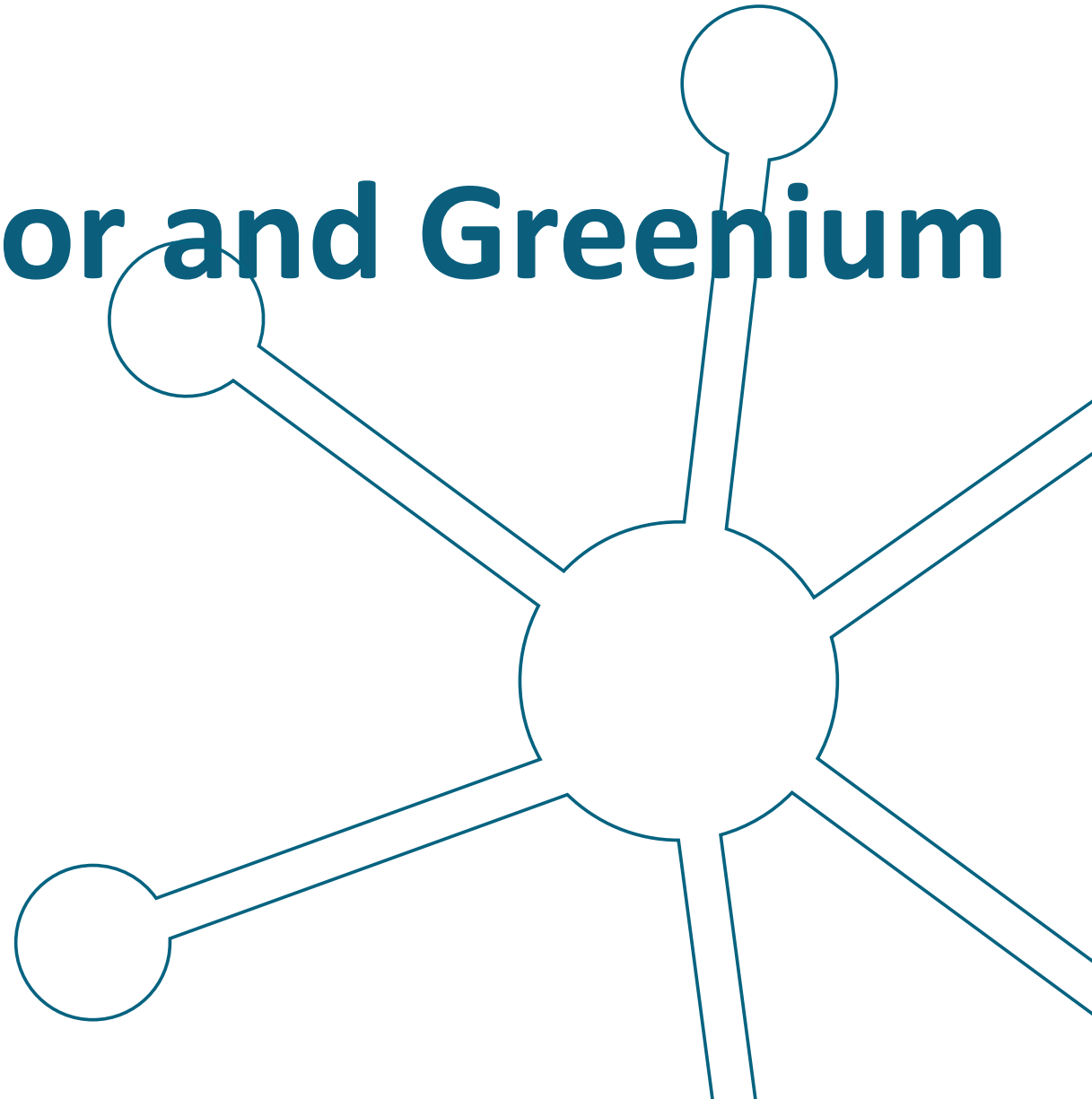


# Green Bond Behavior and Greenium During a shock

Erick Ramos Murillo

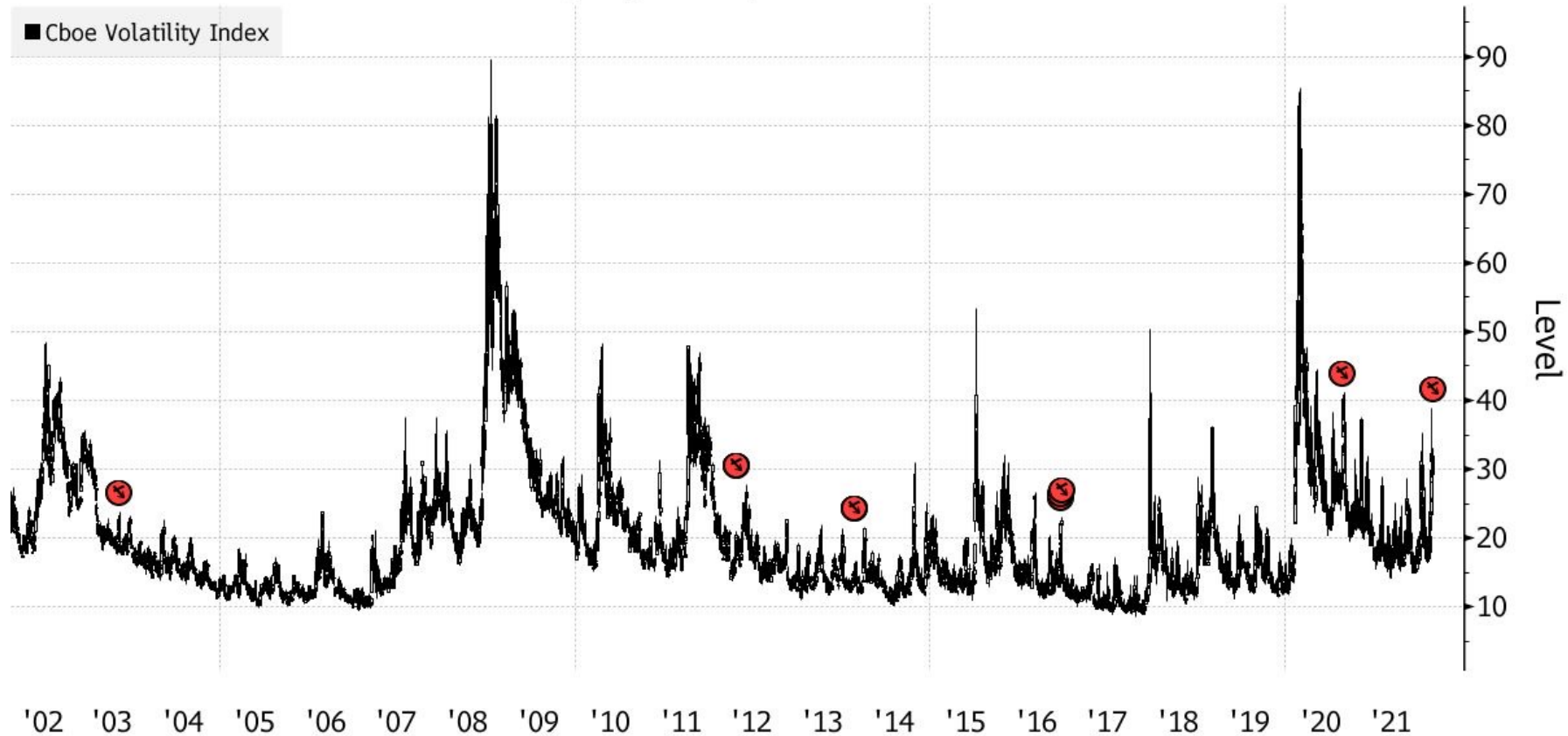
December 13, 2022



# COVID19 shock: decades' largest and surprising

## Upward Streak

VIX ends lower after seven-day upmove, its 10th in two decades

