Bank Loans and Monetary Aggregates: Seasonal Adjustment for Colombia

September 6, 2021*

1 Introduction

This document makes an analysis of seasonal patterns for Currency (C), Monetary Base (MB), M1, Deposits held by the public, M3, Consumer and Corporate loans, and Gross adjusted loans [1]. Monetary aggregates sample starts in January 1984 while loan series start in May 2002.

In order to make the seasonal analysis and adjustment, TRAMO-SEATS and X13-ARIMA-SEATS procedures were proved, using a specialized statistical software named JDemetra+. [2]

TRAMO-SEATS is a model-based procedure, developed by Gómez and Maravall (1998), that consists of two programs: *Time series Regression with ARIMA noise, Missing observations and Outliers (TRAMO)* and *Signal Extraction in ARIMA Time Series (SEATS)*. The first one performs estimation, forecasting and interpolation of regression models with missing observations and ARIMA errors and takes into account the presence of outliers. SEATS performs an ARIMA-based decomposition into unobserved components [3].

On the other hand, X13-ARIMA-SEATS is a seasonal adjustment program developed by the U.S. Census Bureau that takes into account two modules, an enhanced X11 and an ARIMA model-based procedure (SEATS) [4].

Colombian calendar is introduced in JDemetra+ to look for calendar effects such as

*From the statistics with a cut-off to August 2020, certificates of deposits (CDTs) and bonds held by the Banco dela Republica were excluded, and the series was reprocessed from March 2020 to date. This change affects the M3 and the Deposits held by the public.

[1] Data adjusted by mortgage loans securitization and operating lease.

[2] JDemetra+ is an statistical software of seasonal adjustment, created by the *European Statistical System*(EUROSTAT). The Seasonal Adjustment Steering Group recommended it for analysis procedures and seasonal treatment on December, 2014.

[3] More information about methodology can be found in Caporello et al. (2001).

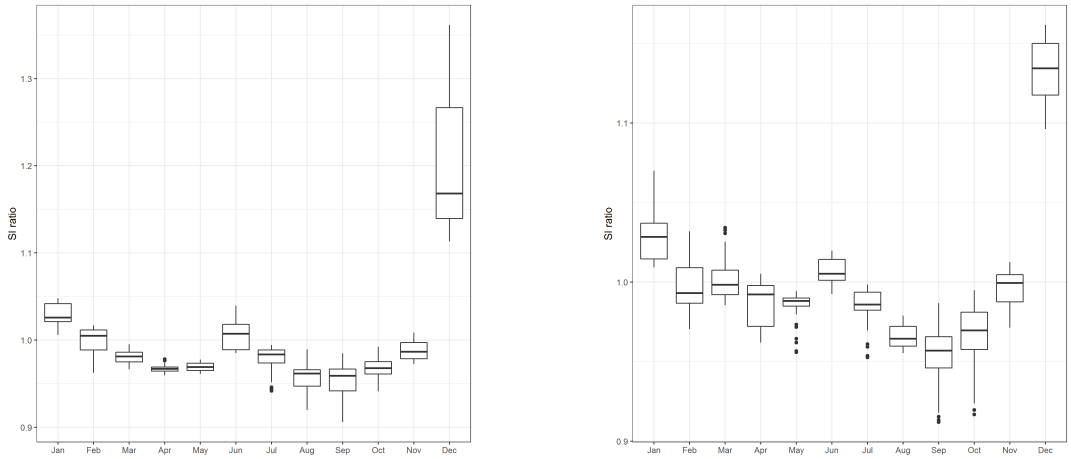
[4] More information about methodology can be found in https://www.census.gov/srd/www/x13as/

working or trading days, as well as Easter. Inclusion of these variables is tested during the seasonal adjustment process. Significant calendar and outliers variables are included in the final model.

A special procedure is implemented in the reestimation done on October 2020, in order to take into account the effects of the Covid-19 shock. Additionally, the X13-ARIMA-SEATS procedure was better in terms of quality than the TRAMO-SEATS approch in this opportunity.

2 Seasonal patterns

Seasonal pattern analysis of each series starts by computing the Seasonal-Irregular ratio (SI ratio thereafter), calculated as the original series divided by the trend-cycle component. After SI-ratio is computed, a time series of each month by years is built in order to analyze the seasonality of each month through time. Figures 2.1 to 2.4 show SI-ratio by month for each variable.



