

Country-report pattern corrections of new cases allow highly accurate two-week predictions of Covid19 evolution with the Gompertz model

Supplemental Material

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Introduction

In this supplemental material we show, first, how countries have been filtered to know whether their reporting data is reliable to make the study or not (Supplementary Table S1). Then, the reporting pattern (Supplementary Figure S1) and performance analysis of the four different prediction methods (Supplementary Figures S2 to S4) can be observed for every country which passed the initial filter. Finally, Supplementary Table S2 represents which prediction days have been considered for every country and what predictions are considered unstable to compare the analysis when considering all the predictions or rejecting the unstable ones.

1 Country filtering: no reporting data

A list of countries belonging to EU, EFTA and UK is shown in Supplementary Table S1 with their population and number of days with no report of new cases. Those countries with more than 2 days without reporting cases are coloured in red, meaning these countries are discarded for our study due to the unreliability of the data: Cyprus, Denmark and Norway. The countries presenting one or two days without reporting data are coloured in yellow, but the data series of these countries is easily corrected by distributing the extra cases of the next day. Finally, the two countries coloured in orange (Estonia and Latvia) present such low amounts of cases that most days do not reach the new cases threshold explained in the methods sections of the main manuscript to take them into account.

Country	Population	Std. deviation	Peak-to-peak diff	No report days
Austria	9,006,400	0.2067	0.4631	0
Belgium	11,589,616	0.1298	1.0774	0
Bulgaria	6,948,445	0.2122	0.9081	2
Croatia	4,105,268	0.1252	0.7782	0
Cyprus	1,207,361	0.4927	0.3253	5
Czech Republic	10,708,982	0.1864	0.8416	0
Denmark	5,792,203	0.3466	0.7869	6
Estonia	1,326,539	0.2981	0.5967	1
Finland	5,540,718	0.3655	0.5737	1
France	65,273,512	0.1899	0.7372	0
Germany	83,783,945	0.0819	0.6318	0
Greece	10,423,056	0.1262	0.4682	0
Hungary	9,660,350	0.1669	0.2180	0
Ireland	4,937,796	0.2324	0.1562	0
Italy	60,461,828	0.0490	0.3823	0
Latvia	1,886,202	0.3287	0.8454	1
Lithuania	2,722,291	0.1913	0.5068	0
Netherlands	17,134,873	0.0744	0.1460	0
Poland	37,846,605	0.1500	0.3093	1
Portugal	10,196,707	0.1863	0.4504	1
Romania	19,237,682	0.1255	0.5121	1
Slovakia	5,459,643	0.2441	1.0163	0
Slovenia	2,078,932	0.1327	0.8995	0
Spain	47,026,000	0.0670	0.7630	0
Sweden	10,099,270	0.1175	0.9697	0
Norway	5,421,242	0.1692	2.3742	26
Switzerland	8,654,618	0.0784	0.7682	0
United Kingdom	67,886,004	0.1425	0.1582	0
Europe	527,862,990	0.0493	0.4129	0

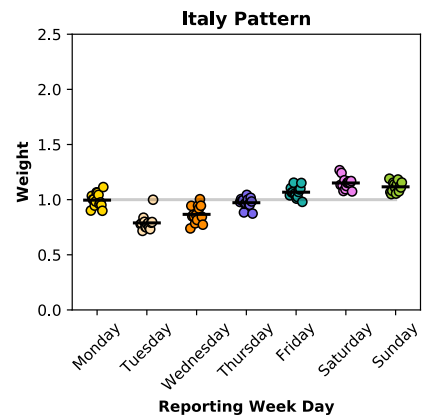
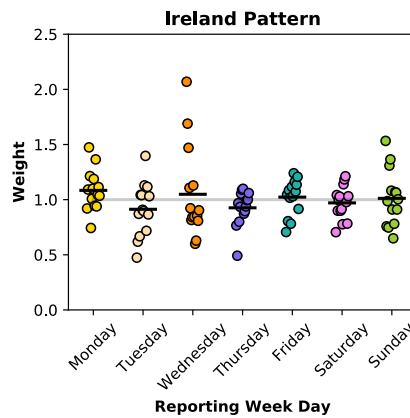
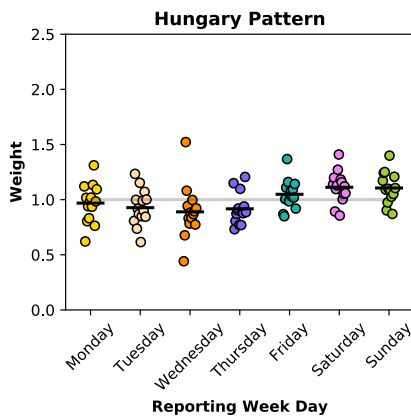
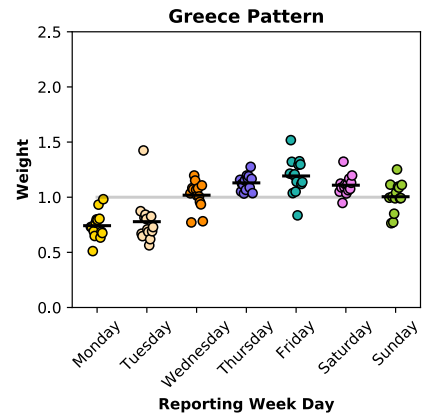
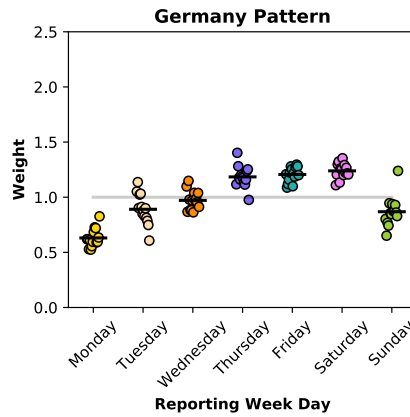
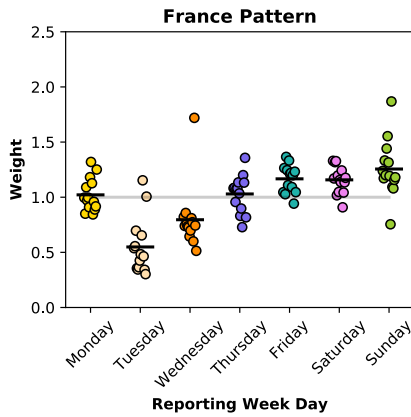
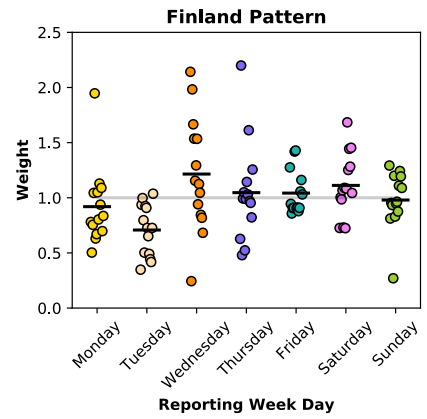
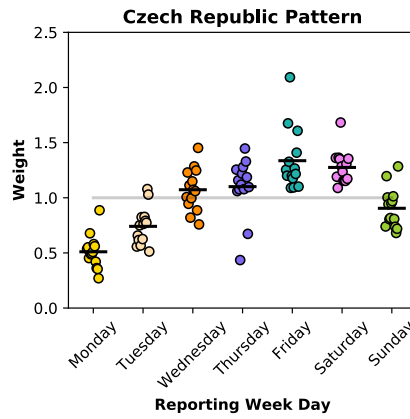
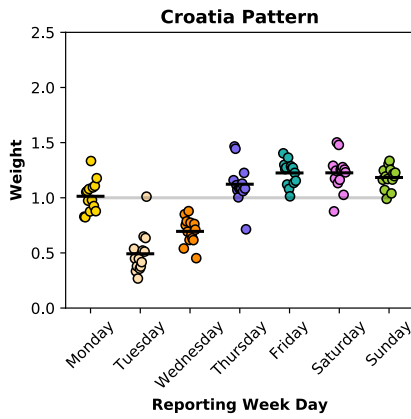
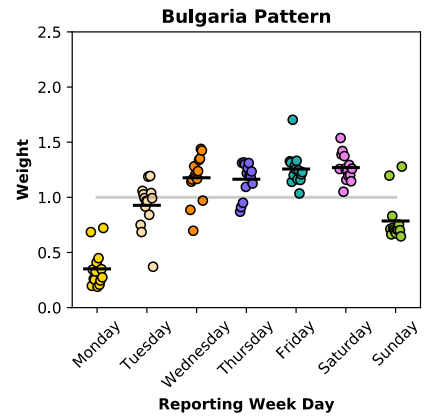
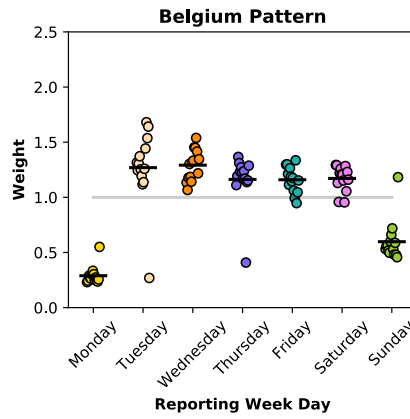
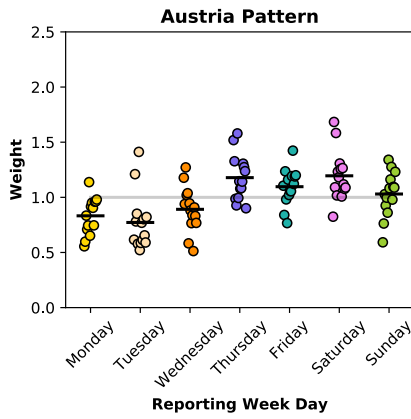
Supplementary Table S1. List of countries with their population, standard deviation and peake-to-peak difference of data of new cases of Covid-19 and number of days without reporting new cases. The eliminated countries for the study are coloured in red and orange due to unreliability of data, while countries with yellow background are marked as countries with days without case reports but with such a little amount that their series are easily corrected.

