# A Statistical Evaluation of COVID-19 Surveillance in the Norwegian Syndromic Surveillance System (NorSySS)

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## 1 Introduction

The Norwegian Syndromic Surveillance System (NorSySS) is a vital public health surveillance system designed to detect outbreaks of infectious diseases and provide early warning for implementation of necessary control measures.[1] As of the time of publishing, NorSySS surveils 87 ICPC-2 code combinations on a daily basis, at the national, county, and municipality level. The data

## 2 Methods

We adapted the guidelines for evaluating public health surveillance systems as provided by the Centers for Disease Control and Prevention.[2] The guidelines were shortened to focus on the attributes that were most relevant to a statistical evaluation.

Table 1: Attributes relevant to the statistical evaluation of COVID-19 surveillance in NorSySS.[2]

| Attribute | Definition |
| --- | --- |
| Sensitivity | Ability to detect outbreaks, including the ability to monitor changes in the number of cases over time. |
| Timeliness | The speed between steps in a public health surveillance system. |

### 2.1 Sensitivity

Sensitivity is defined as the ability to detect outbreaks, including the ability to monitor changes in the number of cases over time (Table 1). We began adressing sensitivity by

inspecting partial autocorrelation (PACF) plots of the four time series to identify autocorrelation. Autocorrelation was then treated by differencing the time series with a lag of one unit (also known as "pre-whitening").[3]

After differencing the time series, we investigated which combination of ICPC-2 codes and tariff groups had the best cross-correlation with the hard endpoints (new hospital admissions, new ICU admissions, and new deaths) over the entire time period (2020-09 to 2023-20).

We then investigated if these associations were robust over different time periods. Cross-correlation coefficients were then calculated for the comparison of NorSySS (ICPC-2 codes R991+R992 and tariff group "fe") against the hard endpoints (new hospital admissions, new ICU admissions, and new deaths) over multiple time periods: Wuhan (2020-09 to 2021-06), Alpha (2021-07 to 2021-26), Delta (2021-27 to 2021-51)[4], Omicron (2021-52 to 2023)[5], no control (2022-07 to 2023-20)[6], all (2020-09 to 2023-20). No control represents the period after which "smitteverntiltakene oppheves" (the infection control measures are lifted).[6]

We then investigated if if a short-term trend algorithm[7] classified weeks (increasing/null/decreasing) in the four timeseries (NorSySS ICPC-2 codes R991+R992 and tariff group "fe", new hospital admissions, new ICU admissions, and new deaths) similarly throughout the study period. Briefly, the algorithm fit a linear trend to a moving six week window of data using a quasipoisson regression. If the linear trend was significantly greater or less than 0, then the last week in the six week window was classified as increasing or decreasing, respectively. Otherwise the last week in the six week window was classified as null.

## 2.2 Timeliness

# 3 Results

Table 2: Purpose and operation of COVID-19 surveillance in NorSySS.

| Indicator | Value |
| --- | --- |
| Purpose and objectives | • Monitor trends of COVID-19. <br><br> • Detect outbreaks of COVID-19 <br><br> • Provide early warning for implementation of necessary control measures. |

| Indicator | Value |
|---|---|
| Health-related event under surveillance | COVID-19<br><br>• R991: Suspected/probably COVID-19. A person who meets the clinical criteria: acute respiratory tract infection and one or more of the following symptoms: fever, cough, shortness of breath, loss of sense of smell/taste, or who is considered by a doctor to have suspected COVID-19.[8]<br><br>• R992: Confirmed COVID-19. A person with coronavirus (SARS-CoV-2) confirmed by RT-PCR test, other nucleic acid amplification test or rapid antigen test (rapid immunoassay).[8] |
| Population under surveillance | All people in Norway who are eligible for treatment by state-sponsored general practitioners or out-of-hours primary care facilities. |
| Period of time of data collection | • R991: 2020-03-05 until present day.[8]<br><br>• R992: 2020-04-30 until present day.[8] |
| What data are collected | Number of consultations performed by state-sponsored general practitioners or out-of-hours primary care facilities corresponding to particular ICPC-2 codes. |
| Reporting sources of data for the system | KUHR (Control and Payment of Health Reimbursements), which is a system that manages reimbursement claims from healthcare providers and institutions to the state (HELFO) in Norway. The system is owned by the Norwegian Directorate of Health. KUHR stores information about each patient's contact with a healthcare provider. |
| Systems data analyzed | Using Surveillance Core 9 ("sc9"), a free and open-source framework for real-time analysis and disease surveillance.[9] |

## 3.1 Sensitivity

Definition: Ability to detect outbreaks, including the ability to monitor changes in the number of cases over time.