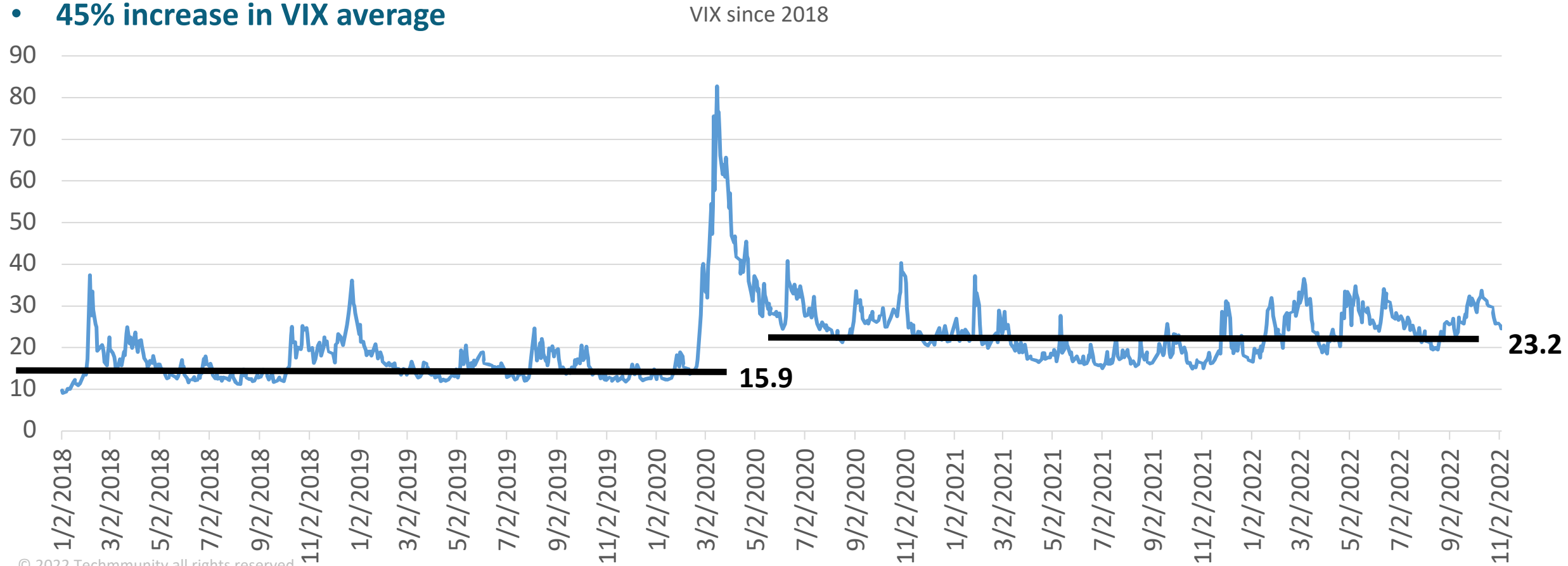


Source: Cboe, Bloomberg

Bloomberg

# Zooming in: long COVID in the markets?

- Average VIX from Jan '18 to Feb '20: 15.9
- Average VIX since Aug '20 to Nov '22: 23.2
- 45% increase in VIX average

