

CU04_MODEL_DEVELOPMENT_02_TS

June 9, 2023

#

CU04_Optimización de vacunas

1 IV. Model development

En este anexo se incluye el código utilizado durante el desarrollo de los modelos incluidos en el caso de uso.

1.1 Modelo TS

1.1.1 Paquetes

```
[1]: library(readr)
library(dplyr)

library(tsibble)

library(ggplot2)
library(fable)
```

Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

filter, lag

The following objects are masked from 'package:base':

intersect, setdiff, setequal, union

Attaching package: 'tsibble'

The following objects are masked from 'package:base':

intersect, setdiff, union

Loading required package: fabletools

1.1.2 Datos

```
[2]: data_04_completo <- read_csv("CU_04_05_19_vacunacion_gripe_completo.csv")
tsdata <- data_04_completo |>
  filter(campana == 2021) |>
  mutate(tsweek = make_yearweek(ano, semana)) |>
  select(GEOCODIGO, n_vacunas, tsweek, tuits_gripe, interes_gripe, tmed, prec)
  ↪ |>
  as_tsibble(key = GEOCODIGO,
             index = tsweek)
```

Rows: 21736 Columns: 47

-- Column specification

Delimiter: ","

chr (3): GEOCODIGO, DESBDT, nombre_zona

dbl (44): ano, semana, n_vacunas, n_citas, tmed, prec, velmedia,
presMax, be...

i Use `spec()` to retrieve the full column specification for this data.

i Specify the column types or set `show_col_types = FALSE` to quiet this message.

1.1.3 Visualización

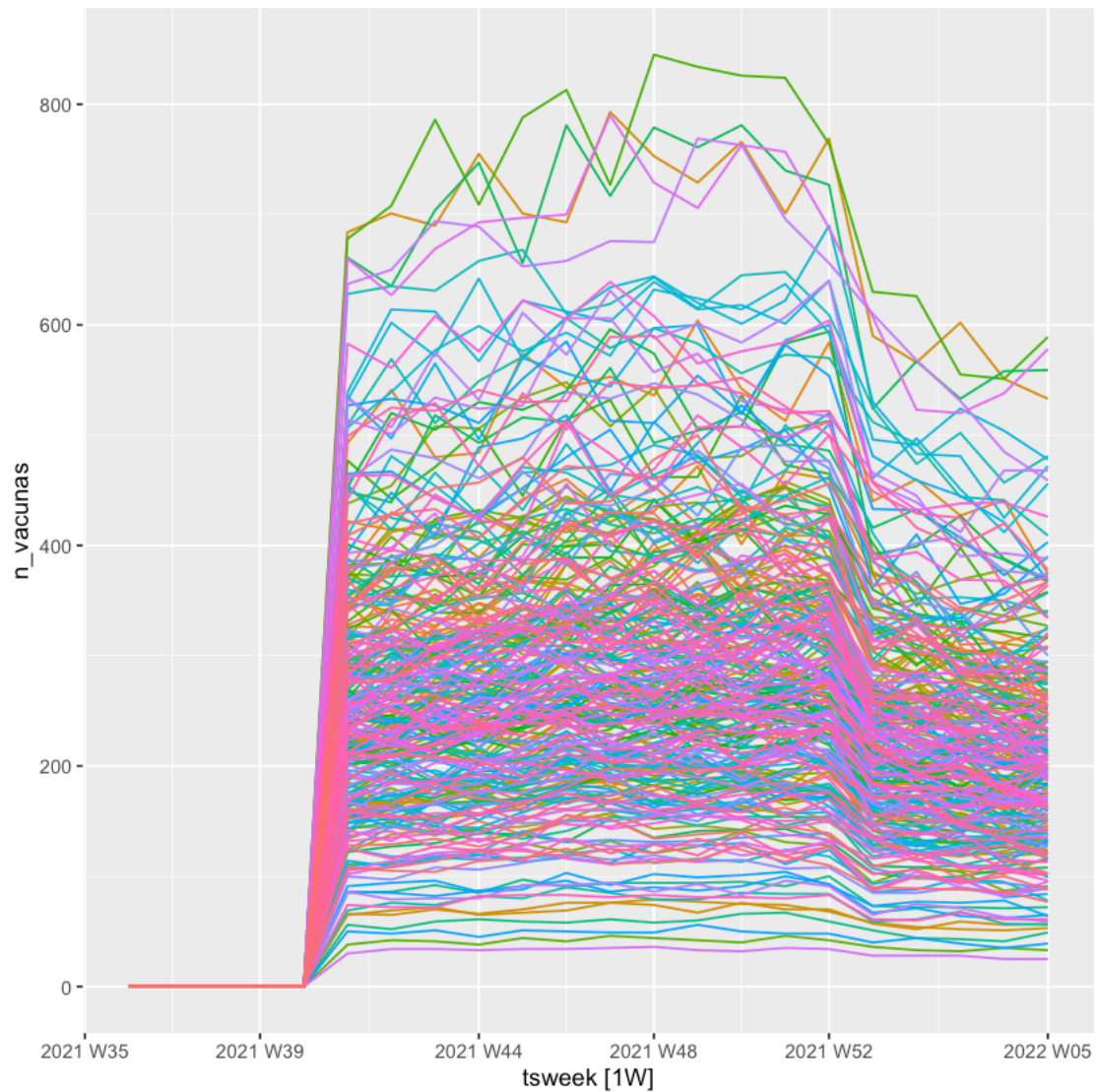
```
[3]: tsdata |>
  group_by(GEOCODIGO) |>
  autoplot(n_vacunas) +
  theme(legend.position = "none")
```

