	\$ 3,470	\$ 3,471	0.0003
20/03/2019	\$ 3,550	\$ 3,522	-0.0032
21/03/2019	\$ 3,565	\$ 3,558	-0.0007
22/03/2019	\$ 3,430	\$ 3,408	-0.0026
25/03/2019	\$ 3,430	\$ 3,399	-0.0037
26/03/2019	\$ 3,470	\$ 3,494	0.0032
27/03/2019	\$ 3,370	\$ 3,396	0.0036
.	.	.	.
.	.	.	.
.	.	.	.
6/02/2020	\$ 3,195	\$ 3,182	-0.0016
7/02/2020	\$ 3,215	\$ 3,201	-0.0017
10/02/2020	\$ 3,215	\$ 3,223	0.0012
11/02/2020	\$ 3,290	\$ 3,285	-0.0005
12/02/2020	\$ 3,375	\$ 3,372	-0.0002
13/02/2020	\$ 3,360	\$ 3,344	-0.0019
14/02/2020	\$ 3,325	\$ 3,313	-0.0014
17/02/2020	\$ 3,355	\$ 3,317	-0.0047
18/02/2020	\$ 3,365	\$ 3,352	-0.0015
19/02/2020	\$ 3,460	\$ 3,450	-0.0010
20/02/2020	\$ 3,460	\$ 3,480	0.0027



VARIACION ERROR



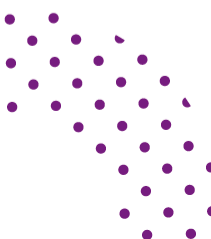
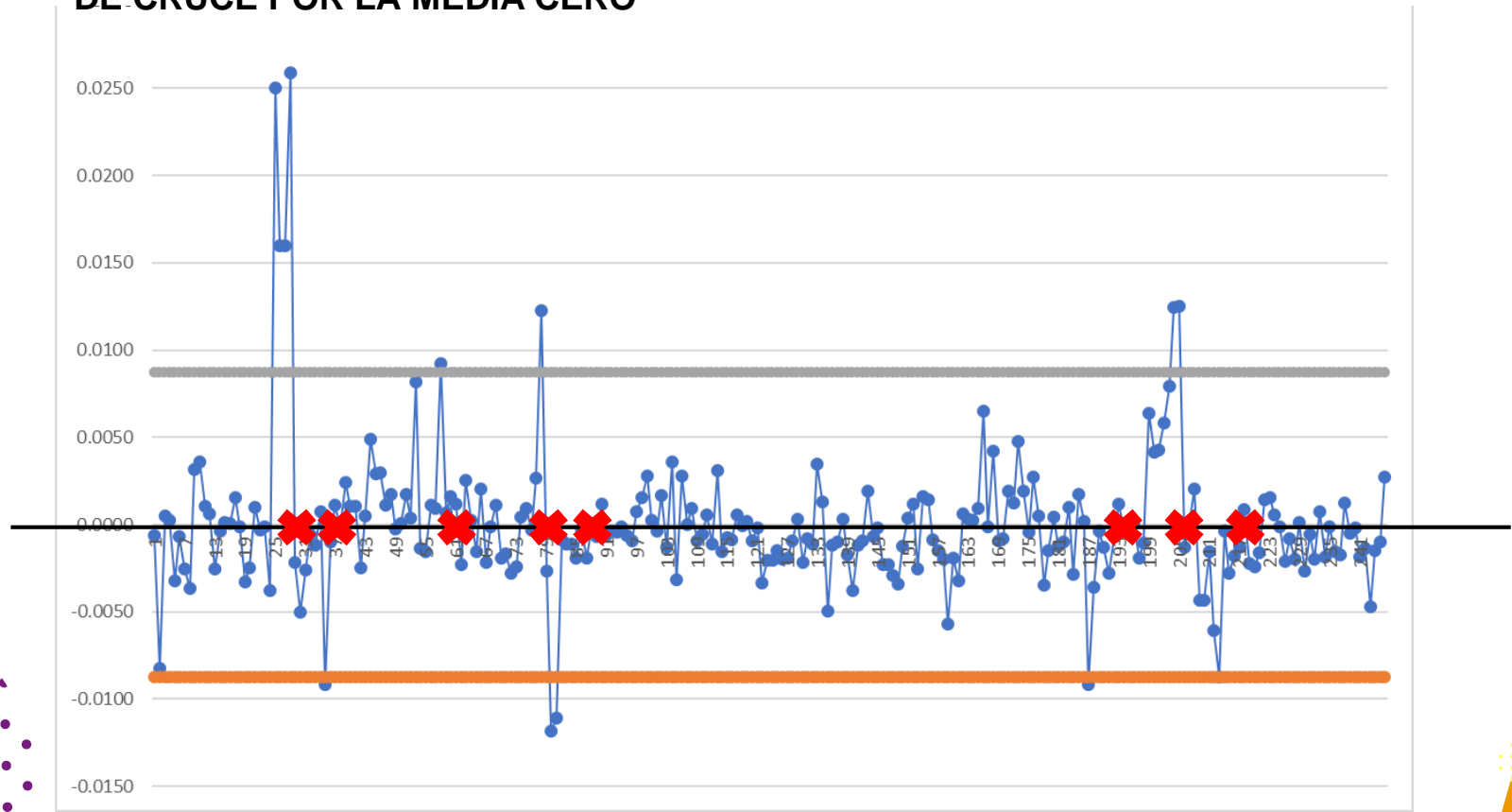
DETERMINACIÓN DE LA OPERACIÓN SEGÚN EL PUNTO DE CORTE



	A	B	C	D	E	K	L	M	N	O	P	Q	R
4	FECHA	COP	EU	ERROR	PUNTOS DE CORTE	OPERACIÓN	VALOR VENTA	VALOR COMISION	TOTAL OPERACIÓN	VALOR COMPRA	VALOR COMISION	TOTAL OPERACIÓN	
26	12/04/2019	\$ 3,275	\$ 3,271.30	-0.0003	N	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
27	15/04/2019	\$ 3,230	\$ 3,227.76	-0.0001	N	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
28	16/04/2019	\$ 3,295	\$ 3,264.89	-0.0038	N	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
29	17/04/2019	\$ 3,030	\$ 3,208.21	0.0250	T	VEU CCOP	\$ 32,082,130	\$ 160,411	\$ 31,921,720	\$ 30,300,000	\$ 303,000	\$ 30,603,000	
30	18/04/2019	\$ 3,030	\$ 3,142.21	0.0160	T	VEU CCOP	\$ 31,422,100	\$ 157,111	\$ 31,264,990	\$ 30,300,000	\$ 303,000	\$ 30,603,000	
31	19/04/2019	\$ 3,030	\$ 3,142.21	0.0160	T	VEU CCOP	\$ 31,422,100	\$ 157,111	\$ 31,264,990	\$ 30,300,000	\$ 303,000	\$ 30,603,000	
32	22/04/2019	\$ 3,095	\$ 3,283.82	0.0259	T	VEU CCOP	\$ 32,838,180	\$ 164,191	\$ 32,673,989	\$ 30,950,000	\$ 309,500	\$ 31,259,500	
39	1/05/2019	\$ 2,985	\$ 2,921.24	-0.0092	P	VCOP CEU	\$ 29,850,000	\$ 149,250	\$ 29,700,750	\$ 29,212,414	\$ 292,124	\$ 29,504,538	
62	3/06/2019	\$ 2,765	\$ 2,823.19	0.0092	T	VEU CCOP	\$ 28,231,865	\$ 141,159	\$ 28,090,706	\$ 27,650,000	\$ 276,500	\$ 27,926,500	
82	1/07/2019	\$ 2,920	\$ 3,002.06	0.0122	T	VEU CCOP	\$ 30,020,609	\$ 150,103	\$ 29,870,506	\$ 29,200,000	\$ 292,000	\$ 29,492,000	
84	3/07/2019	\$ 3,010	\$ 2,927.81	-0.0118	P	VCOP CEU	\$ 30,100,000	\$ 150,500	\$ 29,949,500	\$ 29,278,108	\$ 292,781	\$ 29,570,889	
85	4/07/2019	\$ 3,010	\$ 2,932.63	-0.0111	P	VCOP CEU	\$ 30,100,000	\$ 150,500	\$ 29,949,500	\$ 29,326,290	\$ 293,263	\$ 29,619,552	
191	29/11/2019	\$ 3,290	\$ 3,219.86	-0.0092	P	VCOP CEU	\$ 32,900,000	\$ 164,500	\$ 32,735,500	\$ 32,198,593	\$ 321,986	\$ 32,520,579	
208	24/12/2019	\$ 3,320	\$ 3,414.86	0.0124	T	VEU CCOP	\$ 34,148,583	\$ 170,743	\$ 33,977,840	\$ 33,200,000	\$ 332,000	\$ 33,532,000	
209	25/12/2019	\$ 3,320	\$ 3,415.33	0.0125	T	VEU CCOP	\$ 34,153,344	\$ 170,767	\$ 33,982,577	\$ 33,200,000	\$ 332,000	\$ 33,532,000	
217	6/01/2020	\$ 3,380	\$ 3,311.13	-0.0087	P	VCOP CEU	\$ 33,800,000	\$ 169,000	\$ 33,631,000	\$ 33,111,342	\$ 331,113	\$ 33,442,455	



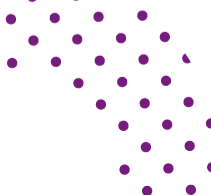
DETERMINACIÓN DEL CIERRE DE LA OPERACIÓN SEGÚN EL PUNTO DE CRUCE POR LA MEDIA CERO