(a) Currency (b) Monetary Base

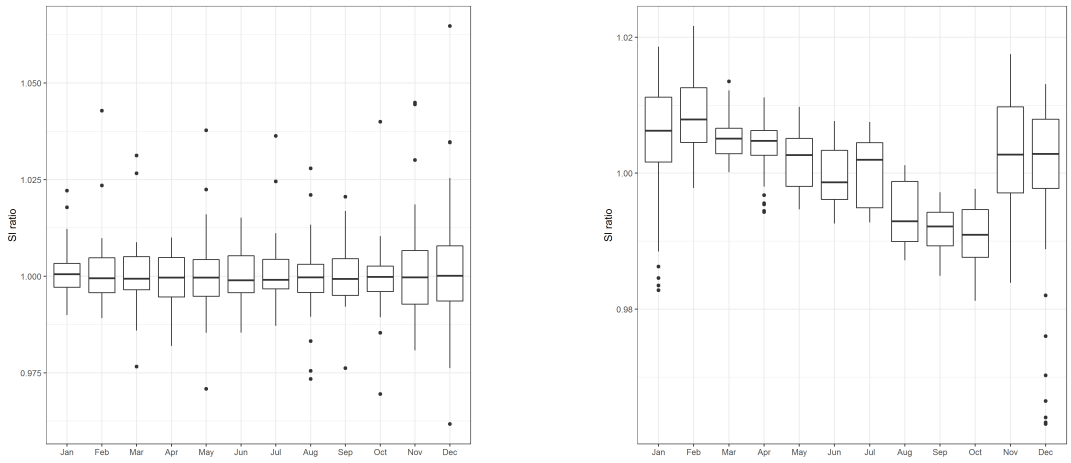
Figure 2.1: SI-Ratio by month

All variables exhibit a seasonal pattern at the end of the year. However, currency, monetary base and M1 show the strongest seasonal pattern in December.

2.1 Seasonality tests

Seasonal tests are used to explore the significance of the seasonal adjustment[5]. It is done for each series in the original form as well as the seasonal adjusted form. The tests used here include seasonal dummies, autocorrelation function analysis at seasonal frequency, no-parametric tests and spectral analysis. In all observed variables the presence of

[5]Seasonal tests are based on EUROSTAT instructions offered in its conceptual framework webpage. You can find it in https://ec.europa.eu/eurostat/sa-elearning/introduction-2.



(a) M1

(b) Deposits held by the public

Figure 2.2: SI-Ratio by month

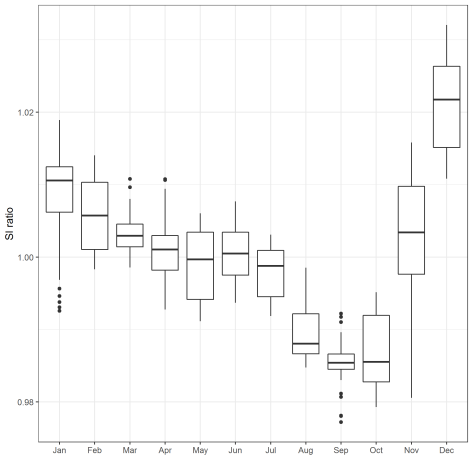
seasonality is identified. Bank consumer loans reject three of the seven original tests of presence of seasonality, but the combined seasonality test identifies seasonality. Tests were also performed for the seasonal adjusted series and they conclude no presence of seasonality. This confirms that the seasonal adjustment procedure was successfully performed.

2.1.1 Residual seasonality test

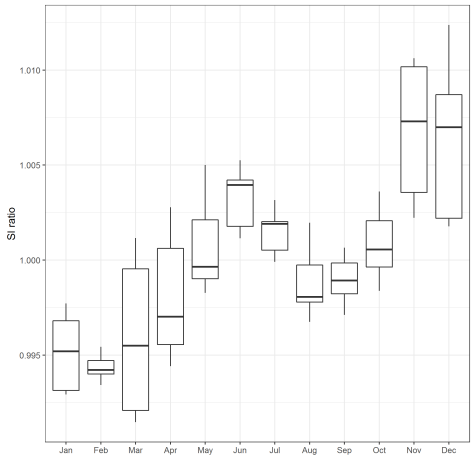
In addition to previous tests, an F-test was computed looking for Residual Seasonality (RS) for all variables, taking the whole sample and the last three years. There was no evidence of residual seasonality in any case.

2.2 Quality measures

Quality measures of the seasonal adjustment procedure are called the M-statistics, and are summarized by the Q-statistic. All statistics are in the range 0-3. It is acceptable when their value is less than 1. Table 1 shows the quality measures for each variable. For all variables, seasonal adjustment process presets good quality measures.