We found that the four time series had an AR(1) pattern (Figure 1 A, C, E, G), which

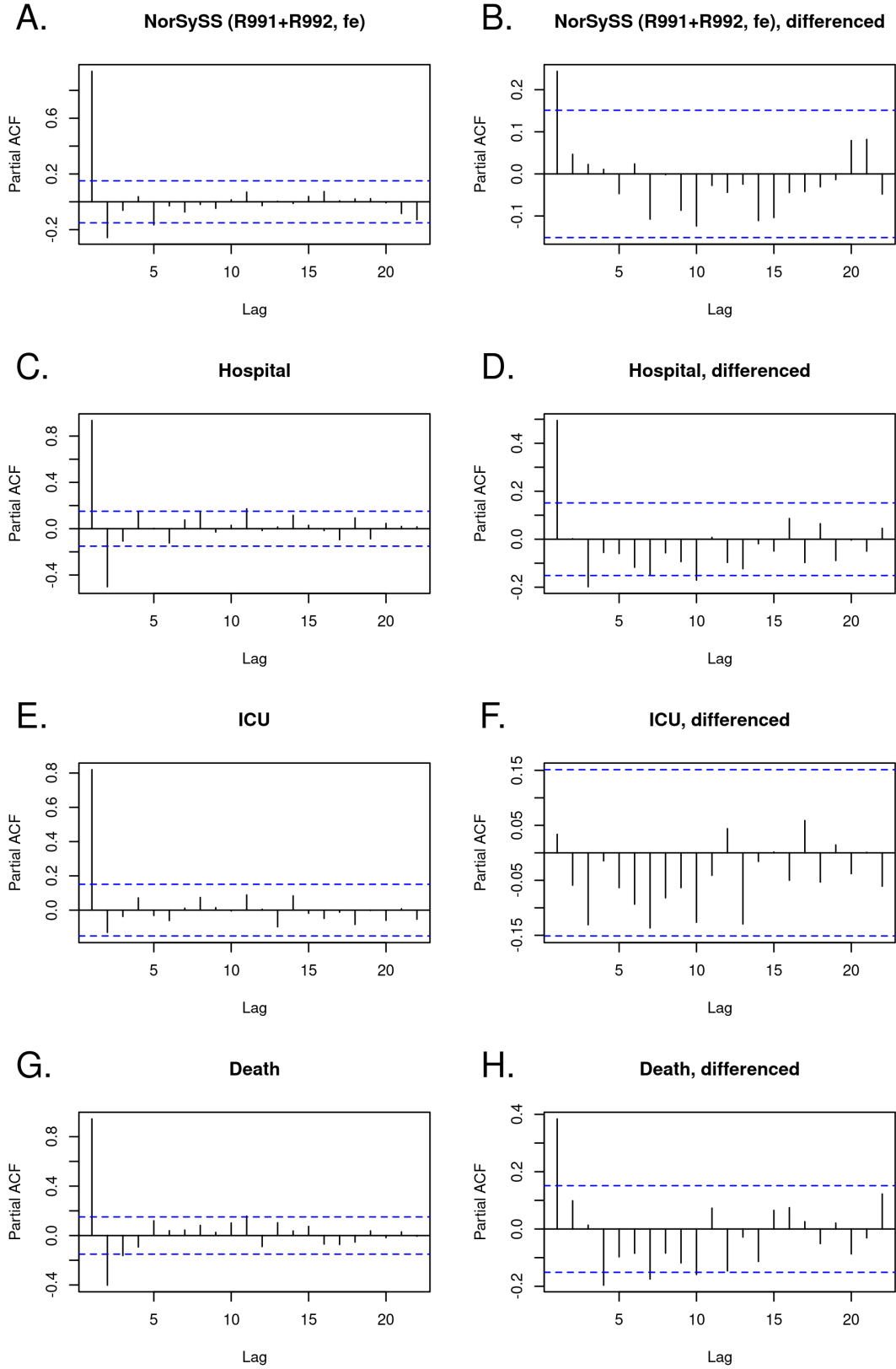was successfully removed via differencing (Figure 1 B, D, F, H).