DETERMINACIÓN DEL CIERRE DE LA OPERACIÓN SEGÚN EL PUNTO DE CRUCE POR LA MEDIA CERO



	A	B	E	F	L	S	U	V	W	X	Y	Z	AA	AB
	FECHA	ERROR		OPERACIÓN	SEÑAL DE CIERRE	CIERRE OPERACIÓN	VALOR COMPRA	VALOR COMISION	TOTAL OPERACIÓN	VALOR VENTA	VALOR COMISION	TOTAL OPERACIÓN		
4														
29	17/04/2019	0.0250		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
30	18/04/2019	0.0160		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
31	19/04/2019	0.0160		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
32	22/04/2019	0.0259		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
33	23/04/2019	-0.0021		0	CERRAR OPERACIÓN	CEU VCOP	\$ 123,529,455	\$ 617,647	\$ 124,147,102	\$ 124,200,000	\$ 621,000	\$ 123,579,000		
39	1/05/2019	-0.0092		VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
40	2/05/2019	-0.0010		0		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
41	3/05/2019	0.0011		0	CERRAR OPERACIÓN	CCOP VEU	\$ 29,250,000	\$ 146,250	\$ 29,396,250	\$ 29,311,864	\$ 146,559	\$ 29,165,305		
62	3/06/2019	0.0092		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
66	7/06/2019	-0.0023		0	CERRAR OPERACIÓN	CEU VCOP	\$ 28,584,169	\$ 142,921	\$ 28,727,090	\$ 28,750,000	\$ 143,750	\$ 28,606,250		
82	1/07/2019	0.0122		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
83	2/07/2019	-0.0027		0	CERRAR OPERACIÓN	CEU VCOP	\$ 29,056,473	\$ 145,282	\$ 29,201,755	\$ 29,250,000	\$ 146,250	\$ 29,103,750		
84	3/07/2019	-0.0118		VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
85	4/07/2019	-0.0111		VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
94	17/07/2019	0.0012		0	CERRAR OPERACIÓN	CCOP VEU	\$ 60,000,000	\$ 300,000	\$ 60,300,000	\$ 60,134,688	\$ 300,673	\$ 59,834,015		
191	29/11/2019	-0.0092		VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
197	9/12/2019	0.0012		0	CERRAR OPERACIÓN	CCOP VEU	\$ 32,800,000	\$ 164,000	\$ 32,964,000	\$ 32,872,243	\$ 164,361	\$ 32,707,882		
208	24/12/2019	0.0124		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
209	25/12/2019	0.0125		VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
210	26/12/2019	-0.0013		0	CERRAR OPERACIÓN	CEU VCOP	\$ 66,667,017	\$ 333,335	\$ 67,000,352	\$ 66,900,000	\$ 334,500	\$ 66,565,500		
217	6/01/2020	-0.0087		VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
222	13/01/2020	0.0009		0	CERRAR OPERACIÓN	CCOP VEU	\$ 34,200,000	\$ 171,000	\$ 34,371,000	\$ 34,251,050	\$ 171,255	\$ 34,079,795		



VENTA - COMPRA

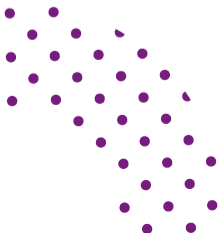
$$(V-C)+(C+V)=\$$$

	A	B	K	L	O	R	S	V	Y	AB	AC	AD	AE	AF
	FECHA	PUNTOS DE CORTE	OPERACIÓN	TOTAL OPERACIÓN	TOTAL OPERACIÓN			CIERRE OPERACIÓN	TOTAL OPERACIÓN	TOTAL OPERACIÓN		V - C	C - V	RESULTADO ESTRATEGIA ABITRAJE
4														
29	17/04/2019	T	VEU CCOP	\$ 31,921,720	\$ 30,603,000			0 \$	- \$	- \$				
30	18/04/2019	T	VEU CCOP	\$ 31,264,990	\$ 30,603,000			0 \$	- \$	- \$				
31	19/04/2019	T	VEU CCOP	\$ 31,264,990	\$ 30,603,000			0 \$	- \$	- \$				
32	22/04/2019	T	VEU CCOP	\$ 32,673,989	\$ 31,259,500			0 \$	- \$	- \$				
33	23/04/2019	N		0 \$	- \$			CEU VCOP	\$ 124,147,102	\$ 123,579,000		\$ 2,978,586	\$ 510,500	\$ 3,489,086
39	1/05/2019	P	VCOP CEU	\$ 29,700,750	\$ 29,504,538			0 \$	- \$	- \$				
40	2/05/2019	N		0 \$	- \$			0 \$	- \$	- \$				
41	3/05/2019	N		0 \$	- \$			CCOP VEU	\$ 29,396,250	\$ 29,165,305		\$ 304,500	-\$ 339,233	-\$ 34,733
62	3/06/2019	T	VEU CCOP	\$ 28,090,706	\$ 27,926,500			0 \$	- \$	- \$				
63	4/06/2019	N		0 \$	- \$			0 \$	- \$	- \$				
64	5/06/2019	N		0 \$	- \$			0 \$	- \$	- \$				
65	6/06/2019	N		0 \$	- \$			0 \$	- \$	- \$				
66	7/06/2019	N		0 \$	- \$			CEU VCOP	\$ 28,727,090	\$ 28,606,250		-\$ 636,384	\$ 679,750	\$ 43,366
82	1/07/2019	T	VEU CCOP	\$ 29,870,506	\$ 29,492,000			0 \$	- \$	- \$				
83	2/07/2019	N		0 \$	- \$			CEU VCOP	\$ 29,201,755	\$ 29,103,750		\$ 668,750	-\$ 388,250	\$ 280,500
84	3/07/2019	P	VCOP CEU	\$ 29,949,500	\$ 29,570,889			0 \$	- \$	- \$				
85	4/07/2019	P	VCOP CEU	\$ 29,949,500	\$ 29,619,552			0 \$	- \$	- \$				
94	17/07/2019	N		0 \$	- \$			CCOP VEU	\$ 60,300,000	\$ 59,834,015		-\$ 401,000	\$ 643,573	\$ 242,573
191	29/11/2019	P	VCOP CEU	\$ 32,735,500	\$ 32,520,579			0 \$	- \$	- \$				
197	9/12/2019	N		0 \$	- \$			CCOP VEU	\$ 32,964,000	\$ 32,707,882		-\$ 228,500	\$ 187,303	-\$ 41,197
208	24/12/2019	T	VEU CCOP	\$ 33,977,840	\$ 33,532,000			0 \$	- \$	- \$				
209	25/12/2019	T	VEU CCOP	\$ 33,982,577	\$ 33,532,000			0 \$	- \$	- \$				
210	26/12/2019	N		0 \$	- \$			CEU VCOP	\$ 67,000,352	\$ 66,565,500		\$ 960,066	-\$ 498,500	\$ 461,566
217	6/01/2020	P	VCOP CEU	\$ 33,631,000	\$ 33,442,455			0 \$	- \$	- \$				
222	13/01/2020	N		0 \$	- \$			CCOP VEU	\$ 34,371,000	\$ 34,079,795		-\$ 740,000	\$ 637,340	-\$ 102,660
250	20/02/2020	N		0 \$	- \$			0 \$	- \$	- \$				

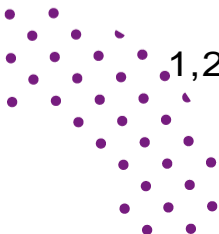
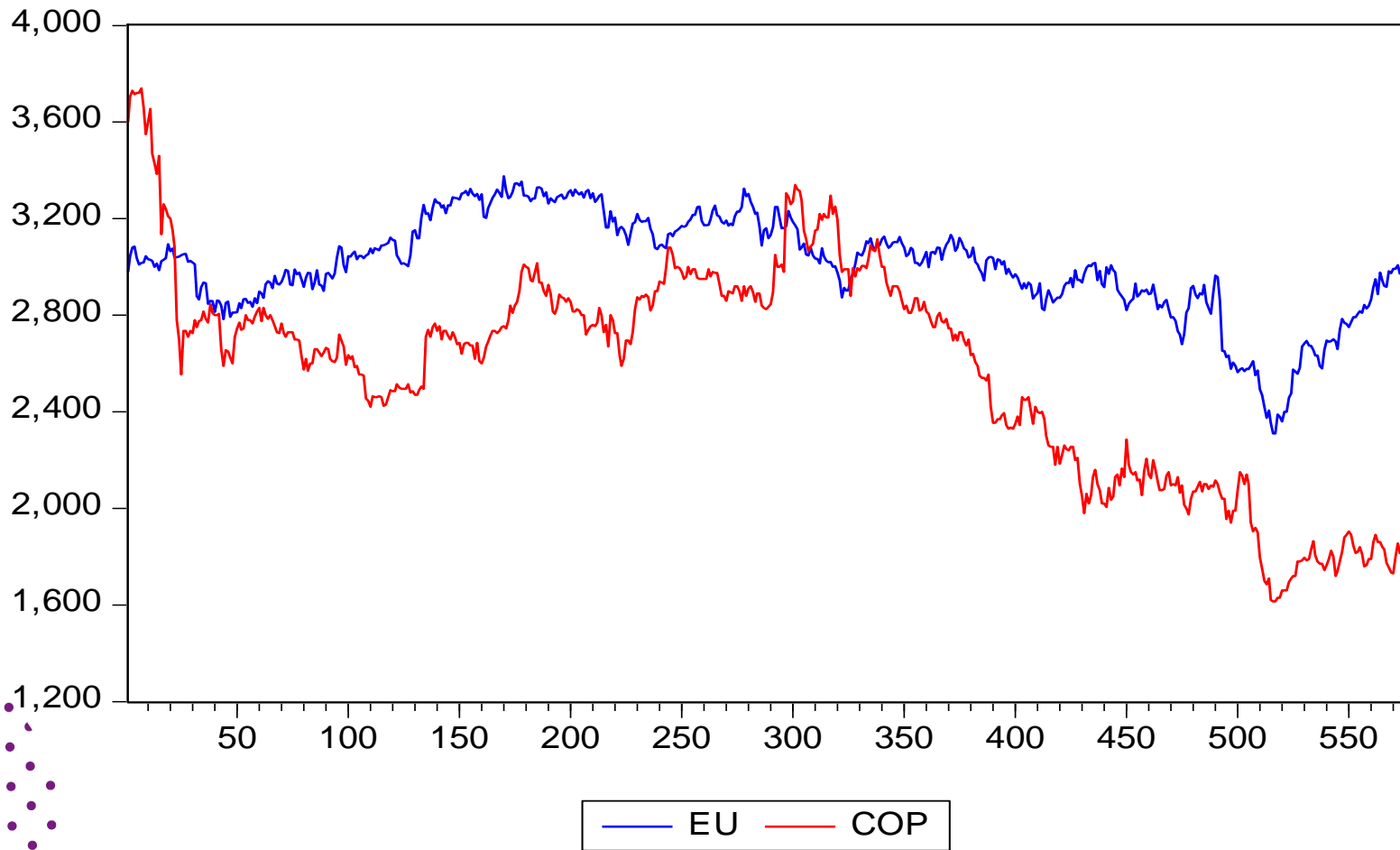
COMPRA + VENTA