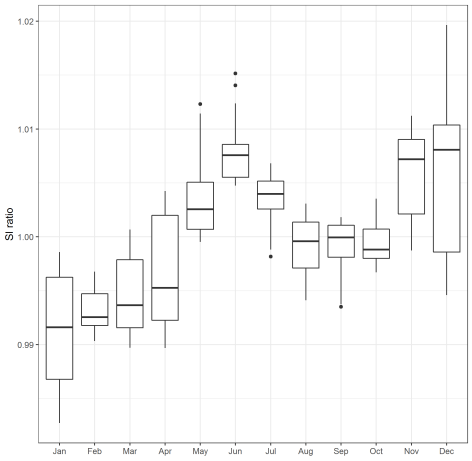


(a) M3

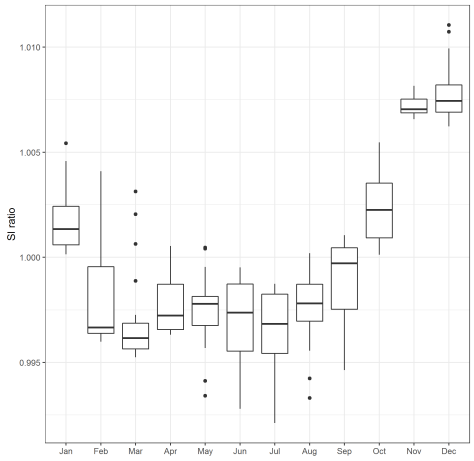


(b) Gross Adjusted Bank Loans

Figure 2.3: SI-Ratio by month



(a) Bank Corporate loans



(b) Bank Consumer Loans

Figure 2.4: SI-Ratio by month

	Currency	Monetary base	M1	Deposits	M3	Loans	Corporate	Consumer
M1	0.112	0.309	0.114	0.089	0.069	0.024	0.103	0.008
M2	0.006	0.012	0.005	0.001	0.001	0.001	0.008	0.000
M3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M4	0.146	0.117	0.410	0.512	0.161	0.622	0.995	0.435
M5	0.064	0.208	0.026	0.000	0.000	0.000	0.000	0.000
M6	0.129	0.142	0.221	0.196	0.200	0.341	0.174	0.602
M7	0.146	0.260	0.140	0.543	0.346	0.496	0.937	0.512
M8	0.398	0.619	0.408	1.246	0.848	0.990	1.242	0.720
M9	0.143	0.199	0.126	0.293	0.227	0.448	0.821	0.508
M10	0.205	0.353	0.245	1.020	0.591	1.734	1.831	1.035
M11	0.161	0.276	0.229	0.948	0.514	1.690	1.810	0.985
Q	0.122	0.208	0.151	0.354	0.222	0.413	0.354	0.355
Q-2	0.137	0.232	0.169	0.398	0.249	0.464	0.398	0.399

Table 1: Quality measure statistics

2.3 Treatment of Covid-19-crisis effects on data

The COVID-19 outbreak has had severe impact on economic time series. In order to treat these changes, the European Statistical Office (EUROSTAT) published a methodological note about it [6]. This note advices to treat the Covid-19 shock as an outlier, taking into account that the type of outlier should depends on the evolution of the time series. We test for the presence of outliers, distinguishing between four types, additive outlier (AO), level shift (LS), temporal change (TC) or seasonal outlier (SO). The methodological note suggests that the COVID-19 shock could be all but the later. Using the anomaly and outlier detection function of the software JDemetra+, we checked for these types of outliers in all the eight series. The results are presented in Figures 2.5 and 2.5. The outlieres identified in 2020 are incorporated as exogenous variables for the model estimation. Remaining outliers could be included automatically during the seasonal adjustment process. Using this approach gives us a significant quality improvement in comparison to not adjustment at all.

[6]EUROSTAT (2020). Methodological note: Guidance on Treatment of Covid-19-crisis Effects on Data.

	Period	Value	StdErr	TStat
TC	11-2011	1268,5920	230,3687	5,5068
TC	4-2013	-1188,1247	237,1625	-5,0097
TC	9-2015	2217,5584	237,1788	9,3497
AO	6-2016	990,3528	199,8444	4,9556
LS	12-2016	-1584,6751	256,8347	-6,1700
TC	2-2017	-1692,3029	228,6118	-7,4025
LS	10-2017	-1144,6571	255,6677	-4,4771
TC	11-2018	-1855,8664	232,2464	-7,9909
LS	3-2020	3387,0074	361,0125	9,3820
LS	4-2020	5310,0558	365,9335	14,5110
LS	5-2020	2023,4635	363,9940	5,5591
AO	9-2020	1754,7855	380,8259	4,6078

(a) Efectivo

	Period	Value	StdErr	TStat
TC	11-2005	1403,1037	322,3043	4,3534
TC	7-2007	-1652,9802	340,0893	-4,8604
TC	9-2007	2026,7144	340,1670	5,9580
AO	11-2011	1415,1142	329,0392	4,3007
LS	1-2012	-1739,9296	393,0205	-4,4271
AO	5-2012	1586,0594	295,7564	5,3627
LS	1-2014	1881,8047	364,8641	5,1575
LS	6-2014	-1499,9884	352,5833	-4,2543
AO	1-2015	2185,6528	308,0182	7,0959
LS	5-2016	-3070,7556	356,8685	-8,6047
AO	2-2017	2197,6037	296,7554	7,4054
LS	12-2017	2391,6145	394,9789	6,0550
LS	5-2018	-1818,1711	368,0035	-4,9406
LS	12-2018	2746,0161	409,7057	6,7024
AO	4-2019	2194,3587	341,6563	6,4227
LS	3-2020	17350,5201	522,5761	33,2019
LS	4-2020	4262,1623	558,4592	7,6320
TC	7-2020	-2758,9045	559,3505	-4,9323