Figure 1: Partial autocorrelation plots (PACF) of four time series (NorSySS R991+R992 fe, new hospital admissions, new ICU admissions, new deaths) for all of Norway.

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We found that the NorSySS combination of ICPC-2 codes R991+R992 and tariff codes fe had the highest cross-correlation coefficient with the hard endpoints of new hospital admissions, new ICU admissions, and new deaths (Figure Figure 2).

Furthermore, NorSySS (R991+R992, fe) was most correlated with new hospital admissions occuring in the same week (0.43) and the week after (0.41) (Figure Figure 2). NorSySS (R991+R992, fe) was most correlated with new ICU admissions occuring in the week after (0.26) (Figure Figure 2). NorSySS (R991+R992, fe) was most correlated with new deaths occuring two weeks after (0.43) (Figure Figure 2).
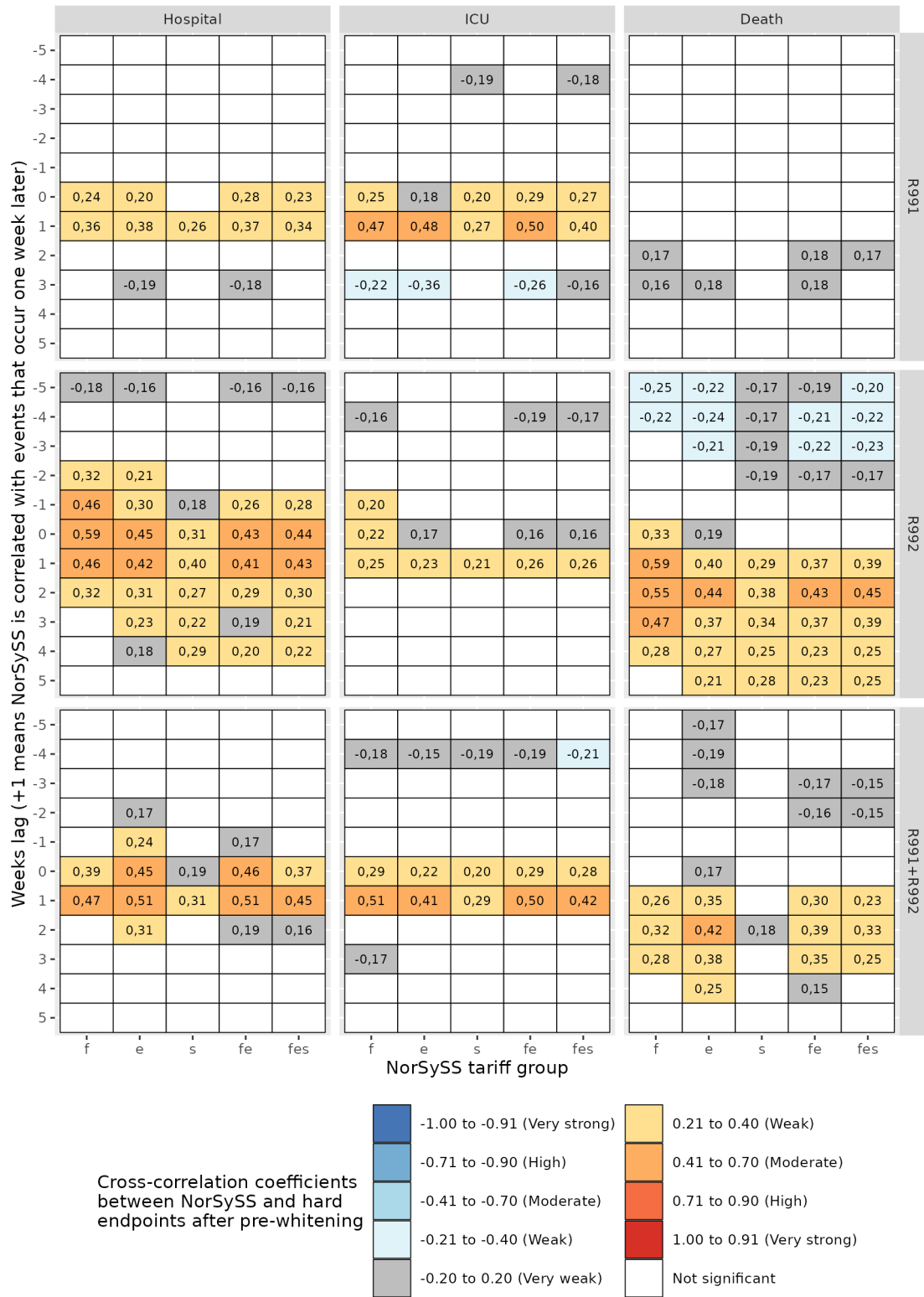
Figure 2: Cross-correlation coefficients (after differencing) between various NorSySS ICPC-2/tariff codes and hard endpoints between 2020-09 and 2023-20 for all of Norway.