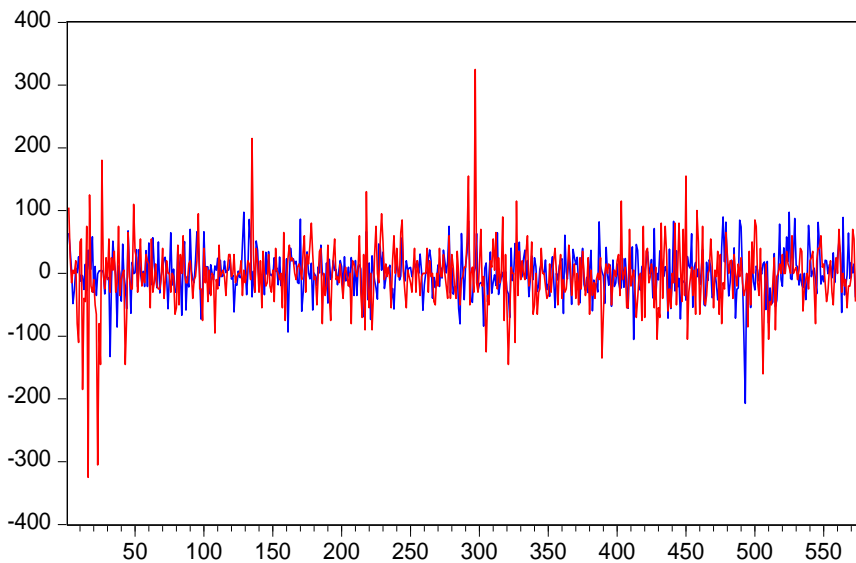
AVIANCA HOLDINGS



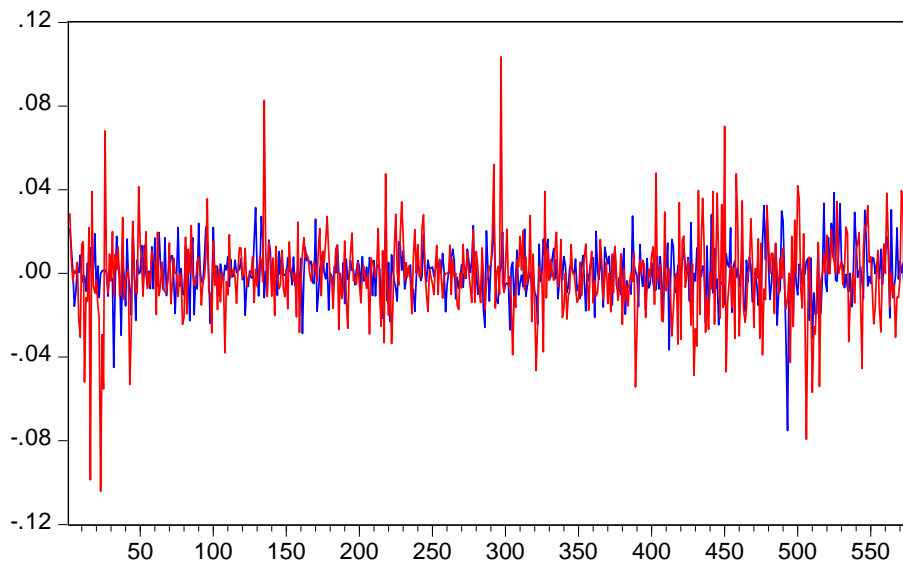
COMPORTAMIENTO DE LAS SERIES DE PRECIOS DE LA ACCION Y EL ADR



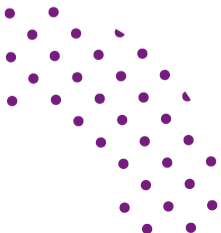
PRIMERAS DIFERENCIAS Y LOGARITMOS



— D(EU) — D(COP)



— DLOG(EU) — DLOG(COP)

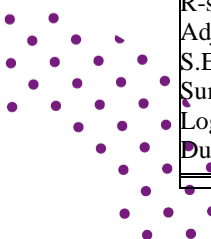


TEST RAICES UNITARIAS EU



Null Hypothesis: LOG(EU) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-0.030058	0.6724
Test critical values:	1% level		-2.569011	
	5% level		-1.941378	
	10% level		-1.616327	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LOG(EU))				
Method: Least Squares				
Date: 06/09/20 Time: 19:25				
Sample (adjusted): 2 573				
Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(EU(-1))	-1.86E-06	6.17E-05	-0.030058	0.9760
R-squared	0.000001	Mean dependent var	-6.15E-06	
Adjusted R-squared	0.000001	S.D. dependent var	0.011824	
S.E. of regression	0.011824	Akaike info criterion	-6.035696	
Sum squared resid	0.079824	Schwarz criterion	-6.028092	
Log likelihood	1727.209	Hannan-Quinn criter.	-6.032729	
Durbin-Watson stat	2.012387			

Null Hypothesis: D(LOG(EU)) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-24.16128	0.0000
Test critical values:	1% level		-2.569018	
	5% level		-1.941379	
	10% level		-1.616327	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LOG(EU),2)				
Method: Least Squares				
Date: 06/09/20 Time: 19:28				
Sample (adjusted): 3 573				
Included observations: 571 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(EU(-1)))	-1.010106	0.041807	-24.16128	0.0000
R-squared	0.505960	Mean dependent var	-5.99E-05	
Adjusted R-squared	0.505960	S.D. dependent var	0.016787	
S.E. of regression	0.011800	Akaike info criterion	-6.039768	
Sum squared resid	0.079360	Schwarz criterion	-6.032154	
Log likelihood	1725.354	Hannan-Quinn criter.	-6.036797	
Durbin-Watson stat	2.004224			

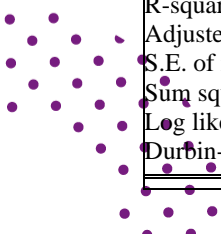


TEST RAICES UNITARIAS COP



Null Hypothesis: LOG(COP) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.510764	0.1227	
Test critical values:		1% level	-2.569011	
		5% level	-1.941378	
		10% level	-1.616327	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LOG(COP))				
Method: Least Squares				
Date: 06/09/20 Time: 19:29				
Sample (adjusted): 2 573				
Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP(-1))	-0.000156	0.000104	-1.510764	0.1314
R-squared	0.000158	Mean dependent var	-0.001202	
Adjusted R-squared	0.000158	S.D. dependent var	0.019420	
S.E. of regression	0.019419	Akaike info criterion	-5.043412	
Sum squared resid	0.215316	Schwarz criterion	-5.035809	
Log likelihood	1443.416	Hannan-Quinn criter.	-5.040446	
Durbin-Watson stat	2.080126			

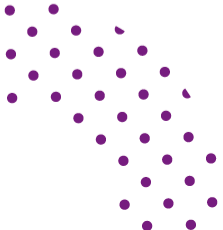
Null Hypothesis: D(LOG(COP)) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-24.85004	0.0000	
Test critical values:		1% level	-2.569018	
		5% level	-1.941379	
		10% level	-1.616327	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LOG(COP),2)				
Method: Least Squares				
Date: 06/09/20 Time: 19:30				
Sample (adjusted): 3 573				
Included observations: 571 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(COP(-1)))	-1.039501	0.041831	-24.85004	0.0000
R-squared	0.520005	Mean dependent var	-9.34E-05	
Adjusted R-squared	0.520005	S.D. dependent var	0.028034	
S.E. of regression	0.019422	Akaike info criterion	-5.043061	
Sum squared resid	0.215014	Schwarz criterion	-5.035447	
Log likelihood	1440.794	Hannan-Quinn criter.	-5.040091	
Durbin-Watson stat	1.996671			



REGRESION LINEAL DE EU Y COP



Dependent Variable: LOG(EU)				
Method: Least Squares				
Date: 06/09/20 Time: 19:33				
Sample (adjusted): 1 573				
Included observations: 573 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP)	1.020916	0.000775	1318.021	0.0000
R-squared	-3.163026	Mean dependent var	8.006455	
Adjusted R-squared	-3.163026	S.D. dependent var	0.071258	
S.E. of regression	0.145392	Akaike info criterion	-1.017020	
Sum squared resid	12.09144	Schwarz criterion	-1.009427	
Log likelihood	292.3763	Hannan-Quinn criter.	-1.014058	
Durbin-Watson stat	0.022121			

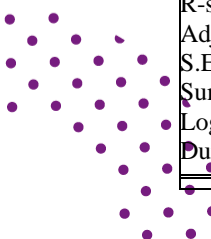


TEST RAICES UNITARIAS ERROR



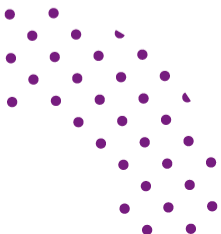
Null Hypothesis: ERROR has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.896043	0.0554
Test critical values: 1% level			-2.569011	
5% level			-1.941378	
10% level			-1.616327	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(ERROR)				
Method: Least Squares				
Date: 06/09/20 Time: 19:35				
Sample (adjusted): 2 573				
Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERROR(-1)	-0.011820	0.006234	-1.896043	0.0585
R-squared	0.003078	Mean dependent var	0.001221	
Adjusted R-squared	0.003078	S.D. dependent var	0.021609	
S.E. of regression	0.021575	Akaike info criterion	-4.832790	
Sum squared resid	0.265796	Schwarz criterion	-4.825186	
Log likelihood	1383.178	Hannan-Quinn criter.	-4.829824	
Durbin-Watson stat	2.197786			

Null Hypothesis: D(ERROR) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-26.53635	0.0000
Test critical values: 1% level			-2.569018	
5% level			-1.941379	
10% level			-1.616327	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(ERROR,2)				
Method: Least Squares				
Date: 06/09/20 Time: 19:35				
Sample (adjusted): 3 573				
Included observations: 571 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ERROR(-1))	-1.105465	0.041659	-26.53635	0.0000
R-squared	0.552652	Mean dependent var	3.54E-05	
Adjusted R-squared	0.552652	S.D. dependent var	0.032203	
S.E. of regression	0.021539	Akaike info criterion	-4.836179	
Sum squared resid	0.264433	Schwarz criterion	-4.828565	
Log likelihood	1381.729	Hannan-Quinn criter.	-4.833208	
Durbin-Watson stat	2.001618			