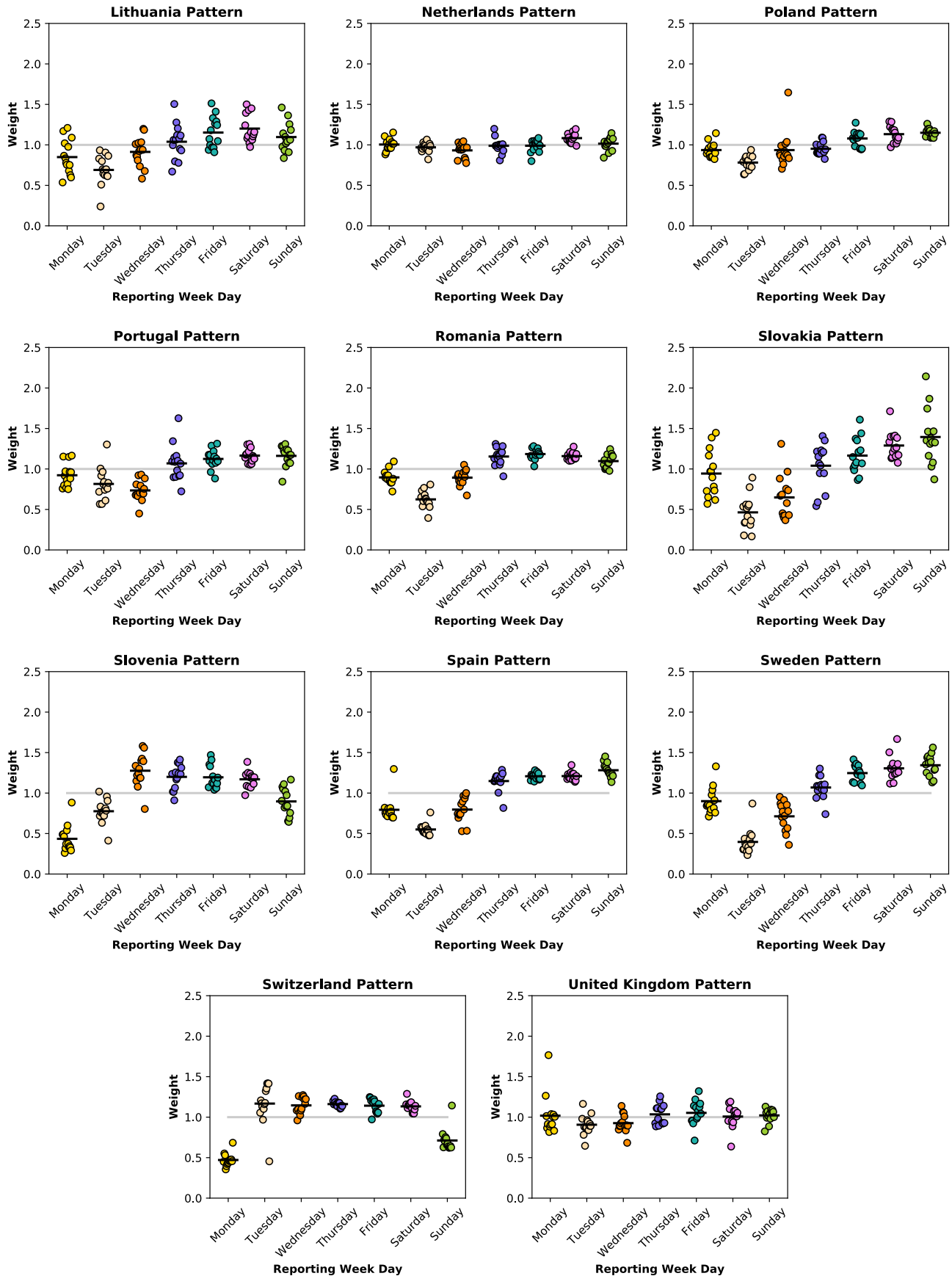
2 Pattern analysis

The ratio between new cases on the day t and the 7-day moving average value, $n_7(t)$ is defined as

$$w(t) = \frac{n(t)}{n_7(t)} \quad (1)$$

In Supplementary Figure S1 we show the reporting patterns, depending on the day of the week, of the 23 countries taken into account in this study.





Supplementary Figure S1. Reporting patterns of the 23 EU+EFTA+UK countries that remain after applying the first filter in Supplementary Table S1.

3 Performance analysis of the prediction methods

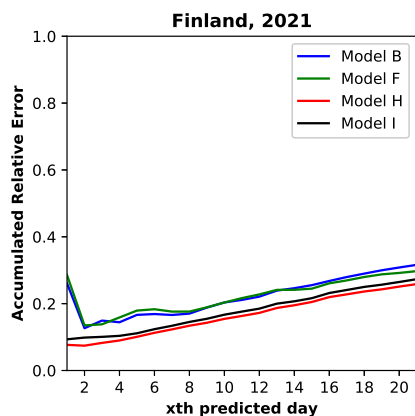
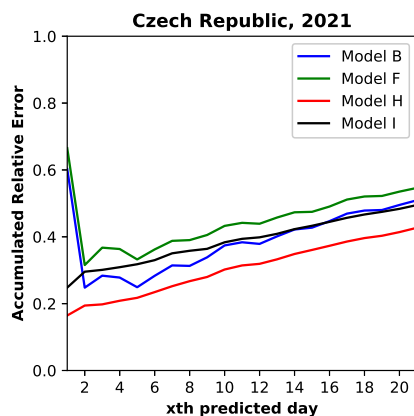
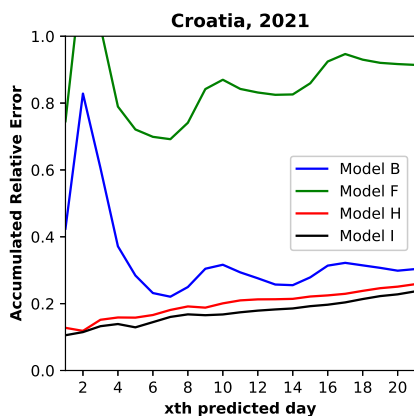
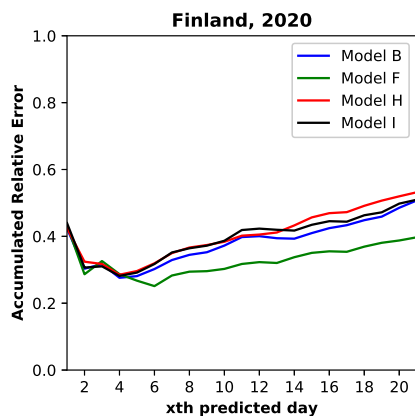
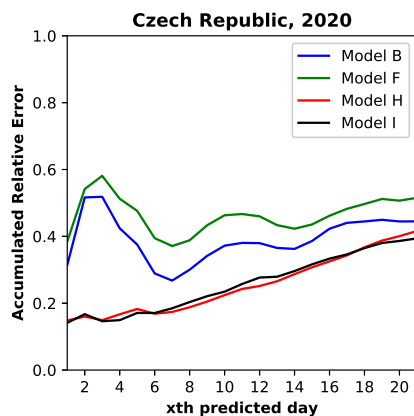
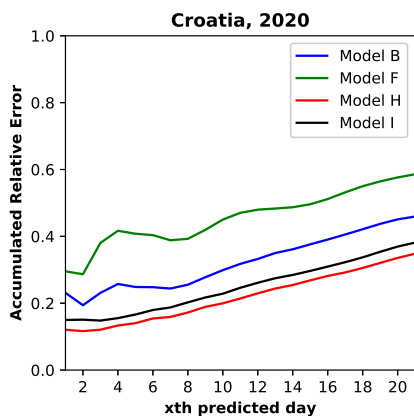
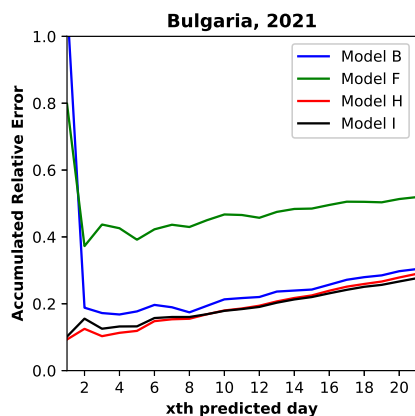
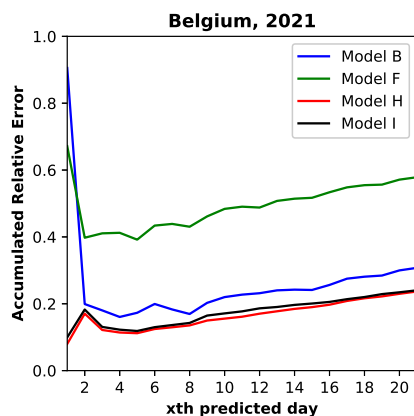
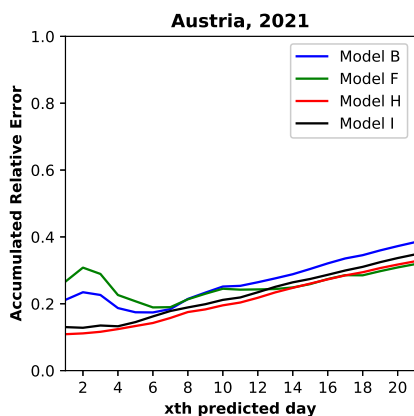
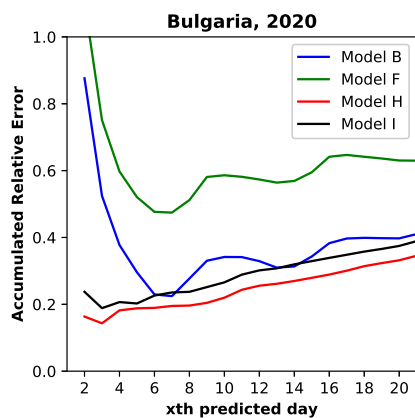
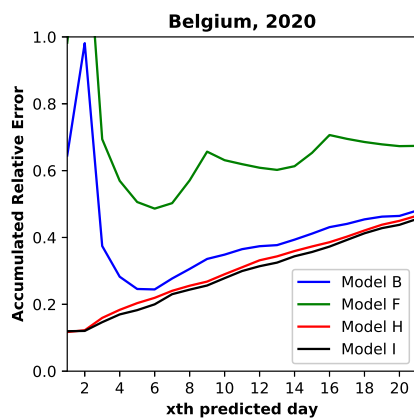
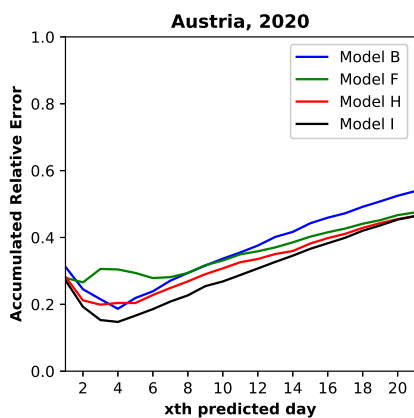
Four different models of prediction have been used in this study to fit the Gompertz function when considering different minimization functions:

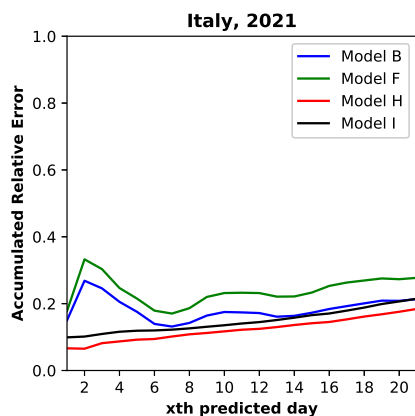
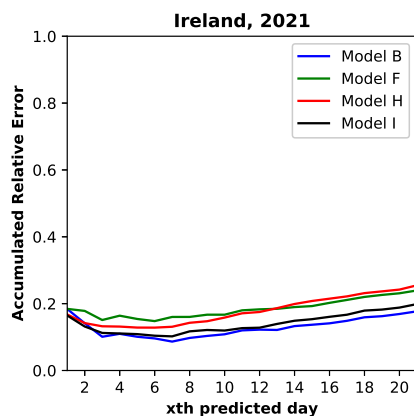
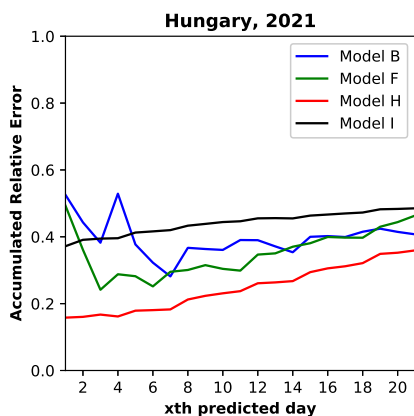
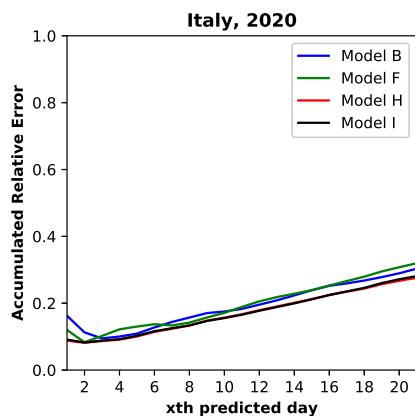
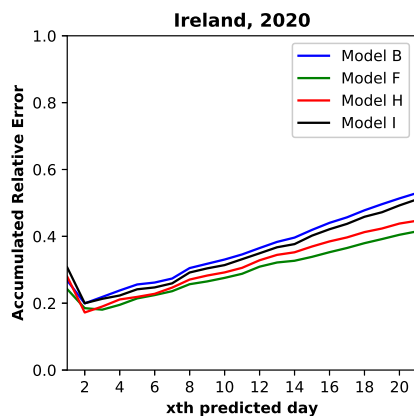
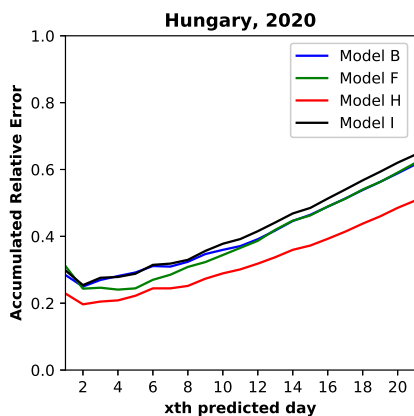
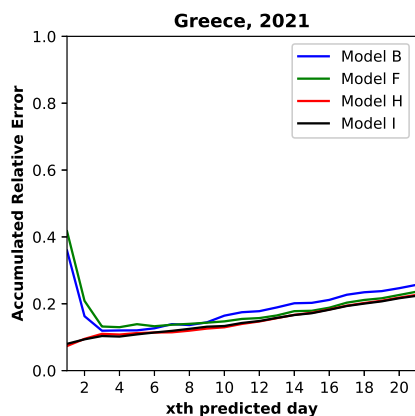
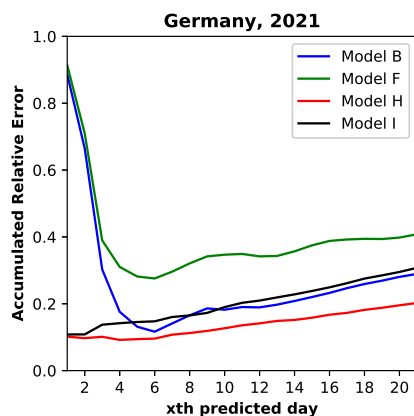
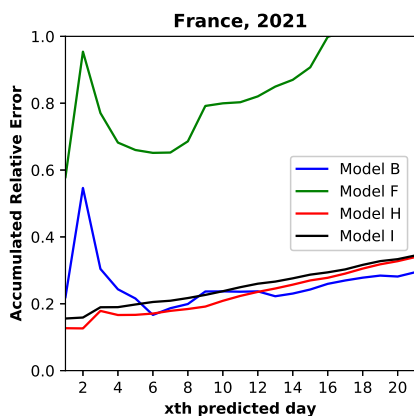
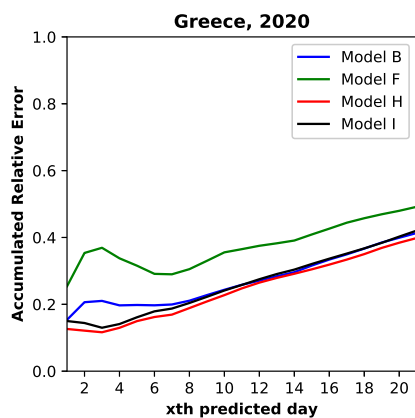
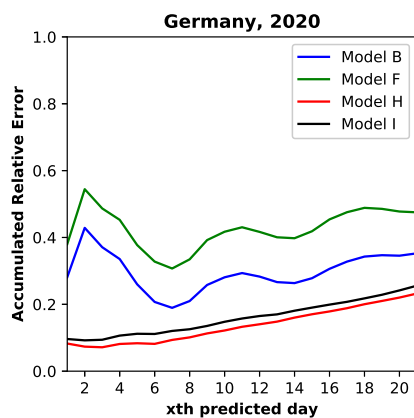
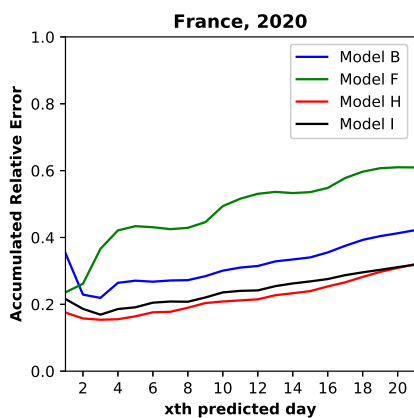
- Model B (Baseline): minimizes the error in accumulated cases.
- Model F (Fallback): minimizes the error in new cases.
- Model H (Hallmark): minimizes the error in new cases with corrected data due to their daily patterns.
- Model I (Introduction of Patterns): minimizes the error in accumulated cases with corrected data due to their daily patterns.