(b) M1

	Period	Value	StdErr	TStat
AO	8-2006	2459,9613	468,9450	5,2457
TC	9-2008	2719,3831	500,1806	5,4368
AO	2-2011	1870,5641	468,6036	3,9918
TC	8-2012	-2358,9269	500,7743	-4,7106
AO	10-2012	2020,7603	485,1361	4,1653
AO	12-2012	2746,6799	493,5784	5,5648
LS	10-2013	2854,3506	442,3597	6,4526
AO	12-2013	-2160,0009	483,3592	-4,4687
TC	4-2015	2237,5214	519,7252	4,3052
LS	9-2015	4938,2182	465,0340	10,6190
AO	10-2015	4220,9950	482,4885	8,7484
LS	6-2016	-5034,3102	441,3501	-11,4066
AO	11-2016	-1832,6302	485,8896	-3,7717
LS	1-2017	-5082,6275	462,0322	-11,0006
AO	3-2017	4429,5432	489,6222	9,0469
LS	2-2018	-2765,7870	469,7054	-5,8883
AO	3-2018	3430,8362	506,1352	6,7785
AO	8-2018	2022,8866	477,7692	4,2340
AO	12-2018	5122,4852	546,1521	9,3792
TC	5-2019	3094,3524	557,7158	5,5483
LS	10-2019	4591,5677	529,2929	8,6749
AO	12-2019	3291,6084	597,6997	5,5071
LS	3-2020	5197,6129	542,1573	9,5869
AO	4-2020	8006,6784	564,1377	14,1928

(c) Base monetaria

	Period	Value	StdErr	TStat
LS	3-2007	6538,7841	1204,7647	5,4274
AO	12-2012	4943,2235	1065,1260	4,6410
TC	12-2017	7043,4980	1193,6386	5,9009
AO	12-2018	6834,1018	1128,8991	6,0538
LS	3-2020	22227,8930	1517,9267	14,6436
TC	4-2020	8042,9660	1432,6108	5,6142

(d) Total deposits held by the public

	Period	Value	StdErr	TStat
LS	3-2007	7730,3438	1023,8358	7,5504
AO	8-2007	-4899,8301	866,6463	-5,6538
AO	4-2008	3434,3683	869,3688	3,9504
AO	7-2012	-4747,3888	866,1772	-5,4809
TC	2-2014	3750,3151	944,2151	3,9719
AO	10-2015	4210,4439	866,6842	4,8581
AO	12-2017	6607,7935	936,9836	7,0522
LS	4-2018	-5775,3294	1067,0848	-5,4122
AO	12-2018	7853,9202	961,2528	8,1705
LS	9-2019	5153,5105	1087,5873	4,7385
LS	3-2020	24550,9440	1276,7807	19,2288
LS	4-2020	11431,7212	1403,0613	8,1477
TC	5-2020	4689,2709	1206,2008	3,8876

(e) M3

Figure 2.5: Outlier identification: Monetary aggregates

	Period	Value	StdErr	TStat
LS	10-2016	-4221,1119	921,0950	-4,5827
AO	4-2019	-2469,5164	636,1837	-3,8818
TC	12-2019	-4403,7712	881,7659	-4,9943
LS	3-2020	5183,8545	1011,3490	5,1257
TC	4-2020	3805,3934	918,9144	4,1412

(a) Adjusted Gross Loans

	Period	Value	StdErr	TStat
LS	8-2015	3967,8737	874,0558	4,5396
TC	12-2019	-4061,7360	842,4751	-4,8212
LS	3-2020	5457,1127	992,9820	5,4957
TC	4-2020	5752,8744	878,5695	6,5480

(b) Corporate loans

	Period	Value	StdErr	TStat
TC	10-2007	808,4549	168,7233	4,7916
AO	11-2015	-672,7767	129,9862	-5,1758
LS	5-2019	1552,3489	214,8728	7,2245
LS	10-2019	1025,0896	213,1826	4,8085
TC	2-2020	1142,4200	203,8662	5,6038
LS	4-2020	-3395,0307	254,0417	-13,3641
LS	5-2020	-2441,3413	255,8000	-9,5439
LS	6-2020	-1085,0232	242,1908	-4,4800
LS	7-2020	-1636,6662	237,1383	-6,9017
TC	8-2020	-1132,8328	216,9661	-5,2212

(c) Consumer loans

Figure 2.6: Outlier identification: Loans

References

Caporello, G., Maravall, A., and Sánchez, F. J. (2001). Program TSW Reference Manual.

Gómez, V. and Maravall, A. (1998). Seasonal Adjustment and Signal Extraction in Economic Time Series.