NorSySS (R991+R992, fe) showed moderate cross-correlation coefficients with new hospital admissions across all time periods (Figure 3).

The cross-correlation coefficients between NorSySS (R991+R992, fe) and new ICU admissions were moderate to high one week later during the Wuhan, Omicron, no control, and all time periods, while moderate to high during the same week for the Alpha and Delta time periods (Figure 3).

The cross-correlation coefficients between NorSySS (R991+R992, fe) and new deaths were moderate for 2-3 weeks later during the Wuhan, Omicron, and no control time periods, weak for 2-3 weeks later during the all time period, moderate two weeks later during the Alpha period, and moderate one week later during the Delta period (Figure 3).
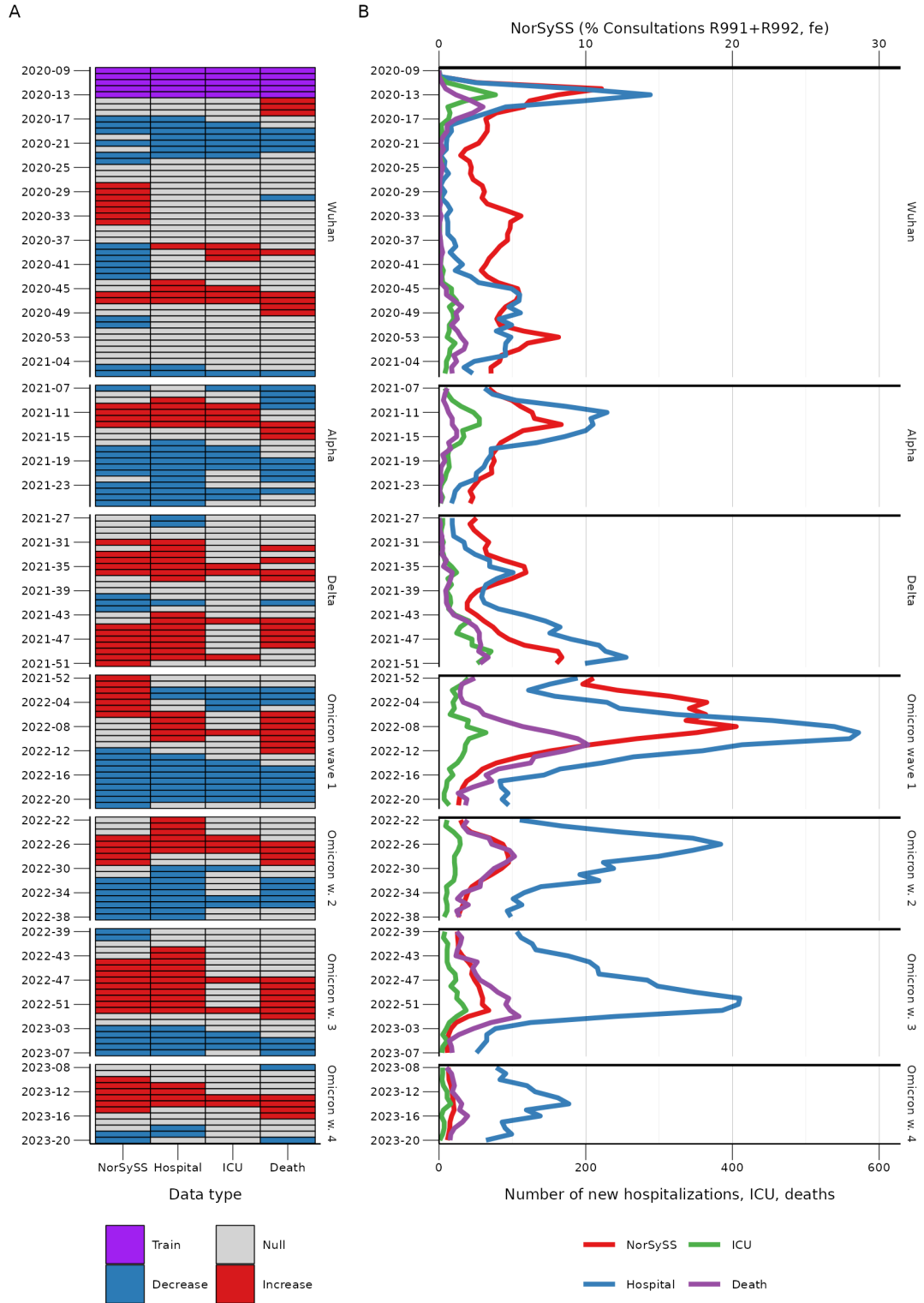
Figure 3: Cross-correlation coefficients (after differencing) between NorSySS (R991+R992, fe) and hard endpoints over various time-periods (Wuhan 2020-09 to 2021-06, Alpha 2021-07 to 2021-26, Delta 2021-27 to 2021-51, Omicron 2021-52 to 2023-20, No control 2022-07 to 2023-20, All 2020-09 to 2023-20) for all of Norway.