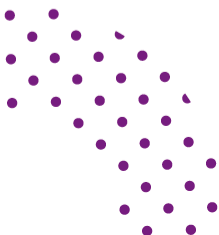
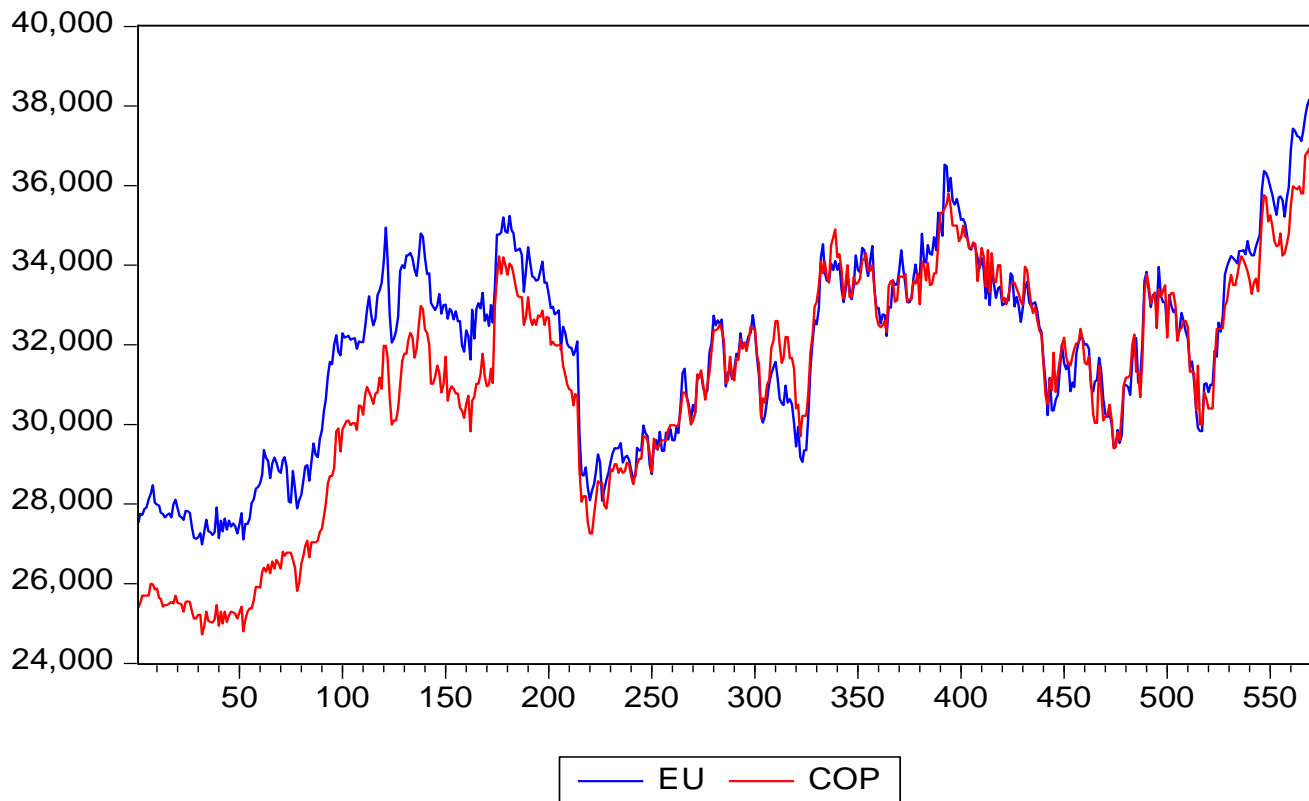




BANCOLOMBIA

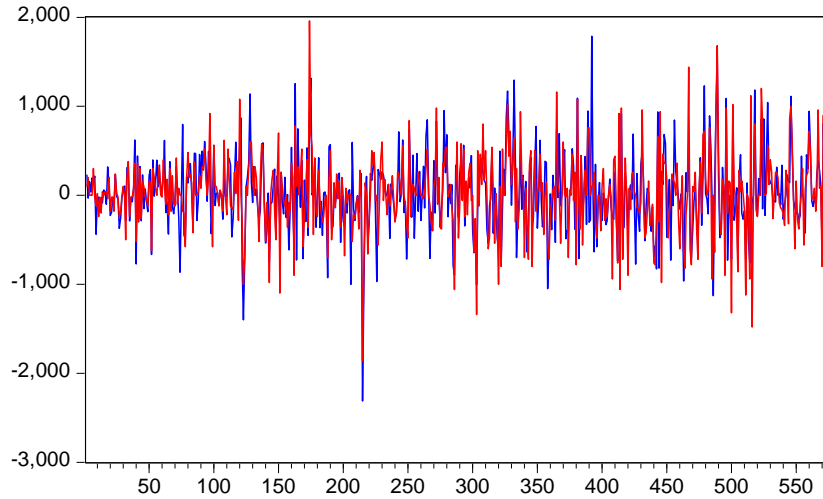


COMPORTAMIENTO DE LAS SERIES DE PRECIOS DE LA ACCION Y ADR

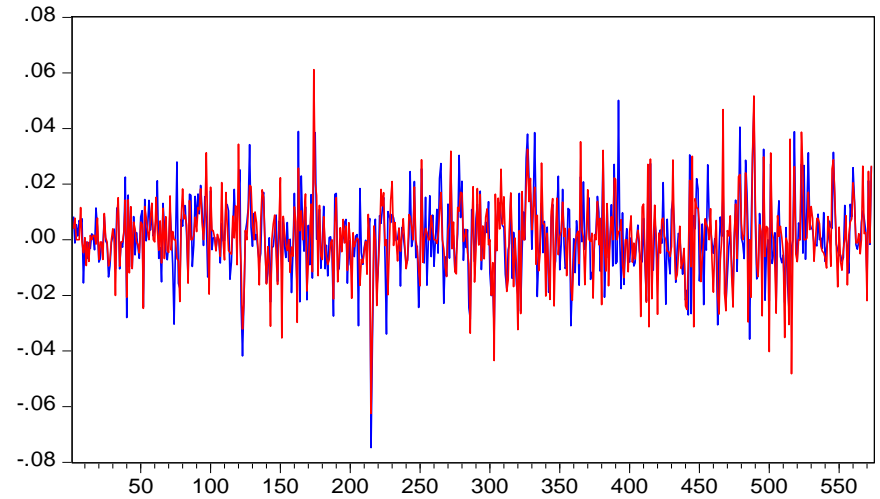




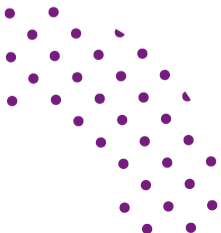
PRIMERAS DIFERENCIAS Y LOGARITMOS



— D(EU) — D(COP)



— DLOG(EU) — DLOG(COP)

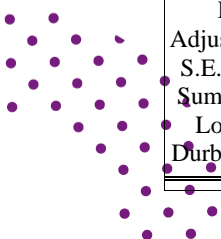


TEST RAICES UNITARIAS EU



Null Hypothesis: LOG(EU) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.061838	0.9250	
Test critical values: 1% level		-2.569011		
5% level		-1.941378		
10% level		-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(EU)) Method: Least Squares Date: 06/09/20 Time: 13:58 Sample (adjusted): 2 573 Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(EU(-1))	5.96E-05	5.62E-05	1.061838	0.2888
R-squared	-0.000046	Mean dependent var	0.000625	
Adjusted R-squared	-0.000046	S.D. dependent var	0.013920	
S.E. of regression	0.013921	Akaike info criterion	-5.709118	
Sum squared resid	0.110653	Schwarz criterion	-5.701514	
Log likelihood	1633.808	Hannan-Quinn criter.	-5.706152	
Durbin-Watson stat	1.933591			

Null Hypothesis: D(LOG(EU)) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-23.05907	0.0000	
Test critical values: 1% level		-2.569018		
5% level		-1.941379		
10% level		-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(EU),2) Method: Least Squares Date: 06/09/20 Time: 14:08 Sample (adjusted): 3 573 Included observations: 571 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(EU(-1)))	-0.968077	0.041982	-23.05907	0.0000
R-squared	0.482626	Mean dependent var	3.15E-05	
Adjusted R-squared	0.482626	S.D. dependent var	0.019374	
S.E. of regression	0.013935	Akaike info criterion	-5.707034	
Sum squared resid	0.110690	Schwarz criterion	-5.699421	
Log likelihood	1630.358	Hannan-Quinn criter.	-5.704064	
Durbin-Watson stat	1.989565			

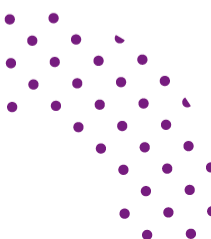


TEST RAICES UNITARIAS COP



Null Hypothesis: LOG(COP) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.195851		0.9409
Test critical values:	1% level	-2.569011		
	5% level	-1.941378		
	10% level	-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(COP)) Method: Least Squares Date: 06/09/20 Time: 14:09 Sample (adjusted): 2 573 Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP(-1))	6.72E-05	5.62E-05	1.195851	0.2323
R-squared	-0.000066	Mean dependent var	0.000704	
Adjusted R-squared	-0.000066	S.D. dependent var	0.013903	
S.E. of regression	0.013904	Akaike info criterion	-5.711564	
Sum squared resid	0.110383	Schwarz criterion	-5.703961	
Log likelihood	1634.507	Hannan-Quinn criter.	-5.708598	
Durbin-Watson stat	2.044108			

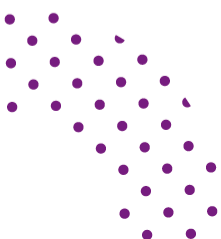
Null Hypothesis: D(LOG(COP)) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-24.34993		0.0000
Test critical values:	1% level	-2.569018		
	5% level	-1.941379		
	10% level	-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(COP),2) Method: Least Squares Date: 06/09/20 Time: 14:10 Sample (adjusted): 3 573 Included observations: 571 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(COP(-1)))	-1.022863	0.042007	-24.34993	0.0000
R-squared	0.509852	Mean dependent var	3.98E-05	
Adjusted R-squared	0.509852	S.D. dependent var	0.019895	
S.E. of regression	0.013929	Akaike info criterion	-5.707966	
Sum squared resid	0.110587	Schwarz criterion	-5.700353	
Log likelihood	1630.624	Hannan-Quinn criter.	-5.704996	
Durbin-Watson stat	1.994094			



REGRESION LINEAL DE EU Y COP



Dependent Variable: LOG(EU)				
Method: Least Squares				
Date: 06/09/20 Time: 14:11				
Sample (adjusted): 1 573				
Included observations: 573 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP)	1.002552	0.000146	6883.492	0.0000
R-squared	0.790554	Mean dependent var	10.36605	
Adjusted R-squared	0.790554	S.D. dependent var	0.078769	
S.E. of regression	0.036049	Akaike info criterion	-3.806138	
Sum squared resid	0.743327	Schwarz criterion	-3.798545	
Log likelihood	1091.459	Hannan-Quinn criter.	-3.803176	
Durbin-Watson stat	0.094816			