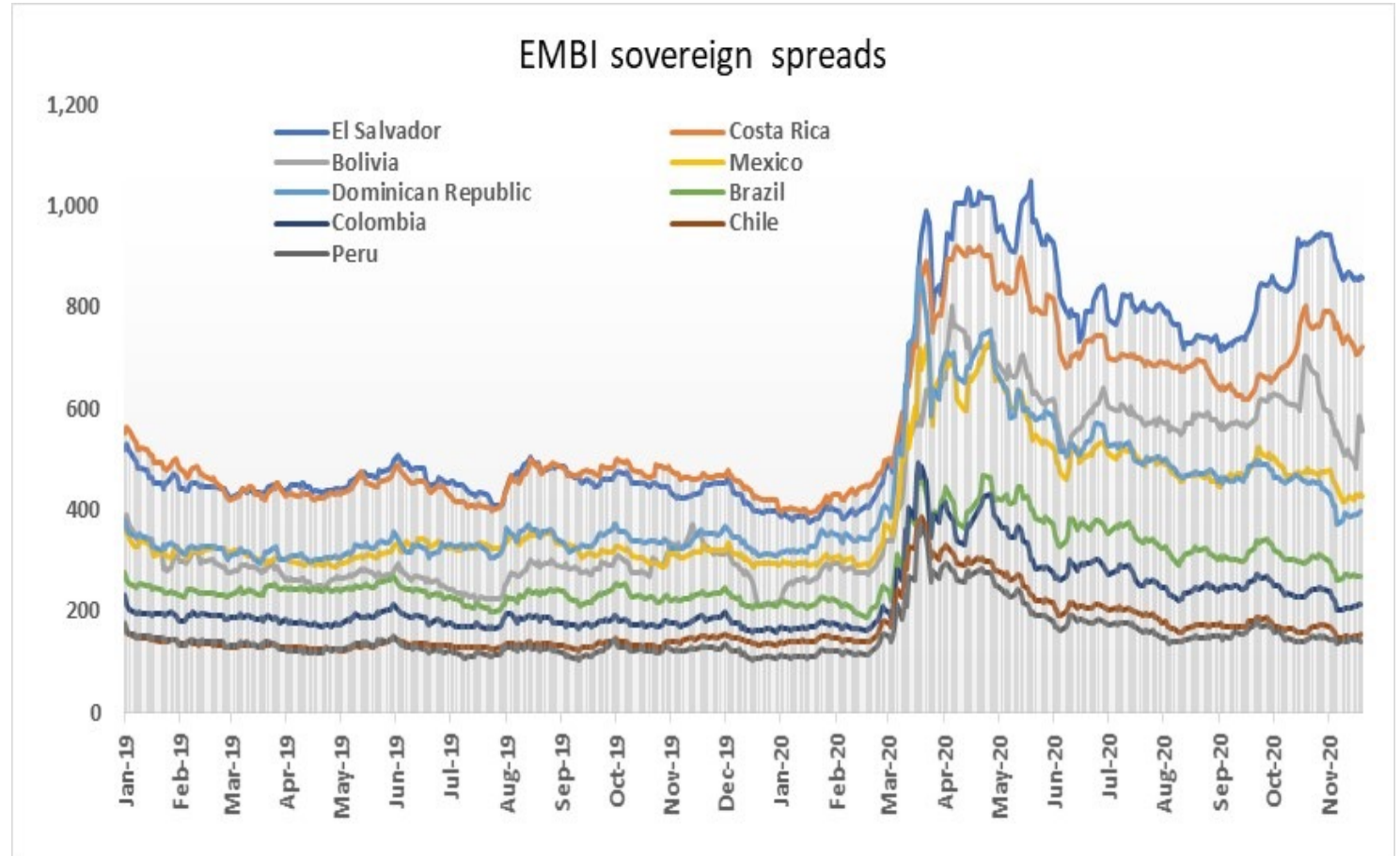
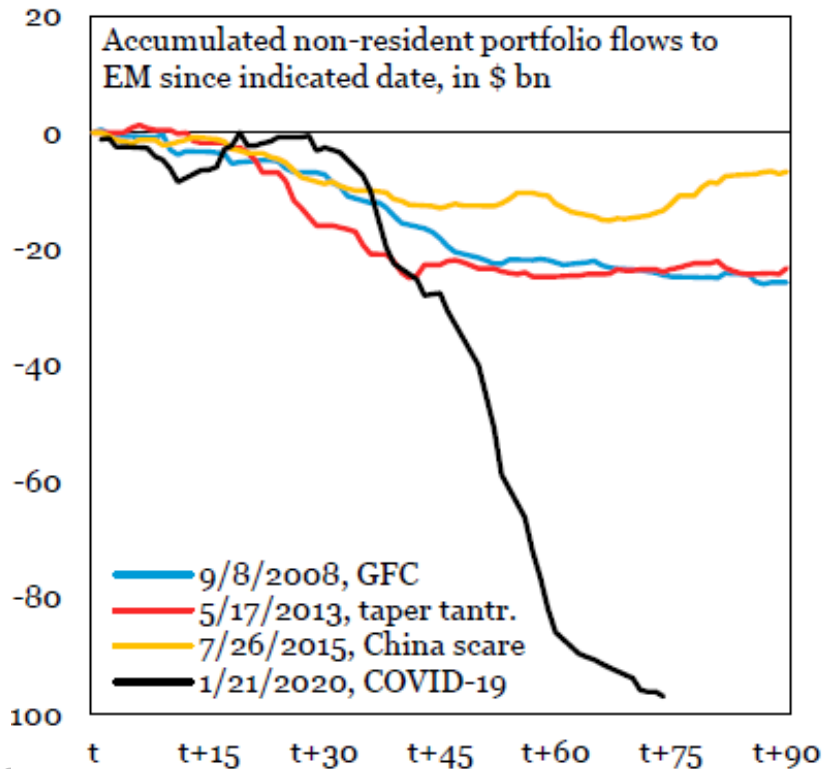