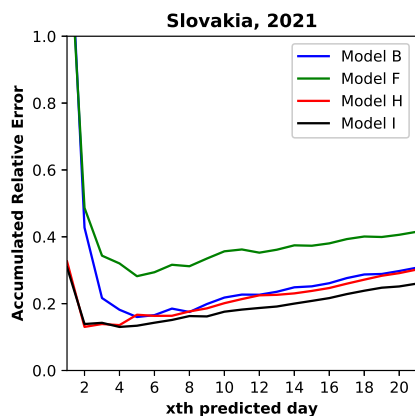
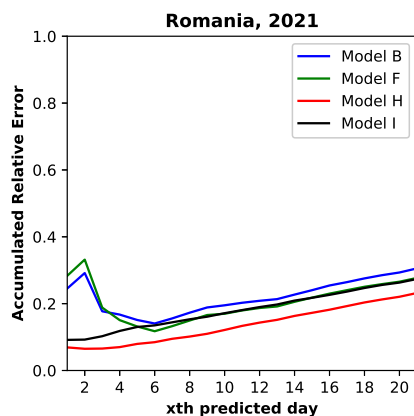
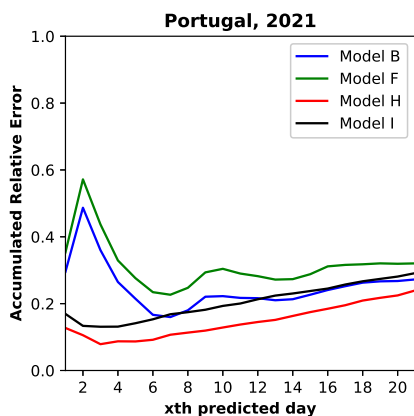
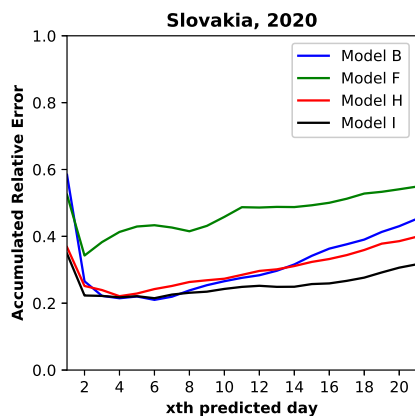
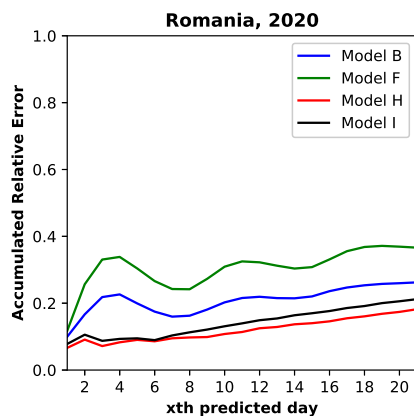
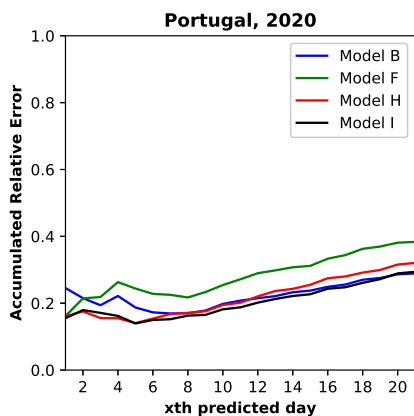
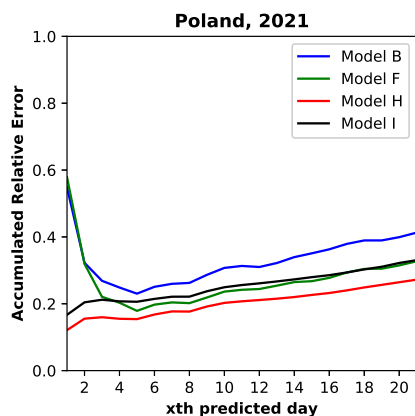
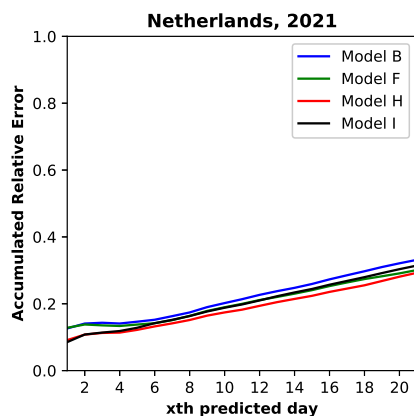
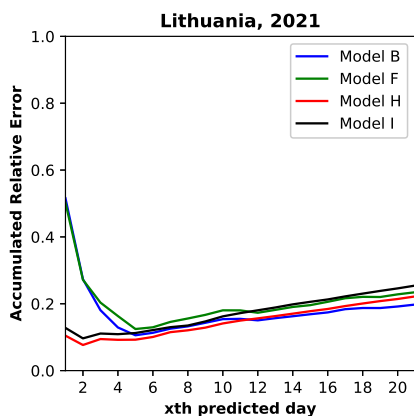
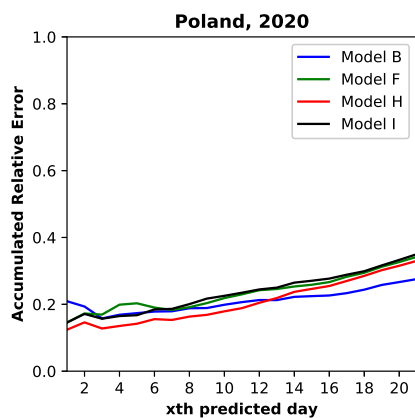
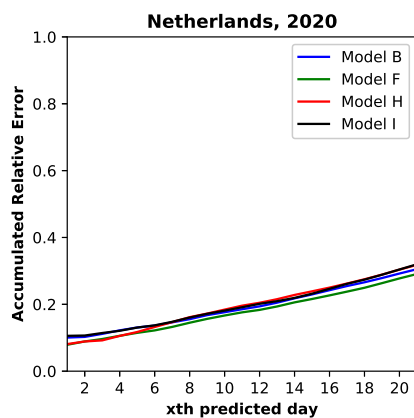
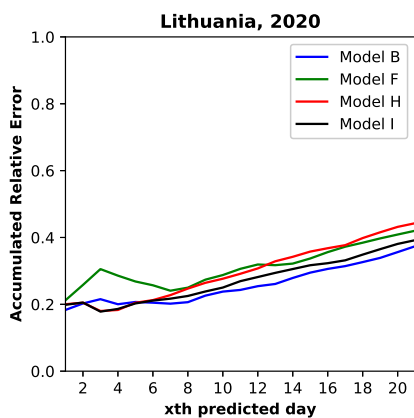
The accumulated relative error of the prediction fit while using the four different models can be observed in Supplementary Figure S2 as a function of the predicted day for each one of the countries which passed the initial filter.