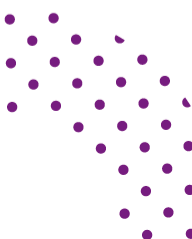


TEST RAICES UNITARIAS ERROR



Null Hypothesis: ERROR has a unit root Exogenous: None Lag Length: 3 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.093100		0.0350
Test critical values: 1% level		-2.569032		
5% level		-1.941381		
10% level		-1.616325		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(ERROR) Method: Least Squares Date: 06/09/20 Time: 14:13 Sample (adjusted): 5 573 Included observations: 569 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERROR(-1)	-0.024881	0.011887	-2.093100	0.0368
D(ERROR(-1))	-0.449993	0.042235	-10.65452	0.0000
D(ERROR(-2))	-0.304338	0.044231	-6.880636	0.0000
D(ERROR(-3))	-0.134042	0.041581	-3.223620	0.0013
R-squared	0.197586	Mean dependent var	-8.28E-05	
Adjusted R-squared	0.193325	S.D. dependent var	0.011129	
S.E. of regression	0.009995	Akaike info criterion	-6.366417	
Sum squared resid	0.056446	Schwarz criterion	-6.335880	
Log likelihood	1815.246	Hannan-Quinn criter.	-6.354502	
Durbin-Watson stat	2.023718			

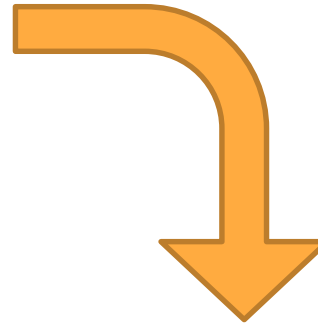
Null Hypothesis: D(ERROR) has a unit root Exogenous: None Lag Length: 2 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-19.96531		0.0000
Test critical values: 1% level		-2.569032		
5% level		-1.941381		
10% level		-1.616325		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(ERROR,2) Method: Least Squares Date: 06/09/20 Time: 14:13 Sample (adjusted): 5 573 Included observations: 569 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ERROR(-1))	-1.922365	0.096285	-19.96531	0.0000
D(ERROR(-1),2)	0.455853	0.071855	6.344111	0.0000
D(ERROR(-2),2)	0.140369	0.041595	3.374686	0.0008
R-squared	0.699056	Mean dependent var	-1.03E-05	
Adjusted R-squared	0.697992	S.D. dependent var	0.018242	
S.E. of regression	0.010025	Akaike info criterion	-6.362208	
Sum squared resid	0.056884	Schwarz criterion	-6.339305	
Log likelihood	1813.048	Hannan-Quinn criter.	-6.353271	
Durbin-Watson stat	2.025939			



CALCULO DE LIMITES

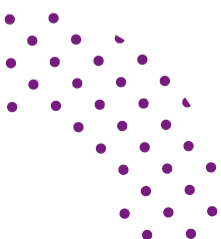


Fecha	ERROR
2/01/2017	0.0546
3/01/2017	0.0590
4/01/2017	0.0500
5/01/2017	0.0555
6/01/2017	0.0568
9/01/2017	0.0638
10/01/2017	0.0574
11/01/2017	0.0657
12/01/2017	0.0548
13/01/2017	0.0522
.	.
.	.
.	.
28/02/2019	0.0072
1/03/2019	0.0095
4/03/2019	0.0157
5/03/2019	-0.0004
6/03/2019	0.0049
7/03/2019	0.0056
8/03/2019	0.0128
11/03/2019	0.0093
12/03/2019	0.0088
13/03/2019	0.0084
Desv Est	0.0360

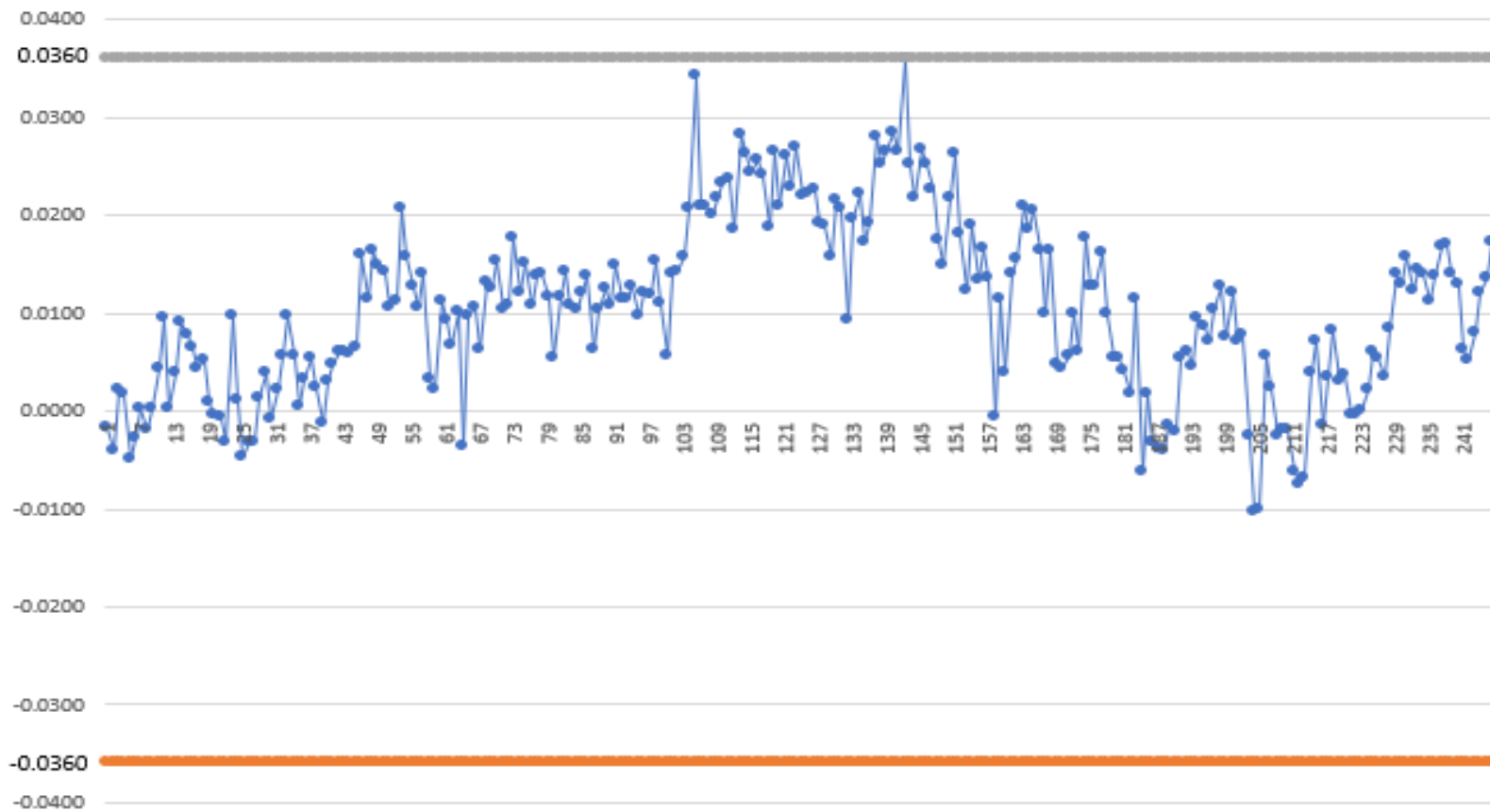


PISO
-0.0360

TECHO
0.0360

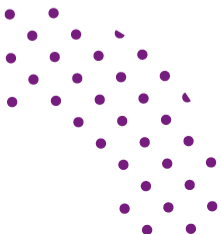


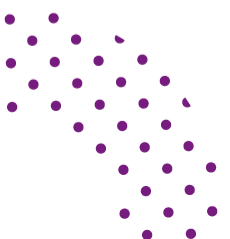
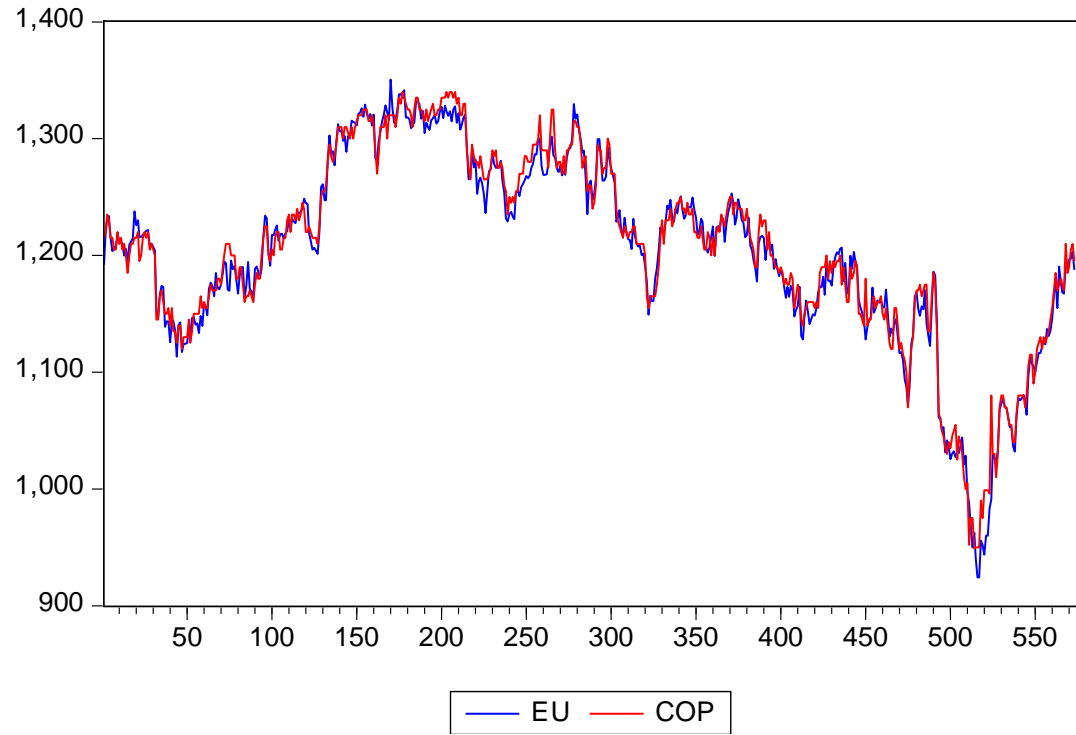
VARIACION ERROR