# Other events less sudden and built up over time

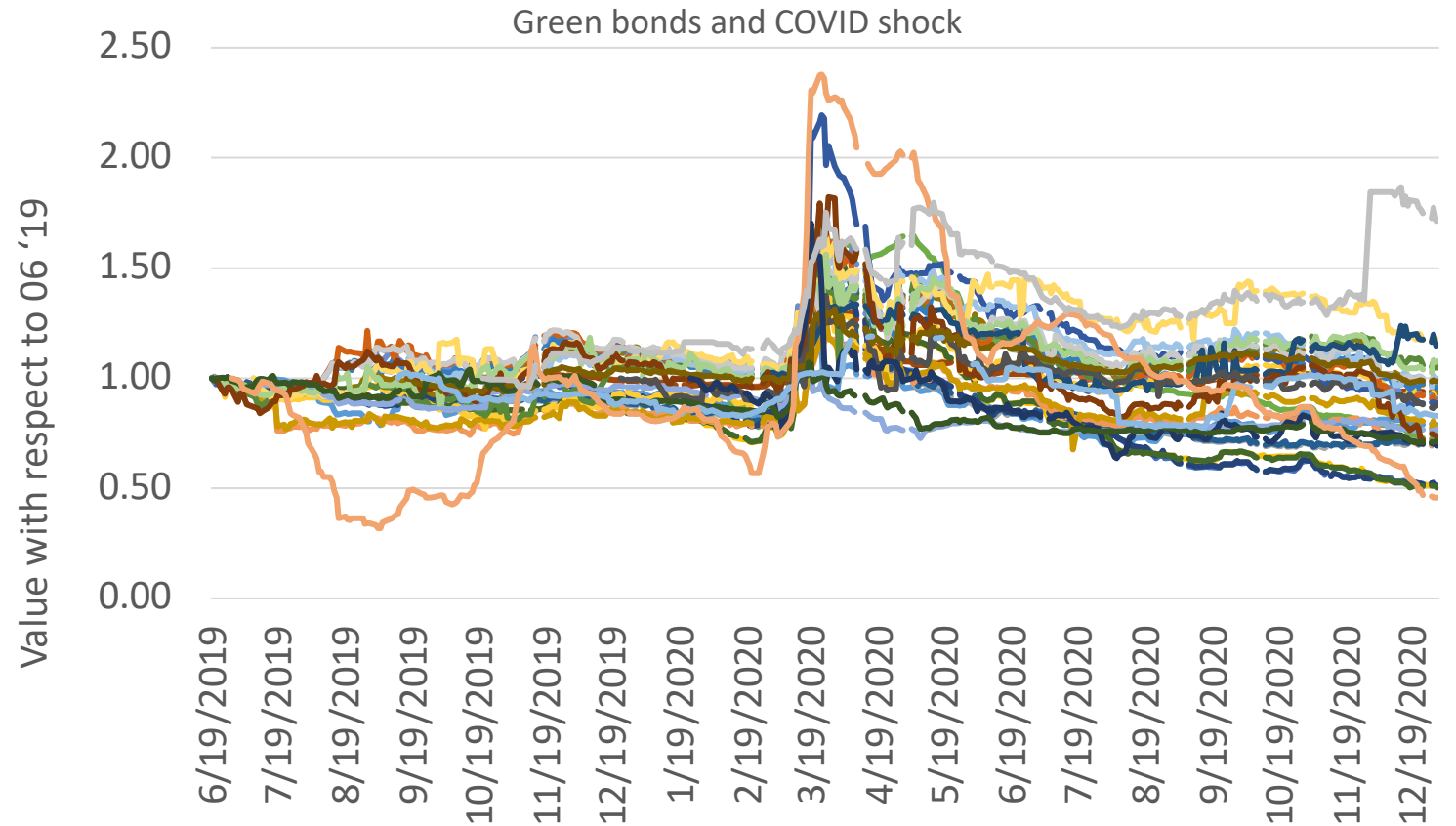
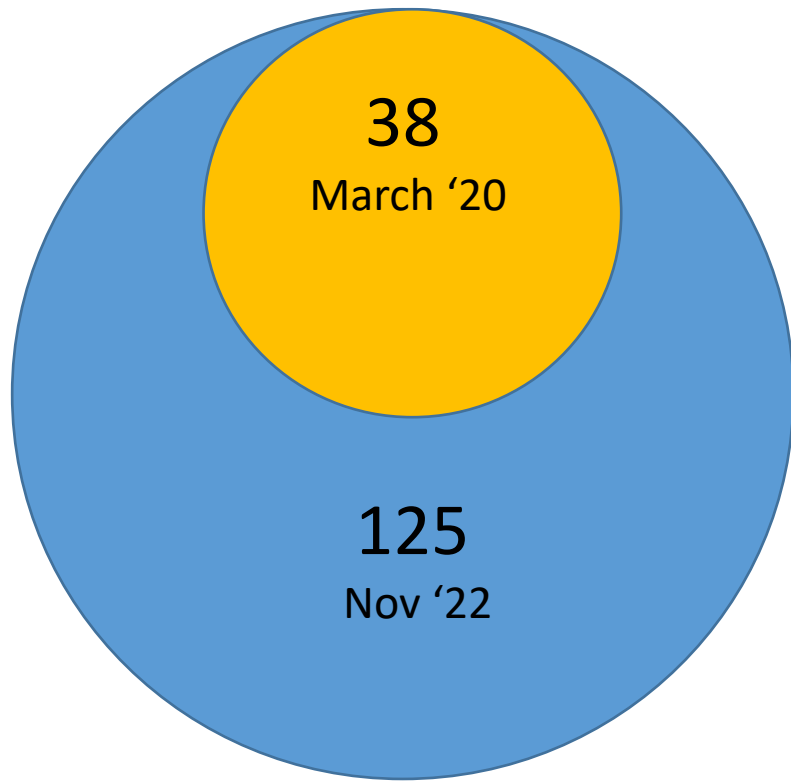