Figure 4: Six-week short-term trend for NorSySS (R991+R992, fe), new hospital admissions, new ICU admissions, and new deaths for all of Norway.

## 3.2 Timeliness
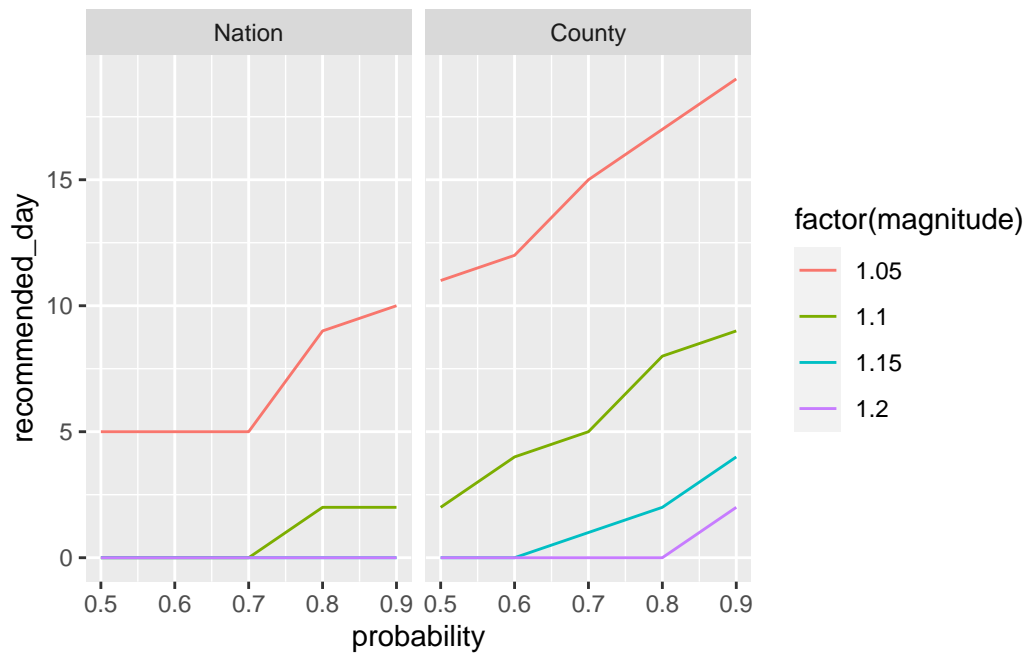


## 4 Discussion

## Conclusions

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