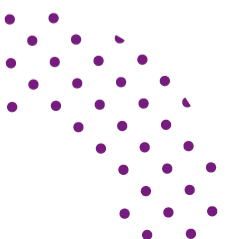
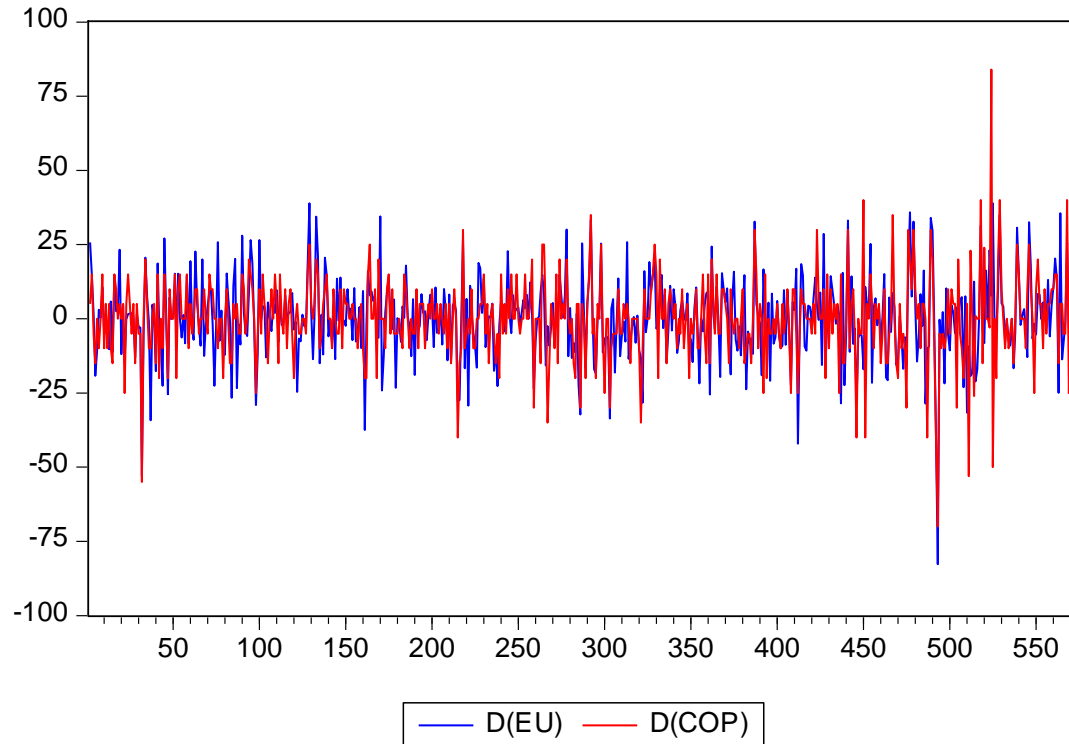


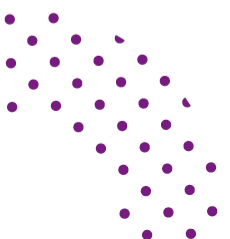
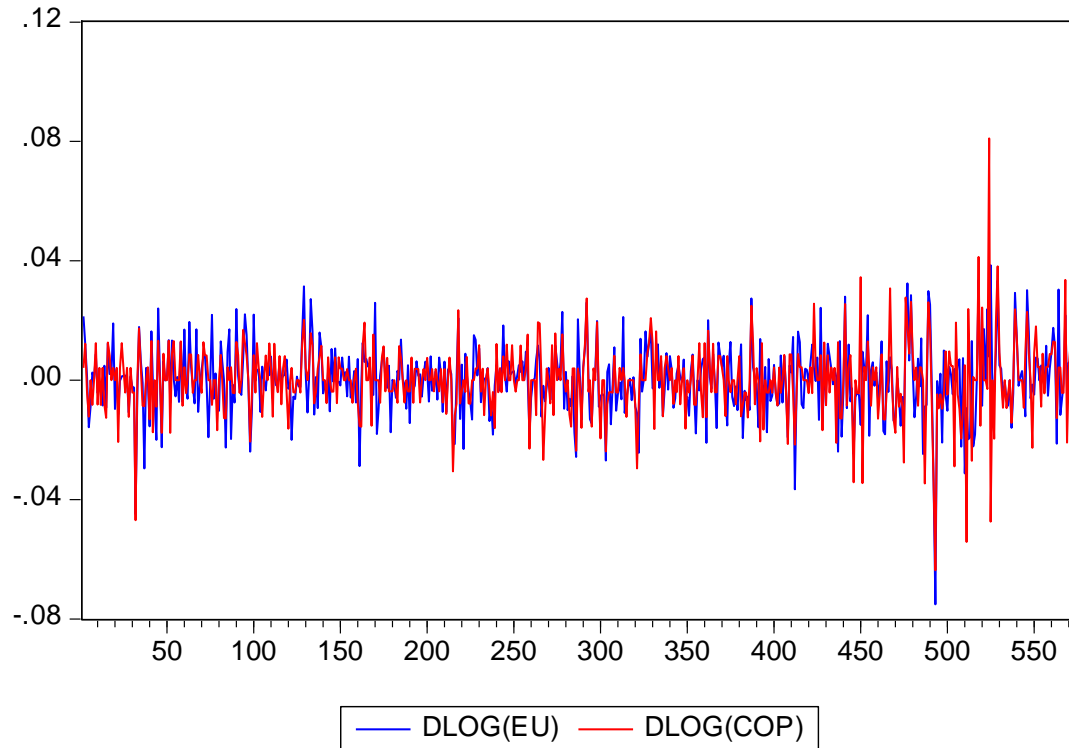


AVAL







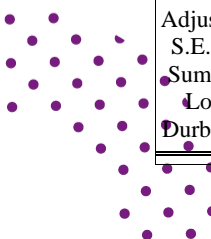


TEST RAICES UNITARIAS EU



Null Hypothesis: LOG(EU) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.032334		0.6716
Test critical values:	1% level	-2.569011		
	5% level	-1.941378		
	10% level	-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(EU)) Method: Least Squares Date: 06/09/20 Time: 16:09 Sample (adjusted): 2 573 Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(EU(-1))	-2.25E-06	6.97E-05	-0.032334	0.9742
R-squared	0.000002	Mean dependent var	-6.15E-06	
Adjusted R-squared	0.000002	S.D. dependent var	0.011824	
S.E. of regression	0.011824	Akaike info criterion	-6.035696	
Sum squared resid	0.079824	Schwarz criterion	-6.028093	
Log likelihood	1727.209	Hannan-Quinn criter.	-6.032730	
Durbin-Watson stat	2.012387			

Null Hypothesis: D(LOG(EU)) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-24.16128		0.0000
Test critical values:	1% level	-2.569018		
	5% level	-1.941379		
	10% level	-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(EU),2) Method: Least Squares Date: 06/09/20 Time: 16:10 Sample (adjusted): 3 573 Included observations: 571 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(EU(-1)))	-1.010106	0.041807	-24.16128	0.0000
R-squared	0.505960	Mean dependent var	-5.99E-05	
Adjusted R-squared	0.505960	S.D. dependent var	0.016787	
S.E. of regression	0.011800	Akaike info criterion	-6.039768	
Sum squared resid	0.079360	Schwarz criterion	-6.032154	
Log likelihood	1725.354	Hannan-Quinn criter.	-6.036797	
Durbin-Watson stat	2.004224			



TEST RAICES UNITARIAS COP

Null Hypothesis: LOG(COP) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.078306	0.6563	
Test critical values:	1% level	-2.569011		
	5% level	-1.941378		
	10% level	-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(COP)) Method: Least Squares Date: 06/09/20 Time: 16:11 Sample (adjusted): 2 573 Included observations: 572 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP(-1))	-5.50E-06	7.02E-05	-0.078306	0.9376
R-squared	0.000005	Mean dependent var	-2.90E-05	
Adjusted R-squared	0.000005	S.D. dependent var	0.011915	
S.E. of regression	0.011915	Akaike info criterion	-6.020223	
Sum squared resid	0.081069	Schwarz criterion	-6.012620	
Log likelihood	1722.784	Hannan-Quinn criter.	-6.017257	
Durbin-Watson stat	2.148854			

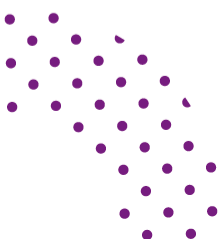
Null Hypothesis: D(LOG(COP)) has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-25.73191	0.0000	
Test critical values:	1% level	-2.569018		
	5% level	-1.941379		
	10% level	-1.616327		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(LOG(COP),2) Method: Least Squares Date: 06/09/20 Time: 16:11 Sample (adjusted): 3 573 Included observations: 571 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(COP(-1)))	-1.075630	0.041801	-25.73191	0.0000
R-squared	0.537386	Mean dependent var	-2.90E-05	
Adjusted R-squared	0.537386	S.D. dependent var	0.017482	
S.E. of regression	0.011891	Akaike info criterion	-6.024391	
Sum squared resid	0.080590	Schwarz criterion	-6.016778	
Log likelihood	1720.964	Hannan-Quinn criter.	-6.021421	
Durbin-Watson stat	2.007084			



REGRESION LINEAL DE EU Y COP



Dependent Variable: LOG(EU)				
Method: Least Squares				
Date: 06/09/20 Time: 16:12				
Sample (adjusted): 1 573				
Included observations: 573 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(COP)	0.999638	6.06E-05	16484.21	0.0000
R-squared	0.979121	Mean dependent var	7.090164	
Adjusted R-squared	0.979121	S.D. dependent var	0.071258	
S.E. of regression	0.010296	Akaike info criterion	-6.312294	
Sum squared resid	0.060642	Schwarz criterion	-6.304701	
Log likelihood	1809.472	Hannan-Quinn criter.	-6.309332	
Durbin-Watson stat	1.246286			

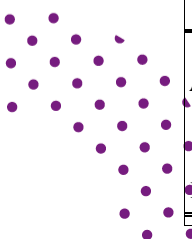


TEST RAICES UNITARIAS ERROR



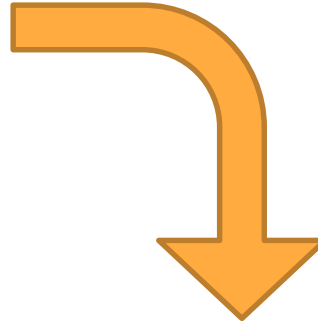
Null Hypothesis: ERROR has a unit root Exogenous: None Lag Length: 2 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.362816		0.0000
Test critical values:	1% level	-2.569025		
	5% level	-1.941380		
	10% level	-1.616326		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(ERROR) Method: Least Squares Date: 06/09/20 Time: 16:13 Sample (adjusted): 4 573 Included observations: 570 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERROR(-1)	-0.410235	0.049055	-8.362816	0.0000
D(ERROR(-1))	-0.338672	0.050221	-6.743633	0.0000
D(ERROR(-2))	-0.118870	0.041581	-2.858729	0.0044
R-squared	0.364998	Mean dependent var	-7.10E-06	
Adjusted R-squared	0.362758	S.D. dependent var	0.011502	
S.E. of regression	0.009182	Akaike info criterion	-6.537911	
Sum squared resid	0.047802	Schwarz criterion	-6.515039	
Log likelihood	1866.305	Hannan-Quinn criter.	-6.528987	
Durbin-Watson stat	2.009257			