Appendix A Level and Growth figures

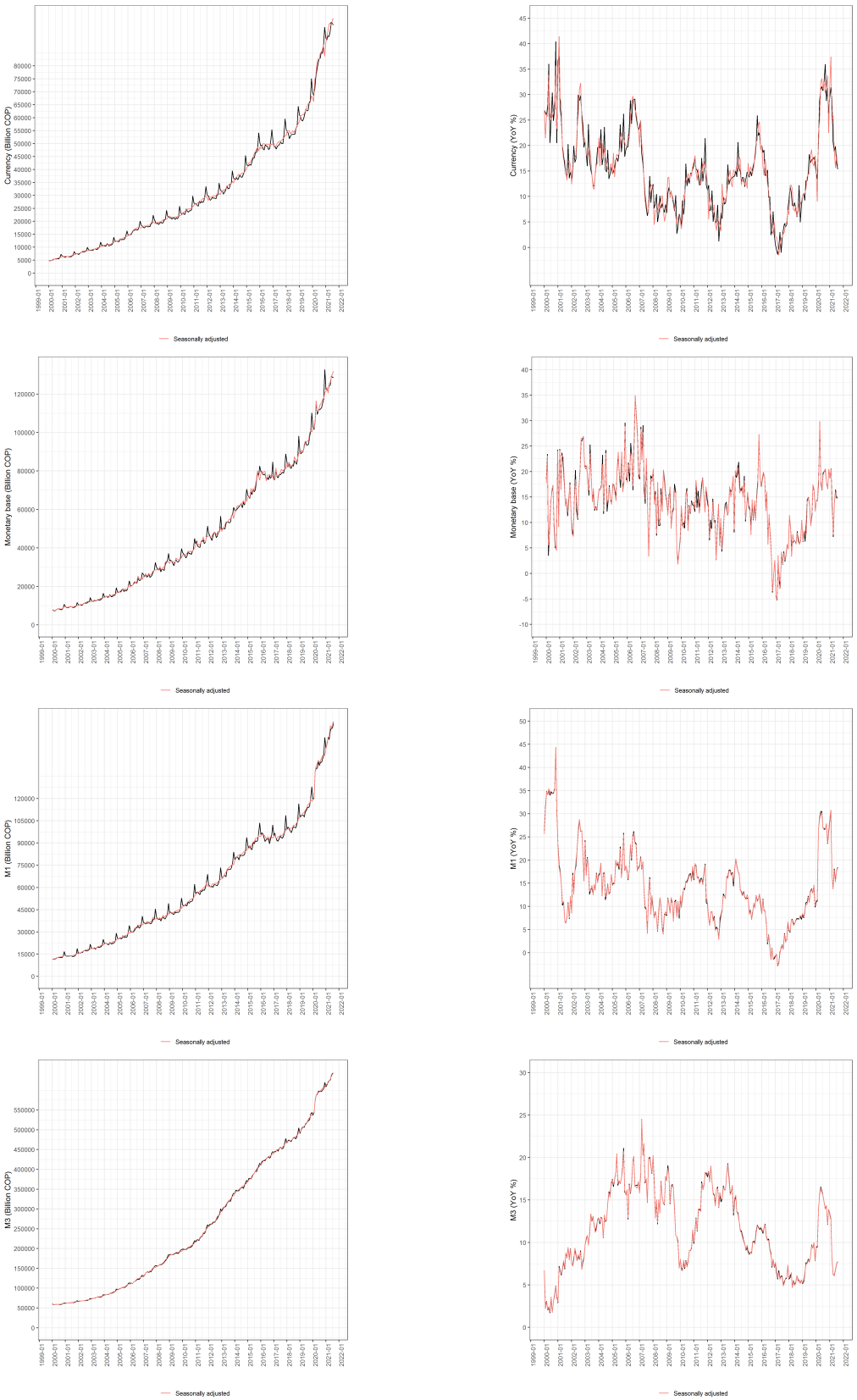


Figure A.1: Original and Seasonal Adjusted series

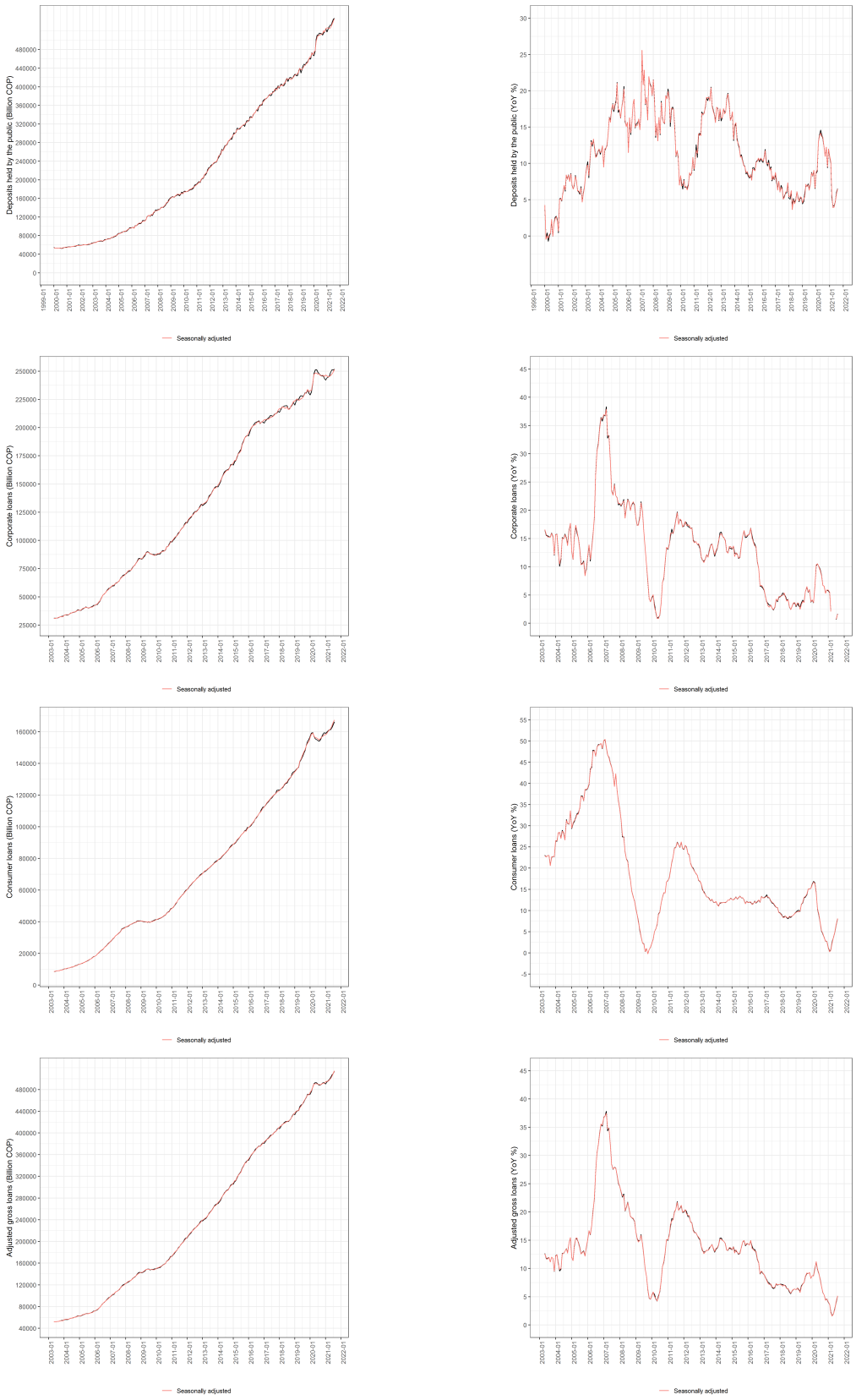


Figure A.2: Original and Seasonal Adjusted series

Appendix B Parameters

Following figures present obtained parameters and model specification for each seasonal adjusted variable analyzed in this document. These parameters should not be used in the seasonal adjustment processes for variables not included here. This fact is because the parameters and specification is unique for each variable and span period analyzed. According with a partial concurrent adjustment, we only reestimate parameters every October. Each month we retest looking for new outliers.

Variable:		**Currency**	
Estimation summary			
Estimation span:		$[1984M1 - 2021M8]$	
Number of Observations:		452	
Transformations:		Logarithm	
Corrections:		Leap year	
Working/trading days:		Trading day effects (6 variables)	
Outliers:		6 outliers detected	
Other:		Easter [15] detected	