# Effect of COVID shock: Capital exodus from EMs

- ~\$100B left emerging markets (01/21/2020 onwards)
- Larger than '08 financial crisis



# What about green bonds? First... how many are there?... Not too many in LAC but all impacted



- Only 35 with consistent yield series available in Bloomberg

# But... impacted more or less than other non-green bonds? Pairwise comparison: almost ideal

- An ideal comparison would be like a randomized experiment (treatment and control) comparing:
  - Simultaneous issuances (green and vanilla) by same issuer
  - ...in the same currency
  - ...with the same maturity
  - ...same coupon
  - ...same tenor
  - ...same issuance amount
  - ...same outstanding amount overtime
  - ...same coupon frequency and other features such as callability

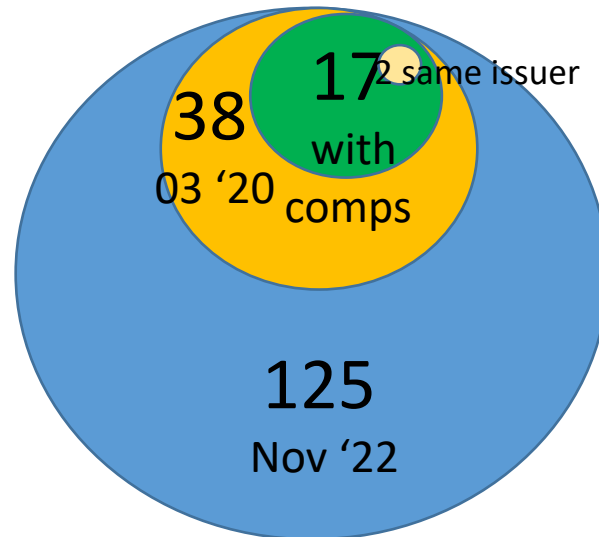
# Pairwise comparison: almost ideal

## Pros

- Ideally the only difference between vanilla and green stems from the use of proceeds
- Easy to identify feature similarity
- Easy to identify behavior differences

## Cons

- Difficult to find comparables -only 17 at the time of the shock & 2 from the same issuer-
- Both bonds can trade far from fair value
- PD and LGD same when the issuer is the same