Null Hypothesis: D(ERROR) has a unit root Exogenous: None Lag Length: 3 (Automatic - based on SIC, maxlag=18)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.69431		0.0000
Test critical values:	1% level	-2.569040		
	5% level	-1.941382		
	10% level	-1.616325		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(ERROR,2) Method: Least Squares Date: 06/09/20 Time: 16:14 Sample (adjusted): 6 573 Included observations: 568 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ERROR(-1))	-2.418408	0.136677	-17.69431	0.0000
D(ERROR(-1),2)	0.750310	0.113834	6.591249	0.0000
D(ERROR(-2),2)	0.357956	0.080237	4.461232	0.0000
D(ERROR(-3),2)	0.129547	0.041675	3.108528	0.0020
R-squared	0.769225	Mean dependent var	5.42E-06	
Adjusted R-squared	0.767997	S.D. dependent var	0.019860	
S.E. of regression	0.009566	Akaike info criterion	-6.454239	
Sum squared resid	0.051608	Schwarz criterion	-6.423660	
Log likelihood	1837.004	Hannan-Quinn criter.	-6.442306	
Durbin-Watson stat	2.006823			



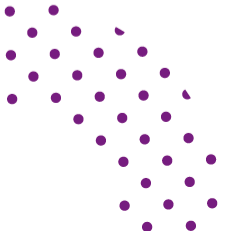
CALCULO DE LIMITES

Fecha	ERROR
2/01/2017	-0.0167
3/01/2017	0.0005
4/01/2017	0.0004
5/01/2017	0.0057
6/01/2017	0.0023
9/01/2017	-0.0067
10/01/2017	0.0042
11/01/2017	0.0045
12/01/2017	0.0009
13/01/2017	0.0049
.	.
.	.
.	.
28/02/2019	0.0156
1/03/2019	-0.0002
4/03/2019	-0.0030
5/03/2019	0.0001
6/03/2019	-0.0117
7/03/2019	0.0065
8/03/2019	0.0081
11/03/2019	-0.0041
12/03/2019	-0.0033
13/03/2019	-0.0036
Desv Est	0.0103

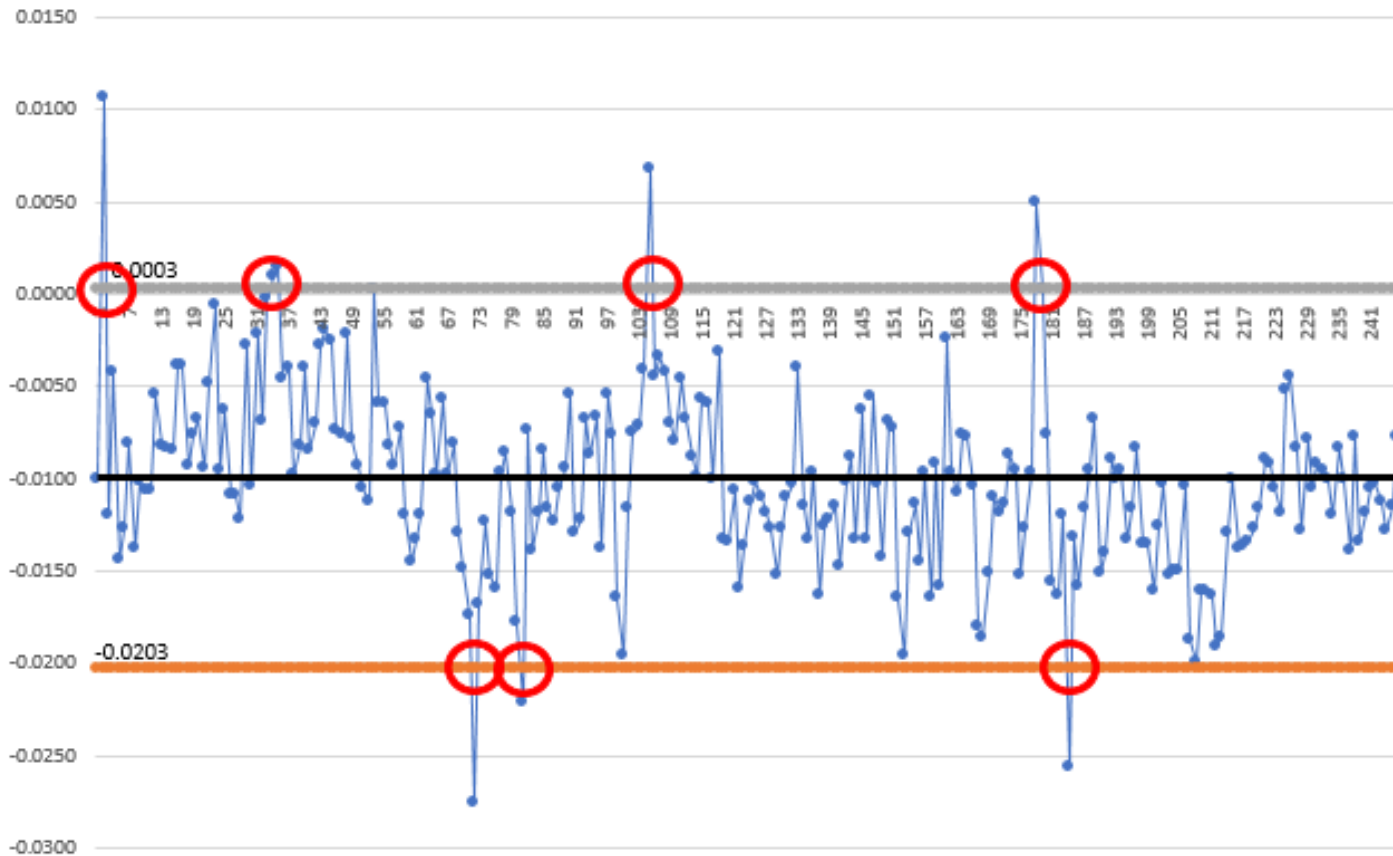


PISO
-0.0103

TECHO
0.0103



VARIACION ERROR



PISO

-0.0203

TECHO

0.0003

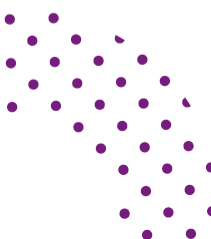


	A	B	C	D	E	K	L	M	N	O	P	Q	R
4		FECHA	COP	EU	ERROR	PUNTOS DE CORTE	OPERACIÓN	VALOR VENTA	VALOR COMISION	TOTAL OPERACIÓN	VALOR COMPRA	VALOR COMISION	TOTAL OPERACIÓN
5		14/03/2019	\$ 1,205	\$ 1,199	-0.0101	N	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
6		15/03/2019	\$ 1,145	\$ 1,195	0.0107	T	VEU CCOP	\$ 11,947,647	\$ 59,738	\$ 11,887,908	\$ 11,450,000	\$ 114,500	\$ 11,564,500
38		30/04/2019	\$ 1,245	\$ 1,271	0.0009	T	VEU CCOP	\$ 12,705,572	\$ 63,528	\$ 12,642,044	\$ 12,450,000	\$ 124,500	\$ 12,574,500
39		1/05/2019	\$ 1,245	\$ 1,272	0.0015	T	VEU CCOP	\$ 12,722,839	\$ 63,614	\$ 12,659,225	\$ 12,450,000	\$ 124,500	\$ 12,574,500
76		21/06/2019	\$ 1,280	\$ 1,223	-0.0276	P	VCOP CEU	\$ 12,800,000	\$ 64,000	\$ 12,736,000	\$ 12,233,970	\$ 122,340	\$ 12,356,310
85		4/07/2019	\$ 1,305	\$ 1,263	-0.0222	P	VCOP CEU	\$ 13,050,000	\$ 65,250	\$ 12,984,750	\$ 12,630,154	\$ 126,302	\$ 12,756,456
109		7/08/2019	\$ 1,220	\$ 1,262	0.0068	T	VEU CCOP	\$ 12,618,179	\$ 63,091	\$ 12,555,089	\$ 12,200,000	\$ 122,000	\$ 12,322,000
182		18/11/2019	\$ 1,385	\$ 1,427	0.0050	T	VEU CCOP	\$ 14,269,992	\$ 71,350	\$ 14,198,642	\$ 13,850,000	\$ 138,500	\$ 13,988,500
188		26/11/2019	\$ 1,405	\$ 1,349	-0.0257	P	VCOP CEU	\$ 14,050,000	\$ 70,250	\$ 13,979,750	\$ 13,490,139	\$ 134,901	\$ 13,625,041





	A	B	C	D	E	K	L	U	V	W	X	Y	Z	AA	AB	
4		FECHA	COP	EU	ERROR	PUNTOS DE CORTE	OPERACIÓN	SEÑAL DE CIERRE	CIERRE OPERACIÓN	VALOR COMPRA	VALOR COMISION	TOTAL OPERACIÓN	VALOR VENTA	VALOR COMISION	TOTAL OPERACIÓN	
5		14/03/2019	\$ 1,205	\$ 1,199	-0.0101	N		0								
6		15/03/2019	\$ 1,145	\$ 1,195	0.0107	T	VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
7		18/03/2019	\$ 1,220	\$ 1,208	-0.0120	N		0	CERRAR OPERACION	CEU VCOP	\$ 12,084,852	\$ 60,424	\$ 12,145,276	\$ 12,200,000	\$ 61,000	\$ 12,139,000
38		30/04/2019	\$ 1,245	\$ 1,271	0.0009	T	VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
39		1/05/2019	\$ 1,245	\$ 1,272	0.0015	T	VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
55		23/05/2019	\$ 1,180	\$ 1,173	-0.0105	N		0	CERRAR OPERACION	CEU VCOP	\$ 23,455,673	\$ 117,278	\$ 23,572,952	\$ 23,600,000	\$ 118,000	\$ 23,482,000
76		21/06/2019	\$ 1,280	\$ 1,223	-0.0276	P	VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
77		24/06/2019	\$ 1,280	\$ 1,254	-0.0168	N		0	CERRAR OPERACION	CCOP VEU	\$ 12,800,000	\$ 64,000	\$ 12,864,000	\$ 12,541,703	\$ 62,709	\$ 12,478,994
85		4/07/2019	\$ 1,305	\$ 1,263	-0.0222	P	VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
87		8/07/2019	\$ 1,310	\$ 1,292	-0.0139	N		0	CERRAR OPERACION	CCOP VEU	\$ 13,100,000	\$ 65,500	\$ 13,165,500	\$ 12,922,117	\$ 64,611	\$ 12,857,506
109		7/08/2019	\$ 1,220	\$ 1,262	0.0068	T	VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
121		23/08/2019	\$ 1,230	\$ 1,224	-0.0101	N		0	CERRAR OPERACION	CEU VCOP	\$ 12,238,298	\$ 61,191	\$ 12,299,489	\$ 12,300,000	\$ 61,500	\$ 12,238,500
182		18/11/2019	\$ 1,385	\$ 1,427	0.0050	T	VEU CCOP		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
185		21/11/2019	\$ 1,385	\$ 1,361	-0.0156	N		0	CERRAR OPERACION	CEU VCOP	\$ 13,611,600	\$ 68,058	\$ 13,679,658	\$ 13,850,000	\$ 69,250	\$ 13,780,750
188		26/11/2019	\$ 1,405	\$ 1,349	-0.0257	P	VCOP CEU		0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
189		27/11/2019	\$ 1,385	\$ 1,369	-0.0132	N		0	CERRAR OPERACION	CCOP VEU	\$ 13,850,000	\$ 69,250	\$ 13,919,250	\$ 13,685,451	\$ 68,427	\$ 13,617,024