Final model			
Likelihood statistics			
Effective observations:		440	
Number of Parameters:		17	
Loglikelihood:		-991.46	
AICC:		5494	
BIC:		-7.21	
ARIMA model			
Specification:		ARIMA(2,1,0)(0,1,1)	
	Coefficients	*T-Stat*	*P-value*
Phi(1)	0.2681	5.51	0.0000
Phi(2)	0.1966	4.03	0.0001
BTheta(1)	-0.8250	-27.82	0.0000
Regression model			
Mean:			
	Coefficients	*T-Stat*	*P-value*
mu	-0.0004	-2.69	0.0075
Trading days:			
	Coefficients	*T-Stat*	*P-value*
Monday	-0.0044	-2.96	0.0033
Tuesday	-0.0061	-3.44	0.0006
Wednesday	0.0193	10.71	0.0000
Thursday	-0.0029	-1.70	0.0898
Friday	-0.0004	-0.25	0.8022
Saturday	0.0001	0.04	0.9695
Easter	0.0243	4.52	0.0000
Outliers:			
	Coefficients	*T-Stat*	*P-value*
LS(2020M03)	0.0770	3.19	0.0015
LS(2020M04)	0.0392	1.57	0.1163
LS(2020M05)	0.0610	2.53	0.0119
AO(2020M09)	0.0131	0.54	0.5891
SO(1986M12)	0.1259	8.89	0.0000
SO(2000M12)	0.0899	8.70	0.0000
SO(1992M12)	0.0611	5.60	0.0000
SO(1985M02)	-0.0731	-4.05	0.0001
AO(1994M11)	0.0797	4.27	0.0000
AO(1995M11)	0.0781	4.19	0.0000