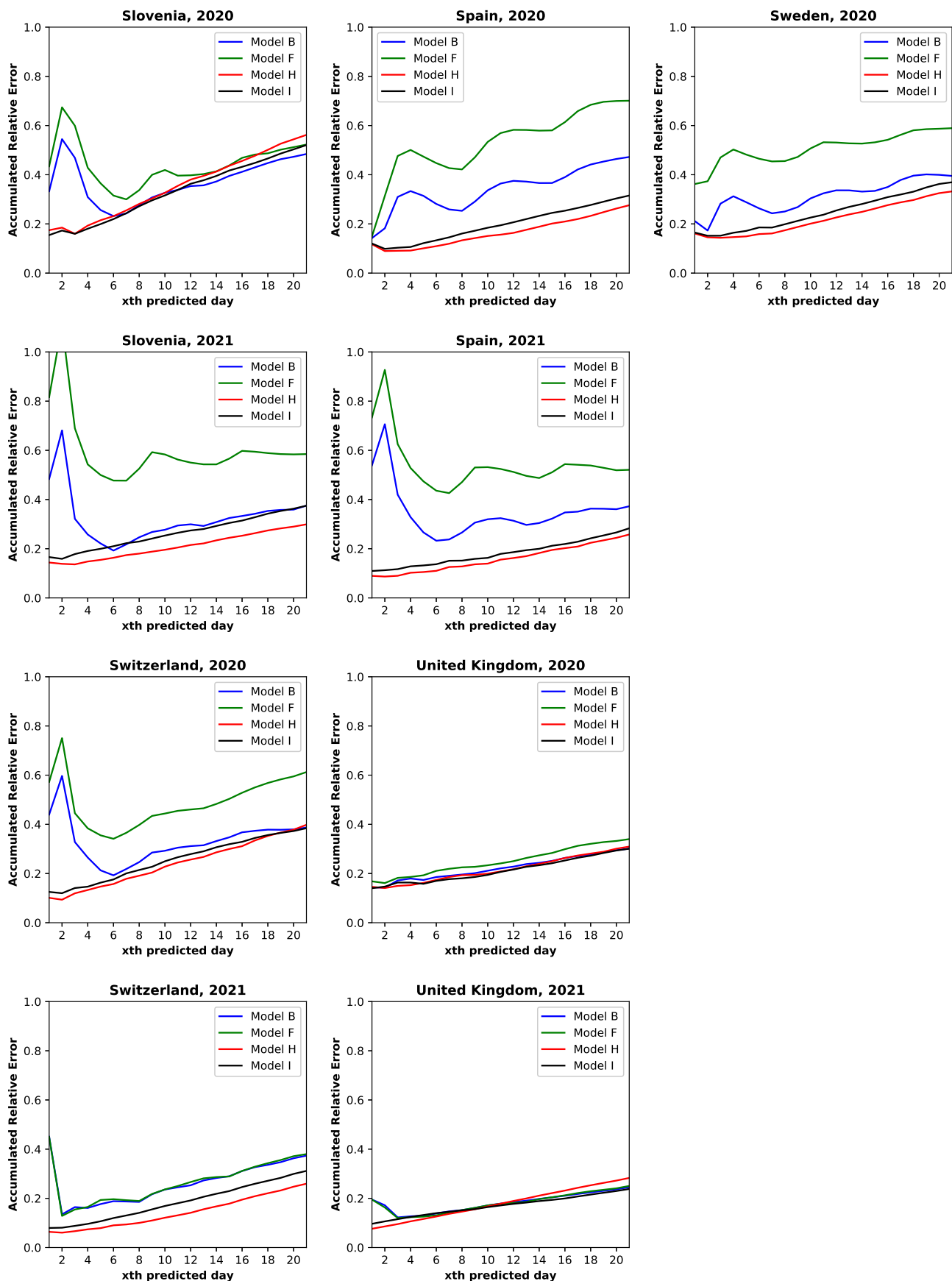
In Supplementary Figure S3, we show the success rate of each model for each country, while different maximum relative errors are allowed (from 0.1 up to 0.5) in different predicted days (7th, 14th and 21st). In Supplementary Figure S4, we show the success rate of each model for the mean of all the predictions of all countries.

Both 2020 and 2021 are represented for each country but Sweden.

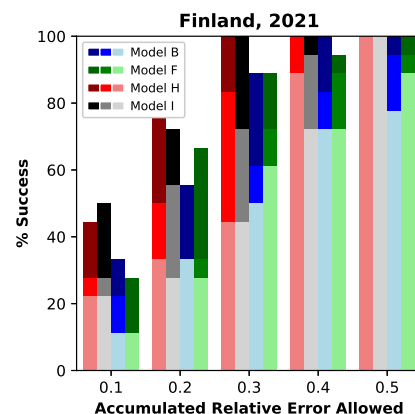
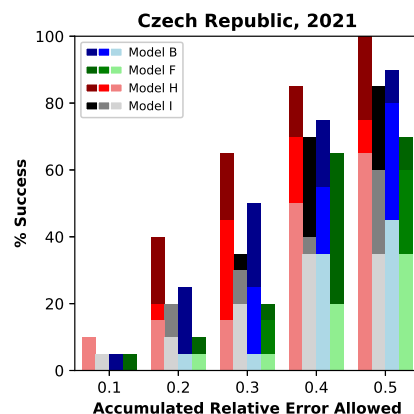
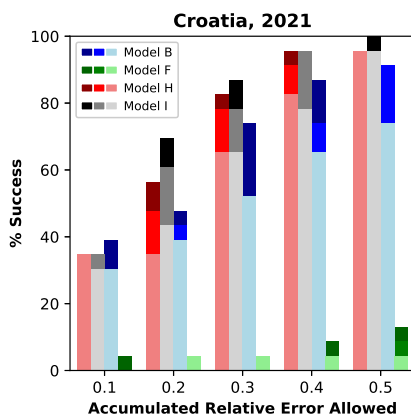
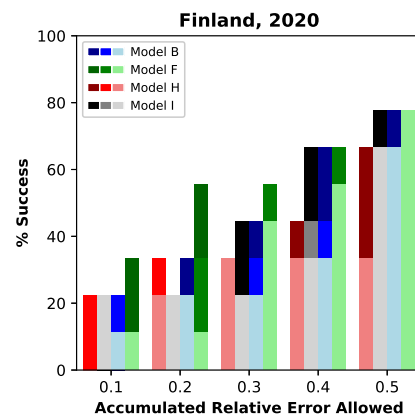
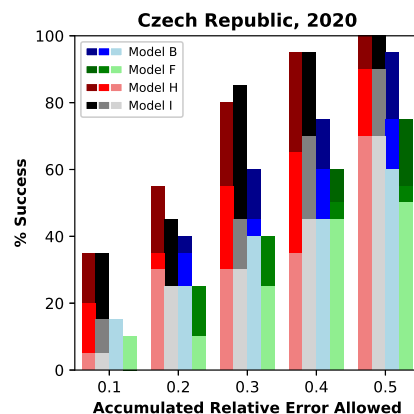
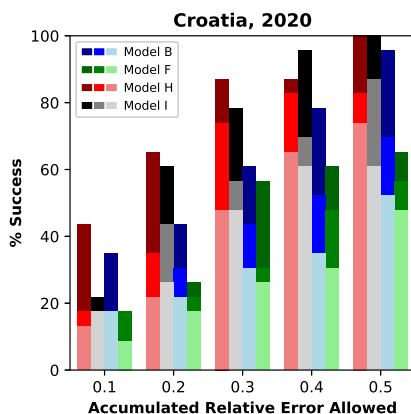
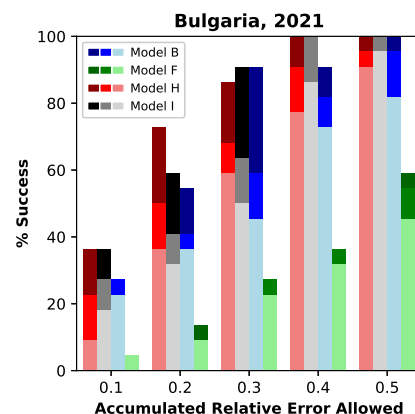
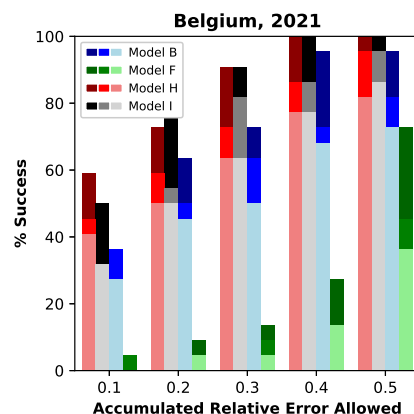
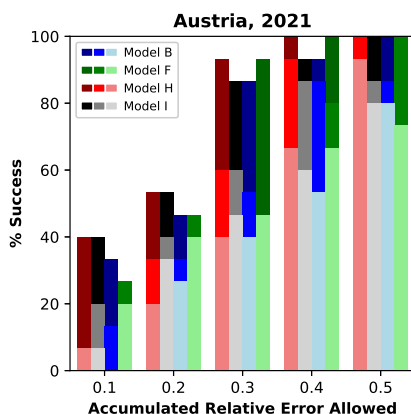
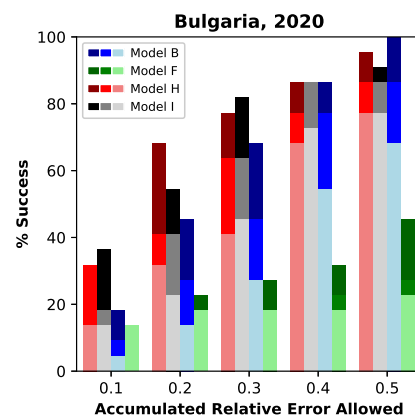
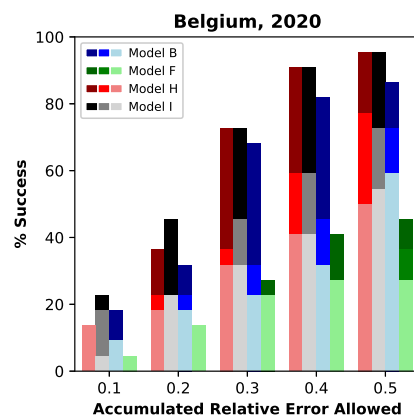
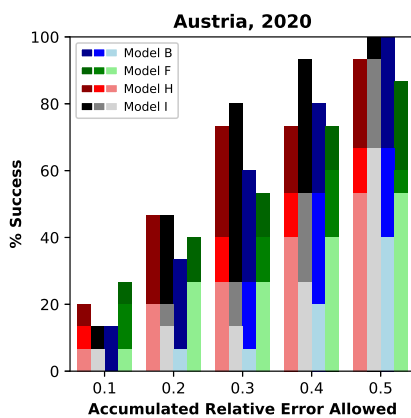