# 11 out of 17 green, had their yield increase less than vanilla comparables

Issuer	Bond type	Country	Bloomberg Composite	Currency	Maturity	Coupon	Issue date	Amount issued in millions
Chile Government International Bond	Green	CL	A-	USD	1/25/2050		3.506/17/2019	2,318,357,000
Chile Government International Bond	Vanilla	CL	A-	USD	6/21/2047		3.866/21/2017	1,243,000,000
Similarities						949	36 726	1.87
Inversiones CMPC SA	Green	CL	BBB-	USD	4/4/2027		4.383/30/2017	500,000,000
CENCOSUD SA	Vanilla	CL	BBB-	USD	7/17/2027		4.387/12/2017	1,000,000,000
Similarities						104	0 104	0.50
Banco Nacional de Desenvolvimento Economico e Social	Green	BR	BB-	USD	5/9/2024		4.755/2/2017	496,798,000
BANCO DO BRASIL (CAYMAN)	Vanilla	BR	BB-	USD	3/20/2024		4.753/13/2019	750,000,000
Similarities						50	0 680	0.66
Banco Votorantim SA	Green	BR	NR	USD	10/24/2024		3.353/5/2020	50,000,000
BRF SA	Vanilla	BR	BB	USD	5/22/2024		4.755/15/2014	750,000,000
Similarities						155	140 2121	0.07
Cea II - Centrais Eolicas Assurua II Spe S/A	Green	BR	NR	BRL	6/15/2030		6.664/15/2018	131,930,000
ENEVA SA	Vanilla	BR	#N/A N/A	BRL	5/15/2029		5.055/15/2019	500,000,000
Similarities						396	161 395	0.26
TSM - Transmissora Serra da Mantiqueira SA	Green	BR	#N/A N/A	BRL	12/15/2044		4.5012/15/2019	530,000,000
EMPRESA SUDESTE ENERGIA	Vanilla	BR	#N/A N/A	BRL	12/15/2044		4.5012/15/2019	415,000,000
Similarities						0	0 0	1.28
Cia de Transmissao de Energia Eletrica Paulista	Green	BR	#N/A N/A	BRL	12/15/2029		3.5012/15/2019	409,325,000
CHESF - HIDRO ELETRICA S	Vanilla	BR	#N/A N/A	BRL	1/15/2029		7.031/15/2017	168,000,000
Similarities						334	353 1064	2.44
Cutia Empreendimentos Eolicos S/A	Green	BR	#N/A N/A	BRL	12/15/2031		5.883/20/2019	302,400,000
RAIZEN ENERGIA SA	Vanilla	BR	#N/A N/A	BRL	11/15/2029		3.5411/15/2019	900,000,000
Similarities						760	234 240	0.34
Omega Geracao SA	Green	BR	#N/A N/A	BRL	5/15/2026		5.605/15/2019	183,400,000
BANDA COURO ENERGETICA	Vanilla	BR	#N/A N/A	BRL	1/15/2027		7.961/15/2017	14,500,000
Similarities						245	236 850	
Engie Brasil Energia SA	Green	BR	#N/A N/A	BRL	7/15/2029		3.707/15/2019	105,400,000
ENEVA SA	Vanilla	BR	#N/A N/A	BRL	5/15/2029		5.055/15/2019	500,000,000
Similarities						61	135 61	0.21
Parque Eolico Laranjeiras V SA	Green	BR	#N/A N/A	BRL	11/28/2030		7.815/28/2018	29,750,000
CENTRAIS ELETRICAS BRASI	Vanilla	BR	#N/A N/A	BRL	5/15/2029		5.184/25/2019	700,000,000
Similarities						562	263 332	0.04

# 6 green reacted > comparables

Issuer	Bond type	Country	Bloomberg Composite	Currency	Maturity	Coupon	Issue date	Amount issued in millions
Consortio Transmantaro SA	Green	PE	BBB-	USD	4/16/2034	4.70	4/11/2019	600,000,000
LIMA METRO LINE 2 FIN LT	Vanilla	KY	BBB-	USD	7/5/2034	5.88	6/10/2015	1,154,923,000
Similarities					80	118	1401	0.52
Omega Energia E Implantacao 2 SA	Green	BR	NR	BRL	12/15/2029	7.11	11/24/2017	162,800,000
VOLTALIA SAO MIGUEL SA	Vanilla	BR	#N/A N/A	BRL	12/15/2028	8.19	3/8/2016	57,000,000
Similarities					365	108	626	2.86
Nacional Financiera SNC	Green	MX	NR	MXN	9/1/2023	6.05	8/30/2016	2,000,000,000
BANCO NAL OBRAS SERV PUB	Vanilla	MX	NR	MXN	4/10/2023	5.16	4/19/2013	6,000,000,000
Similarities					144	89	1229	0.33
Cia de Transmissao de Energia Eletrica Paulista	Green	BR	#N/A N/A	BRL	4/15/2025	4.70	4/15/2018	621,000,000
CIA SANEAMENTO BASICO	Vanilla	BR	#N/A N/A	BRL	2/15/2025	6.00	2/15/2018	250,000,000
Similarities					59	130	59	2.48
AES Tiete Energia SA	Green	BR	NR	BRL	3/15/2029	4.71	3/15/2019	641,090,000
SAO SIMAO ENERGIA SA	Vanilla	BR	#N/A N/A	BRL	11/15/2029	3.54	11/13/2019	775,000,000
Similarities					245	117	243	0.83
Pirapora Solar Holding SA	Green	BR	NR	BRL	8/15/2034	5.77	8/15/2018	193,757,080
FOTOVOLTAICA SAO PEDRO	Vanilla	BR	#N/A N/A	BRL	12/15/2034	4.40	11/29/2019	95,518,000
Similarities					122	137	471	2.03

# More reactive greens: almost all not rated, smaller term, higher coupon rate, and larger than comparables?

	Difference in maturity between green and vanilla comparable	Tenor at issuance from green issuers in that group	Coupon difference between green and vanilla comparable	Average coupon rate from green issuers in that group	Green % of the Vanilla comparable*	Diference in Issue date
Less reactive green group	329	13.07	142	4.88	0.77	598
More reactive green group	169	11.34	116	5.51	1.51	672

\*excludes an outlier OMEGA GERACAO SA whose issuance amount was more than 12 times the comparable amount