Table B.1: Parameters: Currency

Variable:			**M1**
Estimation summary			
Estimation span:			$[1984M1 - 2021M8]$
Number of Observations:			452
Transformations:			Logarithm
Corrections:			No
Working/trading days:			No
Outliers:			3 pre-specified / 5 outliers detected
Other:			No
Final model			
Likelihood statistics			
Effective observations:			439
Number of Parameters:			11
Loglikelihood:			1076.56
AICC:			6052
BIC:			7.72
ARIMA model			
Specification:			ARIMA(3,1,0)(0,1,1)
	Coefficients	*T-Stat*	*P-value*
Phi(1)	0.2619	5.37	0.0000
Phi(2)	0.0460	0.91	0.3634
Phi(3)	-0.1236	-2.53	0.0117
BTheta(1)	-0.8286	-27.74	0.0000
Regression model			
Mean:			
	Coefficients	*T-Stat*	*P-value*
mu	-0.0004	-2.74	0.0064
Outliers:			
	Coefficients	*T-Stat*	*P-value*
LS(2020M03)	0.1465	7.56	0.0000
LS(2020M04)	0.0309	1.58	0.1137
LS(2020M07)	-0.0190	-0.99	0.3204
LS(1999M12)	0.0992	5.45	0.0000
SO(1995M12)	-0.0585	-7.02	0.0000
LS(1992M4)	0.0816	4.54	0.0000
SO(2011M12)	0.0493	6.03	0.0000
SO(2002M12)	0.0352	4.18	0.0000

Table B.2: Parameters: M1

Variable:		**M3**	
Estimation summary			
Estimation span:		$[1984M1 - 2021M8]$	
Number of Observations:		452	
Transformations:		Logarithm	
Corrections:		No	
Working/trading days:		No	
Outliers:		3 pre-specified	
Other:		No	
Final model			
Likelihood statistics			
Effective observations:		439	
Number of Parameters:		6	
Loglikelihood:		1284	
AICC:		6809	
BICC:		-8.82	
ARIMA model			
Specification:		ARIMA(0,2,1)(0,1,1)	
	Coefficients	*T-Stat*	*P-value*
Theta(1)	-0.9191	-47.00	0.0000
BTheta(1)	-0.8225	-28.61	0.0000
Outliers:			
	Coefficients	*T-Stat*	*P-value*
LS(2020M03)	0.0476	4.08	0.0001
LS(2020M04)	0.0235	2.01	0.0448
TC(2020M05)	0.0052	0.49	0.6227

Table B.3: Parameters: M3

Variable:			**Monetary Base**
Estimation summary			
Estimation span:			$[1984M1 - 2021M8]$
Number of Observations:			452
Transformations:			Logarithm
Corrections:			No
Working/trading days:			No
Outliers:			2 pre-specified / 5 outliers detected
Other:			No Easter detected
Final model			
Likelihood statistics			
Effective observations:			441
Number of Parameters:			14
Loglikelihood:			860
AICC:			6228
BICC:			-6.74
ARIMA model			
Specification:			ARIMA(1,1,1)(0,1,1)
	Coefficients	*T-Stat*	*P-value*
Phi(1)	-0.2372	-1.88	0.0605
Theta(1)	-0.5504	-5.07	0.0000
BTheta(1)	-0.8309	-29.75	0.0000
Regression model			
Outliers:			
	Coefficients	*T-Stat*	*P-value*
LS(2020M03)	0.0450	1.48	0.1409
AO(2020M04)	0.0770	2.89	0.0041
AO(1999M12)	0.1367	5.41	0.0000
TC(1998M12)	-0.1259	-4.26	0.0000
LS(1998M10)	-0.1223	-4.19	0.0000
LS(1991M09)	0.3151	5.85	0.0000
TC(1991M09)	-0.2330	-4.29	0.0000