`mutate_if()` ignored the following grouping variables:

* Column `GEOCODIGO`

Warning message:

"Removed 88 rows containing missing values (`geom_line()`)."



1.1.4 Spot checking

```
[4]: # Sin regresores
# mod_04_ts <- tsdata |>
#   model(arima = ARIMA(n_vacunas))

mod_04_ts <- tsdata |>
  model(arima = ARIMA(n_vacunas))

write_rds(mod_04_ts, "mod_04_ts.rds")

mod_04_ts |> coef()
mod_04_ts |> glance()
```

```
mod_04_ts |> filter(GEOCODIGO == "030") |> report()
mod_04_ts |> augment()
mod_04_ts |> accuracy() |> arrange(MAE)
```

Warning message:

"4 errors (1 unique) encountered for arima

[4] All observations are missing, a model cannot be estimated without data.

"

	GEOCODIGO <chr>	.model <chr>	term <chr>	estimate <dbl>	std.error <dbl>	statistic <dbl>	p.value <dbl>
	001	arima	ar1	0.8707149	0.09852963	8.837086	1.088626e-08
	001	arima	constant	27.8786865	13.16282011	2.117987	4.571020e-02
	002	arima	ar1	0.8756490	0.09494508	9.222690	5.152467e-09
	002	arima	constant	15.6908325	7.96831555	1.969153	6.165796e-02
	003	arima	ar1	0.8900573	0.08887818	10.014351	1.176063e-09
	003	arima	constant	22.9777007	11.70394122	1.963245	6.238232e-02
	004	arima	ar1	0.8792957	0.09479647	9.275617	4.656590e-09
	004	arima	constant	18.9786969	9.15780005	2.072408	5.014848e-02
	005	arima	ar1	0.8897349	0.08904555	9.991907	1.225074e-09
	005	arima	constant	21.1463948	10.74771824	1.967524	6.185691e-02
	007	arima	ar1	0.8726074	0.09718446	8.978878	8.250100e-09
	007	arima	constant	11.3474621	5.46337413	2.077006	4.968381e-02
	008	arima	ar1	0.8895951	0.08900180	9.995249	1.217644e-09
	008	arima	constant	21.2453276	10.83967207	1.959960	6.278823e-02
	010	arima	ar1	0.8761828	0.09567723	9.157694	5.837066e-09
	010	arima	constant	25.3520486	12.30398594	2.060474	5.137257e-02
	011	arima	ar1	0.8728190	0.09679712	9.016994	7.660911e-09
	011	arima	constant	22.2293108	10.83360889	2.051884	5.227021e-02
	012	arima	ar1	0.8670561	0.09922195	8.738551	1.321987e-08
	012	arima	constant	25.4301564	12.35419035	2.058424	5.158562e-02
	013	arima	ar1	0.8776821	0.09414164	9.322996	4.254586e-09
	013	arima	constant	13.0151551	6.53823620	1.990622	5.908815e-02
	014	arima	ar1	0.8884825	0.08927109	9.952635	1.315991e-09
	014	arima	constant	27.6487832	14.17738665	1.950203	6.400792e-02
	015	arima	ar1	0.8810013	0.09282522	9.490970	3.096193e-09
	015	arima	constant	19.3315283	9.70408273	1.992103	5.891444e-02
	016	arima	ar1	0.8539017	0.10617389	8.042482	5.405780e-08
	016	arima	constant	29.6884395	13.16325907	2.255402	3.439169e-02
	017	arima	ar1	0.8779826	0.09475564	9.265756	4.745083e-09
A tibble: 512 x 7	017	arima	constant	12.1577058	5.93457629	2.048622	5.261471e-02