# Can holders behavior explain the greenium?

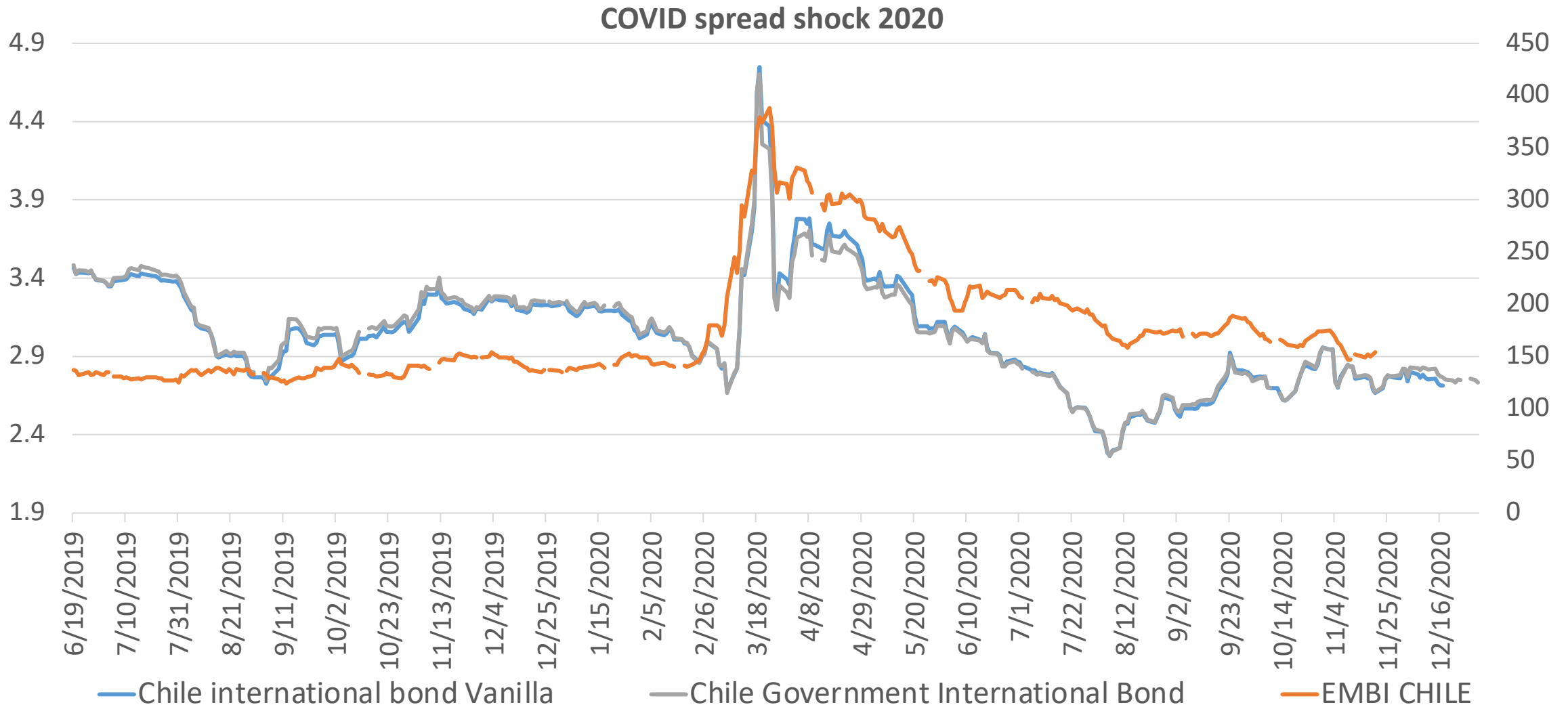
	% Outs reported Green	% Outs reported Vanilla	Green number of holders	Vanilla number of holders
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Green less reactive (average)	30.6	17.25	23.9	15.7
Green more reactive (average)	15.7	19.8	13.5	12.7

- Green bonds seem to have more holders reported
- The group less reactive seems to have a higher number of holders
- Consistent with that issuers responded in a survey: more investors show up for green bonds, more interested in long-term holding.



# The yield relationship inverted, significant impact from COVID, less so for the green bond



# The series had a common trend... moved in sync...

Sample: 6/19/2019 3/06/2020

Included observations: 175

Series: VANILLACHILE GREENCHILE

Lags interval: 1 to 12

Selected (0.05 level\*) Number of Cointegrating Relations by Model

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Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	0	0	0	1
Max-Eig	1	0	0	1	1

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\*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

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# The model with a deterministic trend had the vanilla as statistically significant and the errors were stationary

Sample: 6/19/2019 3/06/2020

Included observations: 188

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.048916	0.021621	2.262470	0.0248
VANILLACHILE	0.994929	0.006666	149.2593	0.0000
T	-7.01E-05	2.24E-05	-3.130112	0.0020

R-squared 0.992585 Mean dependent var 3.157867

Null Hypothesis: ERROR has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=14)