Table B.4: Parameters: Monetary Base

Variable:		**Deposits held by the public**	
Estimation summary			
Estimation span:		$[1984M1 - 2021M8]$	
Number of Observations:		432	
Transformations:		Logarithm	
Corrections:		No	
Working/trading days:		No	
Outliers:		2 pre-specified / 3 outliers detected	
Other:		No	
Final model			
Likelihood statistics			
Effective observations:		439	
Number of Parameters:		7	
Loglikelihood:		1258	
AICC:		6772	
BICC:		-8.65	
ARIMA model			
Specification:		ARIMA(0,2,2)(0,1,1)	
	Coefficients	*T-Stat*	*P-value*
Theta(1)	-1.1480	-24.29	0.0000
Theta(2)	0.2523	5.36	0.0000
BTheta(1)	-0.8069	-27.37	0.0000
Regression model			
Outliers:			
	Coefficients	*T-Stat*	*P-value*
LS(2020M03)	0.0504	4.05	0.0001
TC(2020M04)	0.0161	1.40	0.1623
TC(1991M07)	-0.0546	-5.14	0.0000
LS(2007M03)	0.0510	4.50	0.0000
SO(1990M12)	-0.0310	-5.80	0.0000

Table B.5: Parameters: Deposits in the Financial System

Variable:		**Bank Corporate Loans**	
Estimation summary			
Estimation span:		$[2002M5 - 2021M8]$	
Number of Observations:		232	
Transformations:		Logarithm	
Corrections:		No	
Working/trading days:		No	
Outliers:		No	
Other:		2 pre-specified / 2 outliers detected	
Final model			
Likelihood statistics			
Effective observations:		218	
Number of Parameters:		4	
Loglikelihood:		1728	
AICC:		3471	
BICC:		13.89	
ARIMA model			
Specification:		ARIMA(1,1,0)(0,1,1)	
	Coefficients	*T-Stat*	*P-value*
Phi(1)	-0.3549	-5.28	0.0000
BTheta(1)	-0.7303	-13.08	0.0000
Regression model			
Outliers:			
	Coefficients	*T-Stat*	*P-value*
LS(2020M03)	5516.5	5.76	0.0000
TC(2020M04)	5766.8	6.83	0.0000
AO(2019M11)	2897.2	5.11	0.0000
LS(2015M08)	3675.6	4.28	0.0000

Table B.6: Parameters: Bank Corporate Loans

Variable:		**Bank Consumer Loans**	
Estimation summary			
Estimation span:		$[2002M5 - 2021M8]$	
Number of Observations:		232	
Transformations:		Logarithm	
Corrections:		No	
Working/trading days:		Trading days (6 variables)	
Outliers:		6 pre-specified / 3 outliers detected	
Other:		No	
Final model			
Likelihood statistics			
Effective observations:		230	
Number of Parameters:		12	
Loglikelihood:		-1421	
AICC:		2889	
BICC:		11.37	
ARIMA model			
Specification:		ARIMA(0,2,1)(0,1,1)	
	Coefficients	*T-Stat*	*P-value*
Theta(1)	-0.4700	-7.13	0.0000
BTheta(1)	-0.7043	-11.81	0.0000
Regression model			
Trading days:			
	Coefficients	*T-Stat*	*P-value*
Monday	-57.11	-4.23	0.0000
Tuesday	-91.56	-5.71	0.0027
Wednesday	78.31	4.94	0.0005
Thursday	- 5.86	-0.38	0.7033
Friday	101.80	6.65	0.0000
Saturday	-26.29	-1.72	0.0878
Outliers:			
	Coefficients	*T-Stat*	*P-value*
TC(2020M02)	1073.87	5.30	0.0000
LS(2020M04)	-3384.26	-14.45	0.0000
LS(2020M05)	-2451.51	-9.86	0.0000
LS(2020M06)	-1285.06	-5.33	0.0000
LS(2020M07)	-1731.63	-7.22	0.0000
TC(2020M08)	- 923.92	-4.57	0.0000
LS(2019M05)	1803.89	8.67	0.0000
SO(2017M11)	- 565.62	-5.98	0.0000
LS(2019M10)	1149.96	5.53	0.0000
TC(2007M10)	877.91	5.24	0.0000
AO(2015M11)	- 621.35	-4.94	0.0000

Table B.7: Parameters: Consumer loans

Variable:			**Adjusted Gross Bank Loans**
Estimation summary			
Estimation span:			$[2002M5 - 2021M8]$
Number of Observations:			232
Transformations:			Logarithm
Corrections:			No
Working/trading days:			No
Outliers:			2 pre-specified / 3 outliers detected
Other:			No
Final model			
Likelihood statistics			
Effective observations:			219
Number of Parameters:			7
Loglikelihood:			-1741
AICC:			3498
BICC:			14.12
ARIMA model			
Specification:			ARIMA(0,2,1)(0,1,1)
	Coefficients	*T-Stat*	*P-value*
Theta(1)	-0.6563	-11.97	0.0000
BTheta(1)	-0.6963	-11.90	0.0000
Regression model			
Outliers:			
	Coefficients	*T-Stat*	*P-value*
LS(2020M03)	5467.13	5.48	0.0000
TC(2020M04)	6951.89	6.79	0.0000
TC(2019M12)	-4246.01	-4.85	0.0000
LS(2016M10)	-4246.35	-4.63	0.0000
SO(2019M04)	2431.97	4.20	0.0000

Table B.8: Parameters: Adjusted Gross Bank Loans