	272	arima	ar1	0.8742492	0.09607686	9.099477	6.530122e-09
	272	arima	constant	16.6859628	8.18369404	2.038928	5.365059e-02
	273	arima	ar1	0.8547542	0.10527764	8.119048	4.615462e-08
	273	arima	constant	14.2200266	6.44217168	2.207334	3.802289e-02
	274	arima	ar1	0.8781606	0.09389600	9.352482	4.022690e-09
	274	arima	constant	22.5734744	11.33904002	1.990775	5.907018e-02
	275	arima	ar1	0.8729322	0.09691832	9.006886	7.812785e-09
	275	arima	constant	8.9295771	4.32987826	2.062316	5.118195e-02
	276	arima	ar1	0.8790506	0.09433338	9.318552	4.290711e-09
	276	arima	constant	22.1878921	10.85176906	2.044634	5.303874e-02
	277	arima	ar1	0.8754679	0.09689029	9.035662	7.388381e-09
	277	arima	constant	33.2646633	15.73407692	2.114180	4.606698e-02
	278	arima	ar1	0.8705603	0.09803097	8.880462	9.998190e-09
	278	arima	constant	15.7926312	7.59424429	2.079553	4.942815e-02
	279	arima	ar1	0.8891785	0.08789377	10.116513	9.773400e-10
	279	arima	constant	11.2638385	6.05198892	1.861180	7.613529e-02
	280	arima	ar1 5	0.8729526	0.09730298	8.971489	8.369637e-09
	280	arima	constant	25.5687576	12.21898289	2.092544	4.814214e-02
	281	arima	ar1	0.8407838	0.11114793	7.564547	1.475842e-07
	281	arima	constant	35.0640392	15.40557618	2.276062	3.293056e-02

	GEOCODIGO <chr>	.model <chr>	sigma2 <dbl>	log_lik <dbl>	AIC <dbl>	AICc <dbl>	BIC <dbl>	ar_roots <list>
	001	arima	6352.667	-127.2009	260.4017	261.7351	263.6749	1.148482+
	002	arima	2315.007	-116.1149	238.2299	239.5632	241.5030	1.14201+0
	003	arima	5406.924	-125.5036	257.0072	258.3406	260.2804	1.123523+
	004	arima	3182.496	-119.6296	245.2592	246.5926	248.5324	1.137274+
	005	arima	4568.519	-123.6488	253.2977	254.6310	256.5708	1.12393+0
	006	arima	2839.143	-113.2859	228.5718	228.7824	229.6163	
	007	arima	1098.238	-107.9009	221.8018	223.1351	225.0749	1.145991+
	008	arima	4619.917	-123.7713	253.5426	254.8759	256.8157	1.124107+
	009	arima	1494.381	-106.5471	215.0942	215.3048	216.1388	
	010	arima	5640.590	-125.9133	257.8265	259.1599	261.0997	1.141314+
	011	arima	4298.383	-122.9115	251.8230	253.1564	255.0962	1.145713+
	012	arima	5437.464	-125.4767	256.9534	258.2868	260.2266	1.153328+
	013	arima	1586.263	-111.9643	229.9286	231.2619	233.2017	1.139365+
	014	arima	7838.476	-129.5819	265.1639	266.4972	268.4370	1.125515+
	015	arima	3555.365	-120.8550	247.7100	249.0433	250.9831	1.135072+
	016	arima	6070.756	-126.6449	259.2899	260.6232	262.5630	1.171095+
	017	arima	1327.272	-110.0046	226.0092	227.3426	229.2824	1.138975+
	018	arima	3972.136	-122.0909	250.1818	251.5151	253.4549	1.129773+
	019	arima	14635.185	-136.3616	278.7232	280.0566	281.9963	1.155781+
	020	arima	6823.204	-127.9456	261.8912	263.2245	265.1643	1.164579+
	021	arima	2928.646	-118.7375	243.4749	244.8083	246.7481	1.130089+
	022	arima	9963.112	-132.0885	270.1769	271.5103	273.4501	1.173706+
	023	arima	4052.011	-122.2521	250.5041	251.8375	253.7773	1.149412+
	024	arima	7401.287	-128.9503	263.9005	265.2339	267.1737	1.125627+
	025	arima	4088.940	-122.2966	250.5932	251.9265	253.8663	1.171609+
	026	arima	2882.324	-118.5329	243.0659	244.3992	246.3390	1.139611+
	027	arima	1619.448	-112.1860	230.3719	231.7052	233.6450	1.141446+
	028	arima	1395.635	-110.5260	227.0520	228.3853	230.3251	1.149999+
	029	arima	3051.882	-119.0907	244.1815	245.5148	247.4546	1.166497+
A tibble: 282 x 9	030	arima	26162.857	-142.7597	291.5195	292.8528	294.7926	1.152675+