VENTA - COMPRA

$$(V-C)+(C+V)=$$$



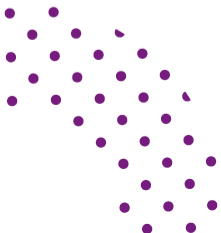
FECHA	PUNTOS DE CORTE	OPERACIÓN	TOTAL OPERACIÓN	TOTAL OPERACIÓN	CIERRE OPERACIÓN	TOTAL OPERACIÓN	TOTAL OPERACIÓN	V - C	C - V	RESULTADO ESTRATEGIA ABITRAJE
14/03/2019	N	0	\$ -	\$ -						
15/03/2019	T	VEU CCOP	\$ 11,887,908	\$ 11,564,500	0	\$ -	\$ -			
18/03/2019	N	0	\$ -	\$ -	CEU VCOP	\$ 12,145,276	\$ 12,139,000	-\$ 257,368	\$ 574,500	\$ 317,132
30/04/2019	T	VEU CCOP	\$ 12,642,044	\$ 12,574,500	0	\$ -	\$ -			
1/05/2019	T	VEU CCOP	\$ 12,659,225	\$ 12,574,500	0	\$ -	\$ -			
23/05/2019	N	0	\$ -	\$ -	CEU VCOP	\$ 23,572,952	\$ 23,482,000	\$ 1,728,317	-\$ 1,667,000	\$ 61,317
21/06/2019	P	VCOP CEU	\$ 12,736,000	\$ 12,356,310	0	\$ -	\$ -			
4/07/2019	P	VCOP CEU	\$ 12,984,750	\$ 12,756,456	0	\$ -	\$ -			
5/07/2019	N	0	\$ -	\$ -	0	\$ -	\$ -			
8/07/2019	N	0	\$ -	\$ -	CCOP VEU	\$ 13,165,500	\$ 12,857,506	-\$ 180,750	\$ 101,051	-\$ 79,699
7/08/2019	T	VEU CCOP	\$ 12,555,089	\$ 12,322,000	0	\$ -	\$ -			
23/08/2019	N	0	\$ -	\$ -	CEU VCOP	\$ 12,293,489	\$ 12,238,500	\$ 255,600	-\$ 83,500	\$ 172,100
18/11/2019	T	VEU CCOP	\$ 14,198,642	\$ 13,988,500	0	\$ -	\$ -			
19/11/2019	N	0	\$ -	\$ -	0	\$ -	\$ -			
20/11/2019	N	0	\$ -	\$ -	0	\$ -	\$ -			
21/11/2019	N	0	\$ -	\$ -	0	\$ -	\$ -			
21/11/2019	N	0	\$ -	\$ -	CEU VCOP	\$ 13,679,658	\$ 13,780,750	\$ 518,984	-\$ 207,750	\$ 311,234
26/11/2019	P	VCOP CEU	\$ 13,379,750	\$ 13,625,041	0	\$ -	\$ -			
27/11/2019	N	0	\$ -	\$ -	CCOP VEU	\$ 13,319,250	\$ 13,617,024	\$ 60,500	-\$ 8,017	\$ 52,483



COMPRA + VENTA



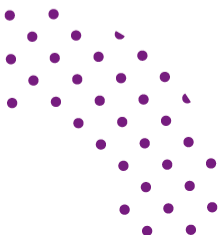
DETERMINACIÓN DE LA EFECTIVIDAD DEL MODELO EN ECOPETROL



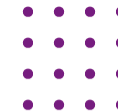
RESUMEN DE LA APLICACIÓN DE LA ESTRATEGIA DE ARBITRAJE



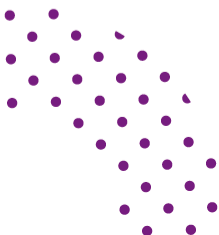
	COINTEGRACION				ARBITRAJE				
	series de precios con comportamiento similar	Raíz unitaria ADR (EU)	Raíz unitaria Acción (COP)	Raíz unitaria ERROR	Procede a aplicación estrategia	Cruce de límites	No. ciclos arbitraje	Resultados positivos	Resultados Negativos
ECOPETROL	SI	SI	SI	SI	SI	SI	8	5 = 62.5%	3 = 37.5%
AVIANCA	NO	SI	SI	NO	NO	N/A	N/A	N/A	N/A
BANCOLOMBIA	SI	SI	SI	SI	SI	NO	0	0	0
AVAL	SI	SI	SI	SI	SI	SI	7	5 = 71%	2 = 29%



COMPARATIVO DE EFECTIVIDAD DE LA ESTRATEGIA DE ARBITRAJE FRENTE A OTROS ACTIVOS LIBRES DE RIESGO



	ESTRATEGIA ARBITRAJE		ACTIVOS LIBRES DE RIESGO	
	ECOPETROL	AVAL	Bono TFIT15240720	CDT 360
Periodo	1 año	1 año	1 año	1 año
Inverison	\$ 100.000.000	\$ 100.000.000	\$ 100.000.000	\$ 100.000.000
Tasa libre de riesgo EA	-	-	4,53%	5,46%
Tasa oportunidad EA	4,34%	0,82%	-	-
utilidades	\$ 4.338.500	\$ 829.251	\$ 4.530.000	\$ 5.460.000

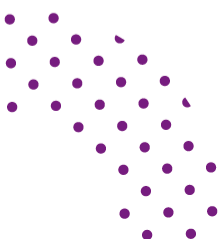


CONCLUSIONES



Al recolectar la información mediante la plataforma Bloomberg, se evidenció que las acciones y sus ADRs tuvieron los mismos días de cotización, lo cual facilitó los procesos de análisis y posterior aplicación de la estrategia.

Para la correlación de los datos, se usó el concepto de cointegración el cual permitió corroborar que si existen una dependencia entre la acción y el ADR, por lo que el comportamiento de una influenciaba la otra. Adicional en los resultados obtenidos en los test de raíces unitarias en que en su nivel que fueron inferiores al 90%, no fueron aptos para la aplicación de la estrategia debido a que la poca probabilidad de cointegración pudo afectar el comportamiento de las series de datos. Así mismo, en el caso de Avianca Holdings, se observó desde un principio la acción y el ADR no estaban cointegrados por lo cual la ampliación de la estrategia de arbitraje hubiese sido ineficaz.

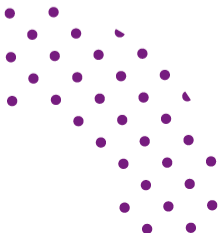




Se logró diseñar una estrategia de arbitraje que permitiera aprovechar los comportamientos atípicos de las series de precios cointegradas.

De las 4 empresas que poseen ADRs, solo en Ecopetrol y Aval se pudo aplicar la estrategia de arbitraje debido a que las series de precios presentaron la suficiente variación o volatilidad en la línea de tendencia para superar los puntos extremos, el cual fue el caso contrario de Bancolombia la cual cumplió todas las condiciones, pero su variación no superó los límites extremos.

Al momento de comparar los resultados de la estrategia frente a otros activos libres de riesgo (CDT360, Bono), en un periodo de tiempo determinado, se evidencia que la acción de Ecopetrol en cierta medida tuvo una rentabilidad igual al de los activos de riesgo, caso contrario con Aval la cual presentó una rentabilidad bastante baja, esto debido a posiblemente a la baja variación o volatilidad de los precios.





INFOGRAFÍA

Acevedo, N., Fleisman, D., Montoya, A., & Mora, A. M. (10 de 03 de 2011). *scielo.org.co*. Obtenido de <http://www.scielo.org.co/pdf/ecos/v15n33/v15n33a1.pdf>

Antequera, W. (10 de 10 de 2016). *Rankia*. Obtenido de <https://www.rankia.co/blog/bolsa-desde-cero/3349076-historia-origenes-bolsa>

Arce Panqueva, H. E., & Archila Rodriguez, A. C. (2014). *Universidad Industrial de Santander*. Obtenido de <http://tangara.uis.edu.co/biblioweb/tesis/2014/153853.pdf>

BVC. (2009). *Bolsa de Valores de Colombia*. Obtenido de [https://www.bvc.com.co/recursos/Files/Acerca de la BVC/Ochenta Anos Mercado de Valores.pdf](https://www.bvc.com.co/recursos/Files/Acerca%20de%20la%20BVC/Ochenta%20Años%20Mercado%20de%20Valores.pdf)

Hong, G., & Susmel, R. (06 de 2013). *universidad de Pensilvania*. Obtenido de <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.642.1799&rep=rep1&type=pdf>

Monterrosa, H. (03 de 02 de 2020). *La Republica*. Obtenido de <https://www.larepublica.co/finanzas/estas-son-las-tarifas-que-cobran-las-comisionistas-de-bolsa-por-transar-acciones-2959659>

Pérez, A. B. (01 de 01 de 2010). *Enciclopedia Financiera*. Obtenido de <https://www.encyclopediainanciera.com/mercados-financieros/acciones/historia-del-mercados-de-acciones.htm>

Stevens, R. (05 de 04 de 2017). *Rankia*. Obtenido de <https://www.rankia.co/blog/analisis-colcap/3527011-bolsa-valores-colombia-definicion-historia-cursos>





Universidad
Autónoma de
Bucaramanga

 @unab.online •  @unab_online •  @unab_online