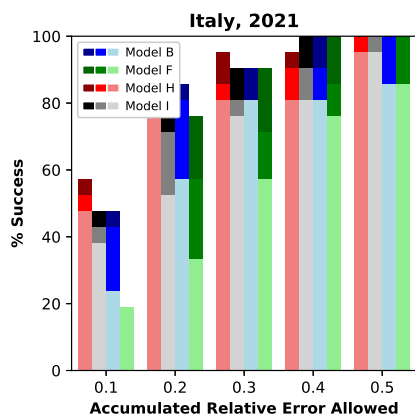
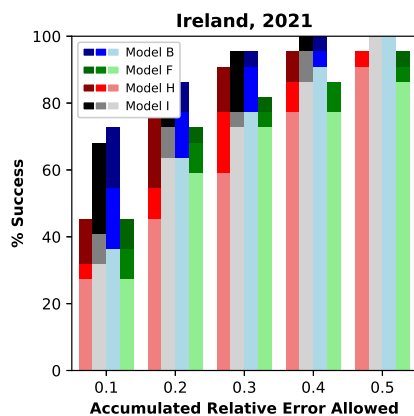
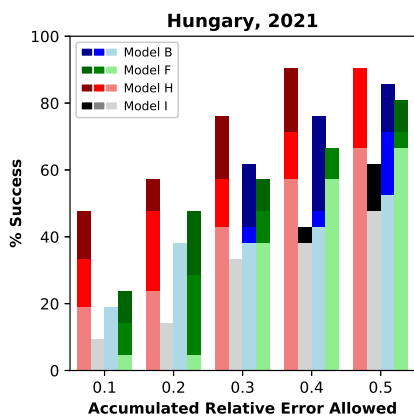
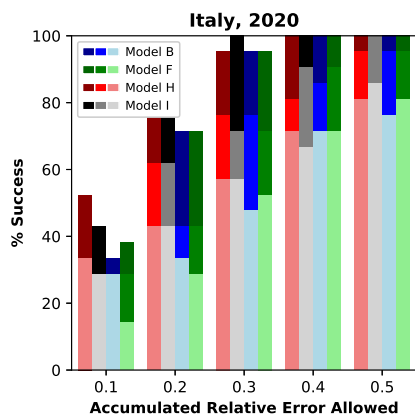
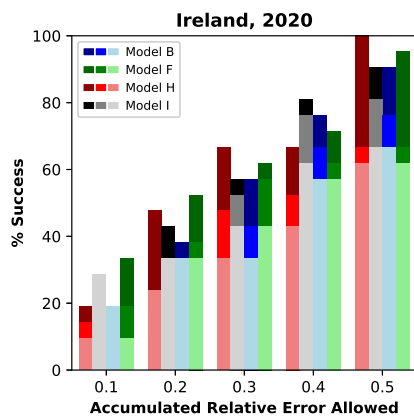
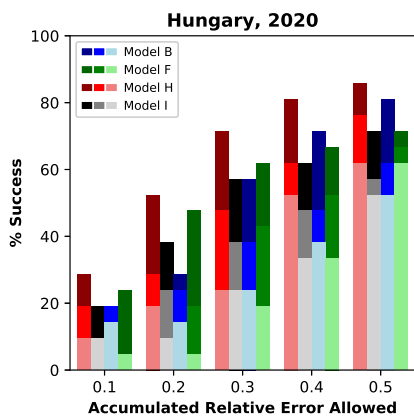
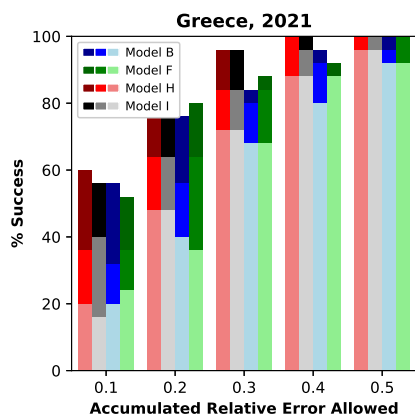
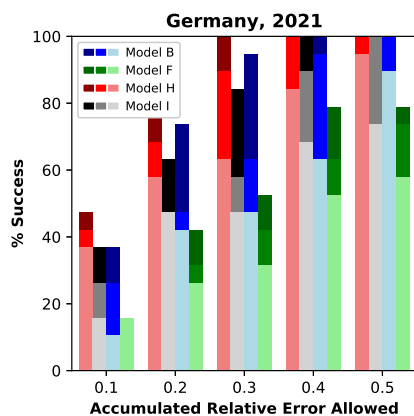
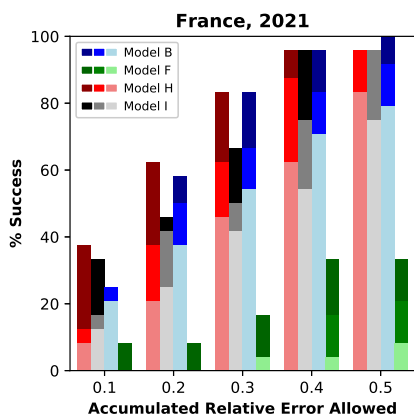
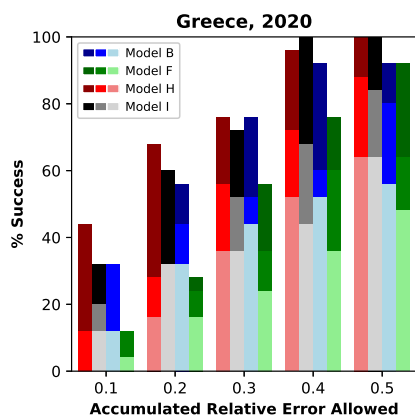
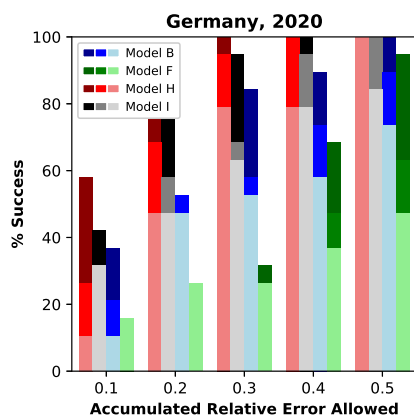
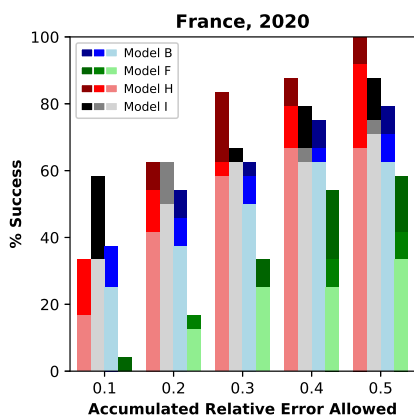