	257	arima	8140.4918	-129.9036	265.8072	267.1406	269.0804	1.157985+
	258	arima	4568.8976	-123.6457	253.2914	254.6247	256.5645	1.125137+
	259	arima	6701.1141	-127.8116	261.6232	262.9566	264.8964	1.140213+
	260	arima	5130.6985	-124.8231	255.6463	256.9796	258.9194	1.159095+
	261	arima	1559.2171	-111.8401	229.6801	231.0135	232.9533	1.119219+
	262	arima	6724.4123	-127.8709	261.7418	263.0751	265.0149	1.133205+
	263	arima	1213.2381	-104.3587	210.7174	210.9280	211.7620	
	264	arima	10880.5438	-133.2164	272.4327	273.7661	275.7058	1.117655+
	265	arima	4487.5036	-123.4243	252.8486	254.1819	256.1217	1.132459+
	266	arima	12995.0994	-135.1106	276.2212	277.5545	279.4943	1.135617+
	267	arima	895.2147	-105.5584	217.1167	218.4500	220.3898	1.185103+
	268	arima	3043.6323	-119.1118	244.2236	245.5569	247.4967	1.146673+
	269	arima	3078.1431	-119.2474	244.4949	245.8282	247.7680	1.142548+
	270	arima	3182.5138	-119.6291	245.2581	246.5915	248.5313	1.137482+
	271	arima	2423.7395	-116.6944	239.3887	240.7221	242.6618	1.118687+
	272	arima	2464.6262	-116.7986	239.5972	240.9305	242.8703	1.143839+
	273	arima	1443.1218	-110.8442	227.6885	229.0218	230.9616	1.169927+
	274	arima	4790.3758	-124.1236	254.2472	255.5806	257.5204	1.138744+
	275	arima	687.5285	-102.7501	211.5003	212.8336	214.7734	1.145564+
	276	arima	4451.4470	-123.3199	252.6397	253.9731	255.9129	1.137591+

Series: n_vacunas
Model: ARIMA(1,0,0) w/ mean

Coefficients:

	ar1	constant
	0.8675	56.8609
s.e.	0.0996	26.9507

sigma² estimated as 26163: log likelihood=-142.76
AIC=291.52 AICc=292.85 BIC=294.79