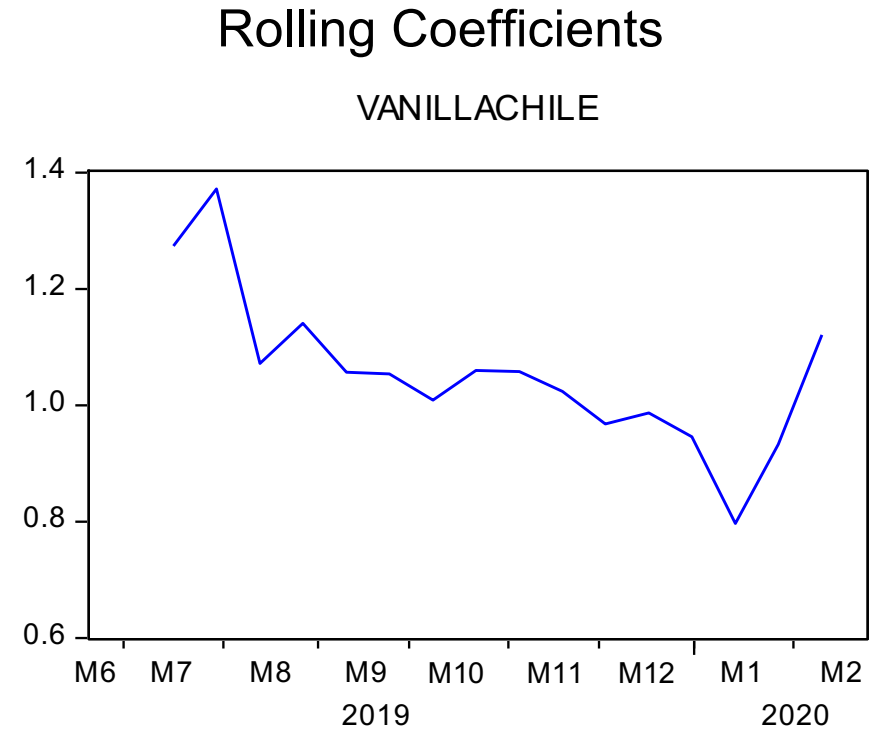
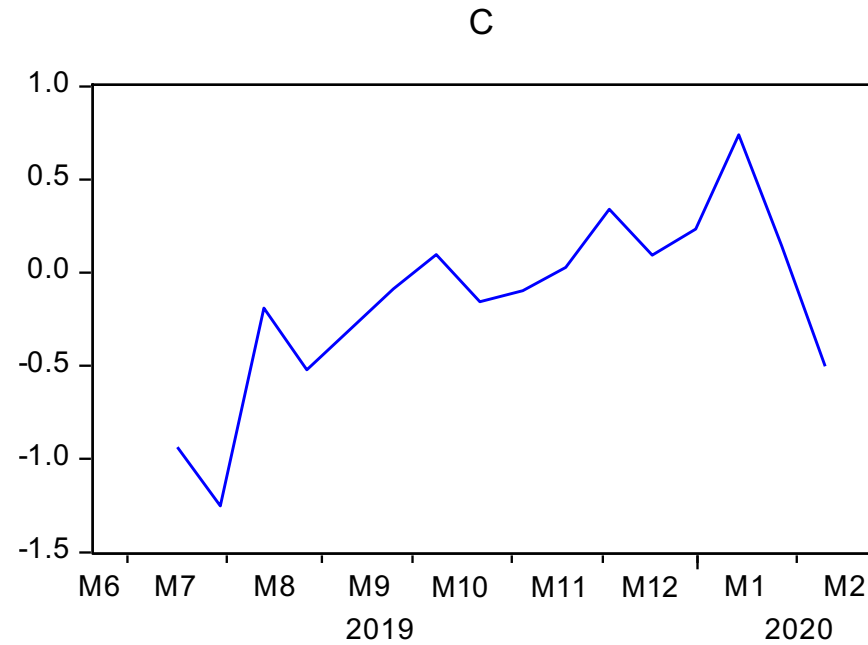
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.806744	0.0182
Test critical values:		
1% level	-4.007882	
5% level	-3.434036	
10% level	-3.140923	

Same stability results for before and after COVID

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



# The regressor coefficient was positive and around 1



# Was COVID impact statistically significant? – yes-

Sample: 6/19/2019 12/17/2020

Included observations: 392

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.138321	0.015554	8.892884	0.0000
VANILLACHILE	0.966865	0.004669	207.0896	0.0000
T	-0.000107	1.33E-05	-8.072625	0.0000
DCOVID	-0.046695	0.003489	-13.38250	0.0000

R-squared	0.995645	Mean dependent var	3.047893
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## Also evidence of chow structural break on 3/20/2020

Chow Breakpoint Test: 3/20/2020

Null Hypothesis: No breaks at specified breakpoints

Varying regressors: All equation variables

Equation Sample: 6/19/2019 12/17/2020

F-statistic	264.8667	Prob. F(3,386)	0.0000
Log likelihood ratio	438.2328	Prob. Chi-Square(3)	0.0000
Wald Statistic	794.6001	Prob. Chi-Square(3)	0.0000

# Who held the bonds and what patterns emerge?

More holders control less % of green bond

Same holders control less % of green bond

Dec 2019

	% of ownership reported	Number of holders	Same holders
Green holders	21.77	73	18%
Vanilla holders	37.36	80	34%
<b>Intersection</b>		<b>43</b>	

~ Dec 2020

	% of ownership reported	Number of holders	Same holders
Green holders	28.00	91	21%
Vanilla holders	40.00	73	37%
<b>Intersection</b>		<b>37</b>	

Dec 2022

	% of ownership reported	Number of holders	Same holders
Green holders	29.91	118	22%
Vanilla holders	26.64	64	25%
<b>Intersection</b>		<b>45</b>	

# Conclusions

- **Data is key to evaluate bonds, make decisions**
- **From the little information, green bonds tended to react less**
- **Hard to find comparables**
- **Government bonds can build term curves and help the market develop**
- **Publish information?**
- **One potential explanation is holder behavior: more sticky to their green holdings**



# Thanks, questions

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<https://www.techmunity.com/>