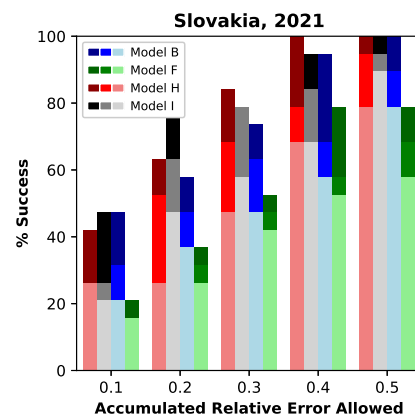
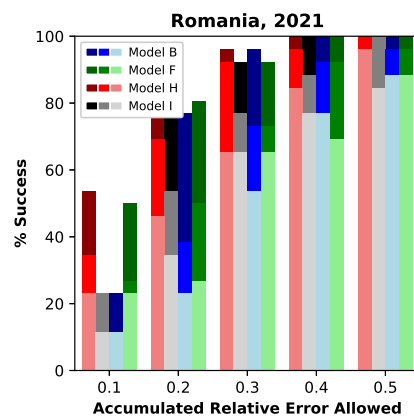
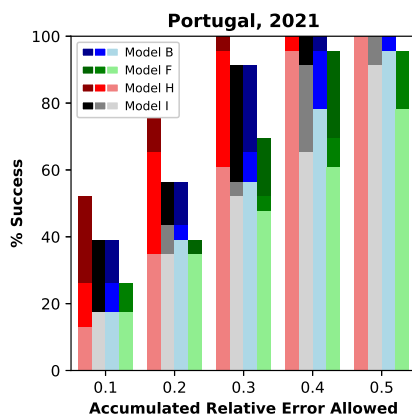
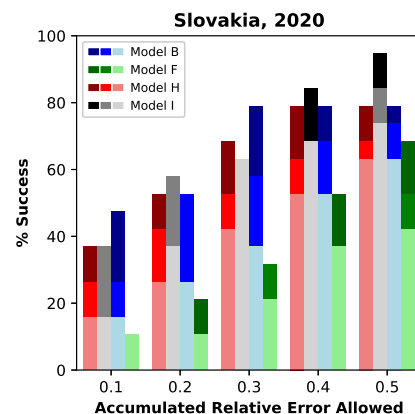
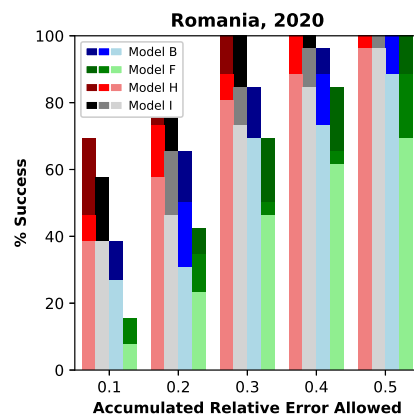
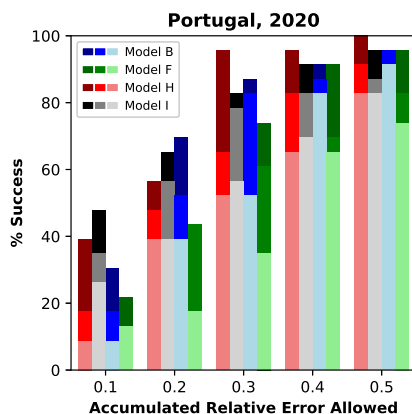
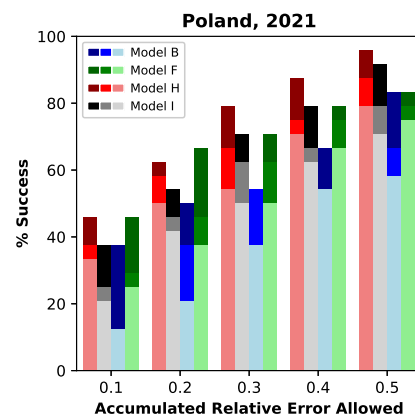
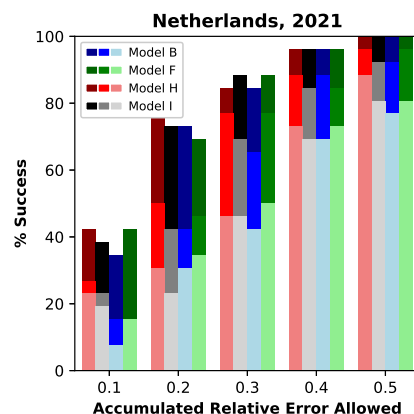
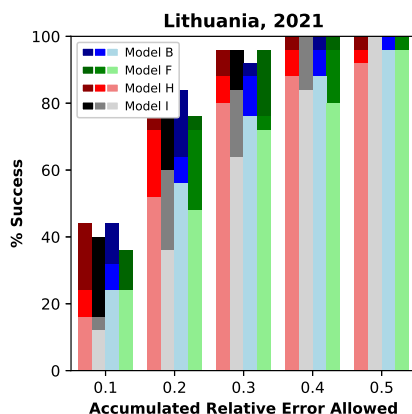
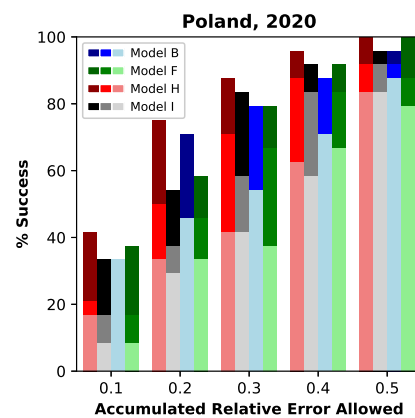
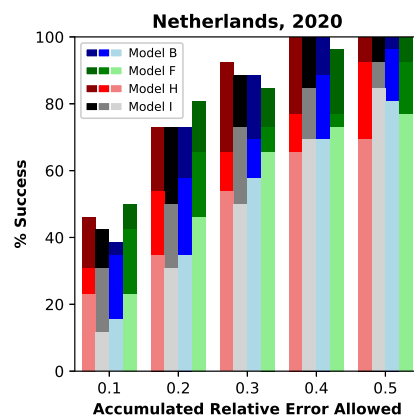
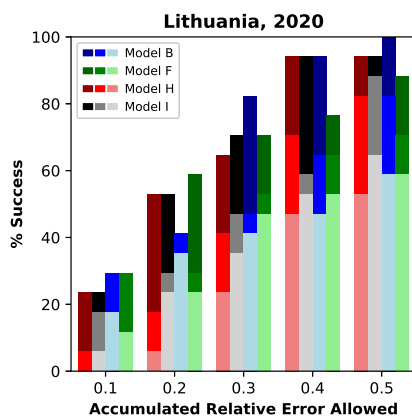


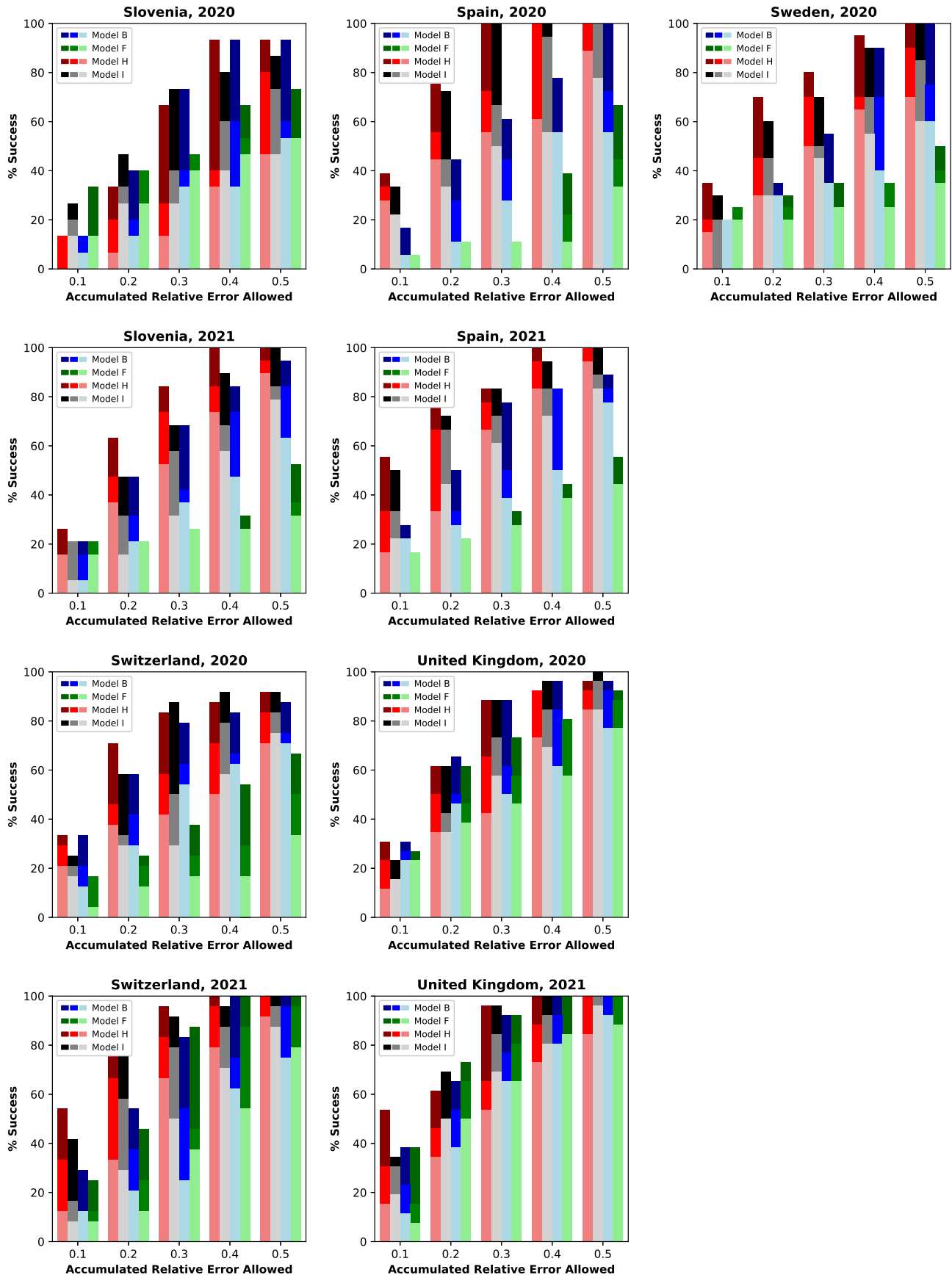


Supplementary Figure S2. Accumulated relative error as a function of the xth day of the prediction for all of the 23 countries in the study for 2020 and 2021.