GEOCODIGO <chr>	.model <chr>	tsweek <week>	n_vacunas <dbl>	.fitted <dbl>	.resid <dbl>	.innov <dbl>
001	arima	2021 W36	0	106.04784	-106.047837	-106.047837
001	arima	2021 W37	0	27.87869	-27.878687	-27.878687
001	arima	2021 W38	0	27.87869	-27.878687	-27.878687
001	arima	2021 W39	0	27.87869	-27.878687	-27.878687
001	arima	2021 W40	0	27.87869	-27.878687	-27.878687
001	arima	2021 W41	328	27.87869	300.121313	300.121313
001	arima	2021 W42	344	313.47316	30.526837	30.526837
001	arima	2021 W43	353	327.40460	25.595399	25.595399
001	arima	2021 W44	371	335.24103	35.758966	35.758966
001	arima	2021 W45	341	350.91390	-9.913902	-9.913902
001	arima	2021 W46	389	324.79246	64.207544	64.207544
001	arima	2021 W47	349	366.58677	-17.586770	-17.586770
001	arima	2021 W48	402	331.75817	70.241825	70.241825
001	arima	2021 W49	350	377.90606	-27.906063	-27.906063
001	arima	2021 W50	376	332.62889	43.371110	43.371110
001	arima	2021 W51	368	355.26748	12.732524	12.732524
001	arima	2021 W52	362	348.30176	13.698243	13.698243
001	arima	2022 W01	270	343.07747	-73.077468	-73.077468
001	arima	2022 W02	286	262.97170	23.028300	23.028300
001	arima	2022 W03	308	276.90314	31.096862	31.096862
001	arima	2022 W04	278	296.05887	-18.058865	-18.058865
001	arima	2022 W05	281	269.93742	11.062581	11.062581
002	arima	2021 W36	0	60.93925	-60.939254	-60.939254
002	arima	2021 W37	0	15.69083	-15.690833	-15.690833
002	arima	2021 W38	0	15.69083	-15.690833	-15.690833
002	arima	2021 W39	0	15.69083	-15.690833	-15.690833
002	arima	2021 W40	0	15.69083	-15.690833	-15.690833
002	arima	2021 W41	207	15.69083	191.309167	191.309167
002	arima	2021 W42	218	196.95018	21.049824	21.049824
002	arima	2021 W43	218	206.58231	11.417685	11.417685
...
285	arima	2021 W50	430	473.29703	-43.297026	-43.297026
285	arima	2021 W51	441	411.38602	29.613985	29.613985
285	arima	2021 W52	456	421.11489	34.885112	34.885112
285	arima	2022 W01	394	434.38153	-40.381534	-40.381534
285	arima	2022 W02	363	379.54607	-16.546067	-16.546067
285	arima	2022 W03	340	352.12833	-12.128334	-12.128334
285	arima	2022 W04	350	331.78614	18.213856	18.213856
285	arima	2022 W05	367	340.63057	26.369426	26.369426
286	arima	2021 W36	0	102.37680	-102.376795	-102.376795
286	arima	2021 W37	0	25.81044	-25.810443	-25.810443
286	arima	2021 W38	0	25.81044	-25.810443	-25.810443
286	arima	2021 W39	0	25.81044	-25.810443	-25.810443
286	arima	2021 W40	0	25.81044	-25.810443	-25.810443
286	arima	2021 W41	343	25.81044	317.189557	317.189557
286	arima	2021 W42	376	327.81366	48.186337	48.186337
286	arima	2021 W43	389	356.86937	32.130634	32.130634
286	arima	2021 W44	359	368.31555	-9.315553	-9.315553
286	arima	2021 W45	403	341.90128	61.098723	61.098723
286	arima	2021 W46	415	380.64221	34.357785	34.357785
286	arima	2021 W47	410	391.20792	18.792075	18.792075