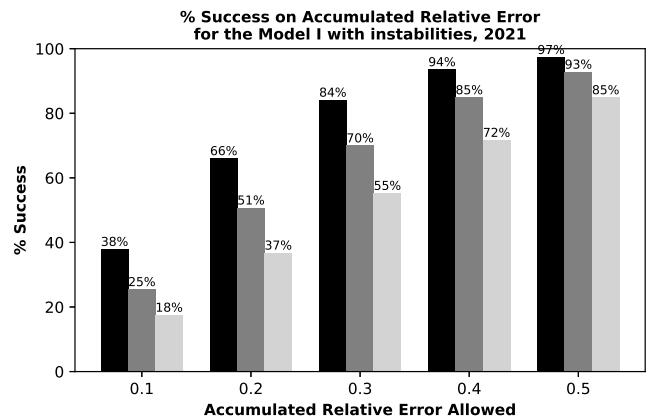
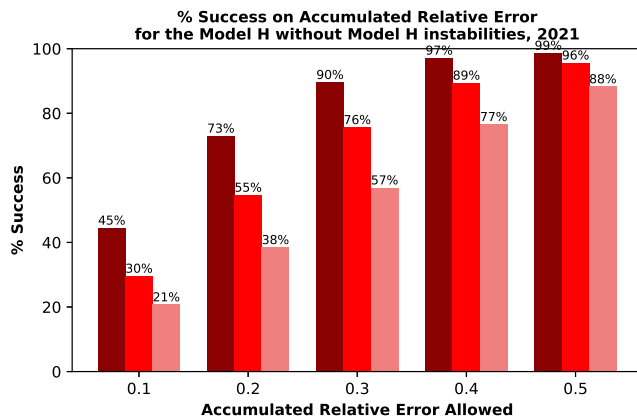
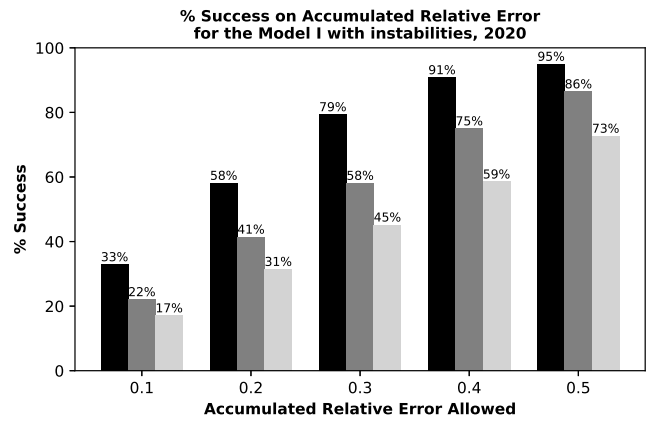
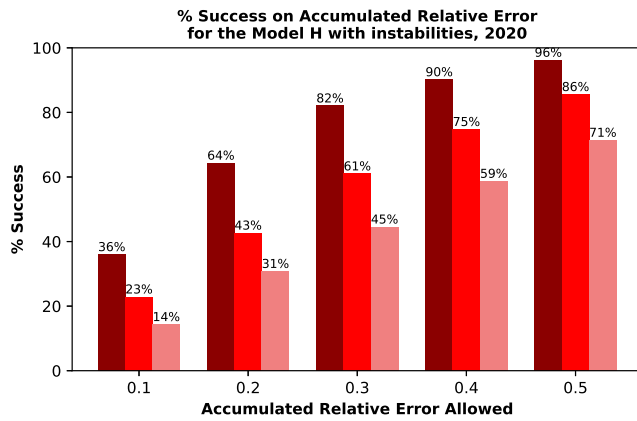
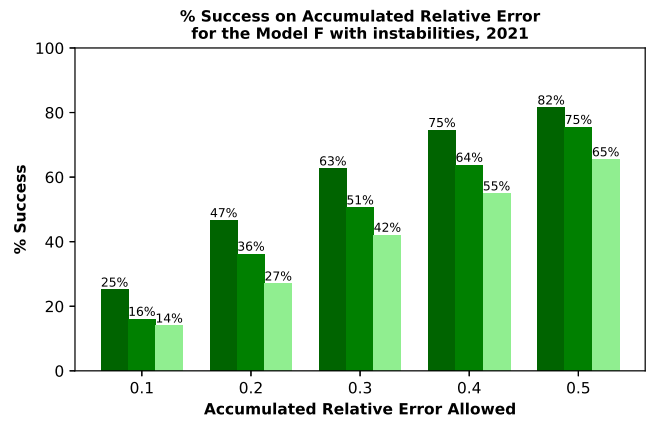
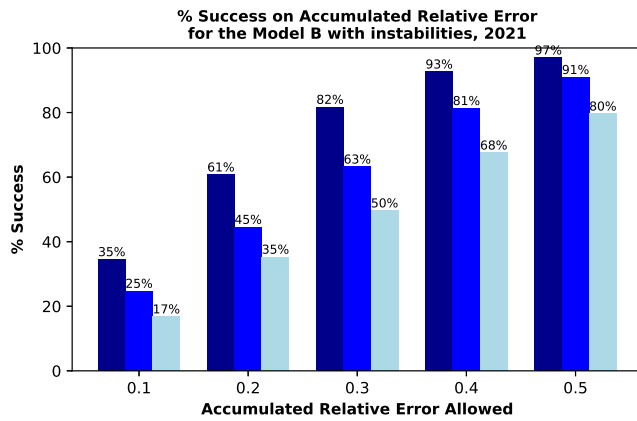
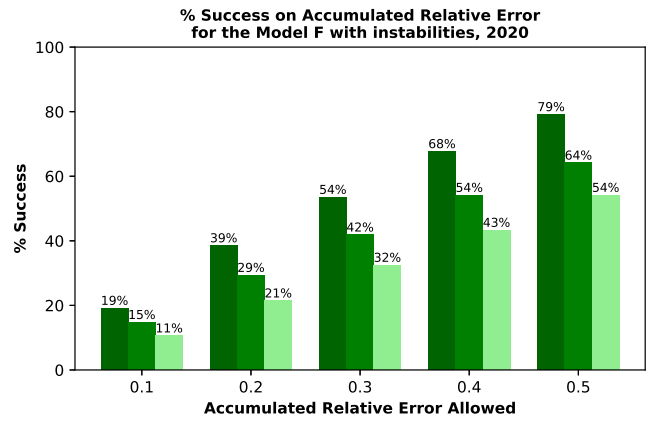
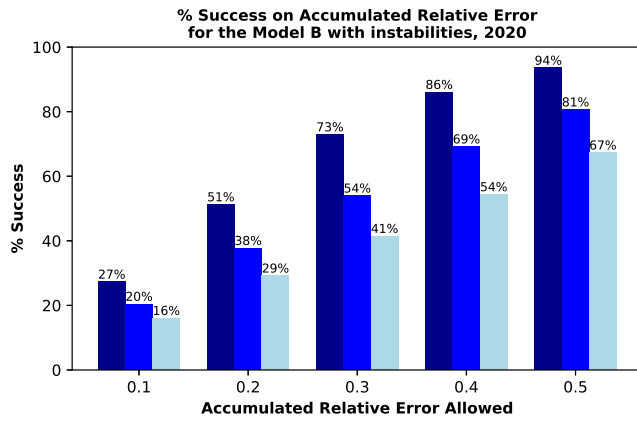








Supplementary Figure S3. Success rate for each of the model when allowing a certain error for the averaged accumulated relative error for all countries in the study, for 2020 and 2021. Lighter colours correspond to closer predicted days (7th, 14th, and 21st).



Supplementary Figure S4. Success rates for the 7th, 14th and 21st predicted days as a function of an allowed accumulated relative error for all the 4 prediction methods and 2020 and 2021. 14/16

4 Prediction filter

For every Tuesday and Saturday (2020) and every country, a filter is applied to determine whether the prediction can be reliable or not. If the average number of cases in the last 7 days is lower than 100 per day, then no prediction is made (marked in gray in Supplementary Table S2). If that is not the case, the prediction for the next 21 days is made. However, some of these predictions can be considered unstable (in red in Supplementary Table S2) if they highly depend on the number of back-days (N in the main manuscript) that is used for the fitting. The same is done with the same days of 2021, in this case Wednesday and Sunday, in Supplementary Table S3.

	AT	BE	BG	HR	CZ	FI	FR	DE	EL	HU	IE	IT	LT	NL	PL	PT	RO	SK	SI	ES	SE	CH	UK
01/09/2020																							
05/09/2020																							
08/09/2020																							
12/09/2020																							
15/09/2020																							
19/09/2020																							
22/09/2020																							
26/09/2020																							
29/09/2020																							
03/10/2020																							
06/10/2020																							
10/10/2020																							
13/10/2020																							
17/10/2020																							
20/10/2020																							
24/10/2020																							
27/10/2020																							
31/10/2020																							
03/11/2020																							
07/11/2020																							
10/11/2020																							
14/11/2020																							
17/11/2020																							
21/11/2020																							
24/11/2020																							
28/11/2020																							

Supplementary Table S2. Table of days without predictions (grey) or unstable predictions (red) for each country with their country codes for 2020.

	AT	BE	BG	HR	CZ	FI	FR	DE	EL	HU	IE	IT	LT	NL	PL	PT	RO	SK	SI	ES	SE	CH	UK
01/09/2021																							
05/09/2021																							
08/09/2021																							
12/09/2021																							
15/09/2021																							
19/09/2021																							
22/09/2021																							
26/09/2021																							
29/09/2021																							
03/10/2021																							
06/10/2021																							
10/10/2021																							
13/10/2021																							
17/10/2021																							
20/10/2021																							
24/10/2021																							
27/10/2021																							
31/10/2021																							
03/11/2021																							
07/11/2021																							
10/11/2021																							
14/11/2021																							
17/11/2021																							
21/11/2021																							
24/11/2021																							
28/11/2021																							

Supplementary Table S3. Table of days without predictions (grey) or unstable predictions (red) for each country with their country codes for 2021.