	GEOCODIGO <chr>	.model <chr>	.type <chr>	ME <dbl>	RMSE <dbl>	MAE <dbl>	MPE <dbl>	MAPE <dbl>
	222	arima	Training	1.262054	6.652044	3.557510	-Inf	Inf
	080	arima	Training	1.591976	8.630690	4.654770	-Inf	Inf
	182	arima	Training	1.827213	11.147013	6.407589	-Inf	Inf
	118	arima	Training	2.253671	12.534624	7.032271	-Inf	Inf
	036	arima	Training	2.640609	14.258804	7.484377	-Inf	Inf
	033	arima	Training	2.675558	14.760815	8.228880	-Inf	Inf
	256	arima	Training	2.965786	16.599597	9.142424	-Inf	Inf
	137	arima	Training	2.926191	16.215838	9.594555	-Inf	Inf
	121	arima	Training	3.442341	19.303507	10.743876	-Inf	Inf
	184	arima	Training	3.221452	19.396697	11.040621	-Inf	Inf
	211	arima	Training	3.095795	19.752116	11.627784	-Inf	Inf
	201	arima	Training	4.202116	22.205571	11.796090	-Inf	Inf
	180	arima	Training	3.422158	20.606722	12.308933	-Inf	Inf
	282	arima	Training	4.088401	23.927934	12.828823	-Inf	Inf
	045	arima	Training	5.500000	30.169973	12.863636	4.982362	12.02005
	263	arima	Training	5.272727	34.030735	13.454545	3.976275	11.64608
	196	arima	Training	5.772727	31.183475	13.590909	5.061824	12.66746
	149	arima	Training	4.225653	24.315378	13.727284	-Inf	Inf
	190	arima	Training	4.656024	27.706312	14.659570	-Inf	Inf
	275	arima	Training	4.424207	25.000519	15.180041	-Inf	Inf
	072	arima	Training	4.583300	25.681124	15.227274	-Inf	Inf
	230	arima	Training	4.476465	24.643264	15.345104	-Inf	Inf
	104	arima	Training	5.123721	27.493076	15.397517	-Inf	Inf
	216	arima	Training	6.409091	38.057970	15.409091	4.457982	12.11036
	219	arima	Training	4.489808	25.092180	15.618020	-Inf	Inf
	176	arima	Training	4.211839	26.418984	16.193213	-Inf	Inf
	130	arima	Training	5.647014	28.418550	16.248796	-Inf	Inf
	250	arima	Training	5.408905	29.371292	16.300700	-Inf	Inf
	241	arima	Training	5.065797	30.450256	16.397942	-Inf	Inf
A tibble: 286 x 11	052	arima	Training	5.447835	28.008944	16.424524	-Inf	Inf

	194	arima	Training	15.95242	90.05386	55.64570	-Inf	Inf
	266	arima	Training	19.68028	108.69097	55.81753	-Inf	Inf
	139	arima	Training	17.00203	101.47889	56.05277	-Inf	Inf
	217	arima	Training	19.86250	112.26252	56.12721	-Inf	Inf
	143	arima	Training	16.67075	100.46807	56.14302	-Inf	Inf
	177	arima	Training	17.74237	92.95117	57.52092	-Inf	Inf
	132	arima	Training	21.11293	111.83989	57.92787	-Inf	Inf
	252	arima	Training	17.03987	104.05711	58.51933	-Inf	Inf
	070	arima	Training	17.93599	100.24606	59.25042	-Inf	Inf
	183	arima	Training	19.63439	117.36659	65.27049	-Inf	Inf
	181	arima	Training	17.68148	107.13983	65.29018	-Inf	Inf
	154	arima	Training	22.25787	114.64651	65.41251	-Inf	Inf
	159	arima	Training	23.22482	121.44000	65.89732	-Inf	Inf
	087	arima	Training	17.38657	108.58400	66.62503	-Inf	Inf
	243	arima	Training	21.34619	128.46635	67.05183	-Inf	Inf
	097	arima	Training	19.32568	109.46466	67.51865	-Inf	Inf
	215	arima	Training	24.79716	138.99417	68.72125	-Inf	Inf
	019	arima	Training	19.55546	115.34606	69.85912	-Inf	Inf
	168	arima	Training	19.83529	121.69786	70.91023	-Inf	Inf
	140	arima	Training	23.33335	135.87784	71.44287	-Inf	Inf

1.1.5 Escenario

```
[5]: actual <- data_04_completo |>
      filter(ano == 2022, semana < 45, semana >= 35) |>
      select(GEOCODIGO, campana, ano, semana, n_vacunas, tuits_gripe, interes_gripe)

write_csv(actual, "ACTUAL_TS.csv")
```

1.1.6 Modelo campaña actual

```
[6]: actualts <- actual |>
      mutate(tweek = make_yearweek(ano, semana)) |>
      as_tsibble(key = GEOCODIGO, index = tweek) |>
      fill_gaps()

mod_04_ts <- actualts |>
      model(arima = ARIMA(n_vacunas))
```

Warning message:

"4 errors (1 unique) encountered for arima

[4] All observations are missing, a model cannot be estimated without data.

"

1.1.7 Predicción

```
[7]: ## Esto lo cogerá el notebook de las variables:

SEMANA_INICIO <- 36
SEMANA_FIN <- 5

h <- as.numeric(
  make_yearweek(min(actualts$ano, na.rm = TRUE) + 1, SEMANA_FIN) -
  min(actualts$tweek, na.rm = TRUE))

prediction <- mod_04_ts |> forecast(h = h)

prediction |> filter(GEOCODIGO == "030") |> autoplot(actualts)
```

