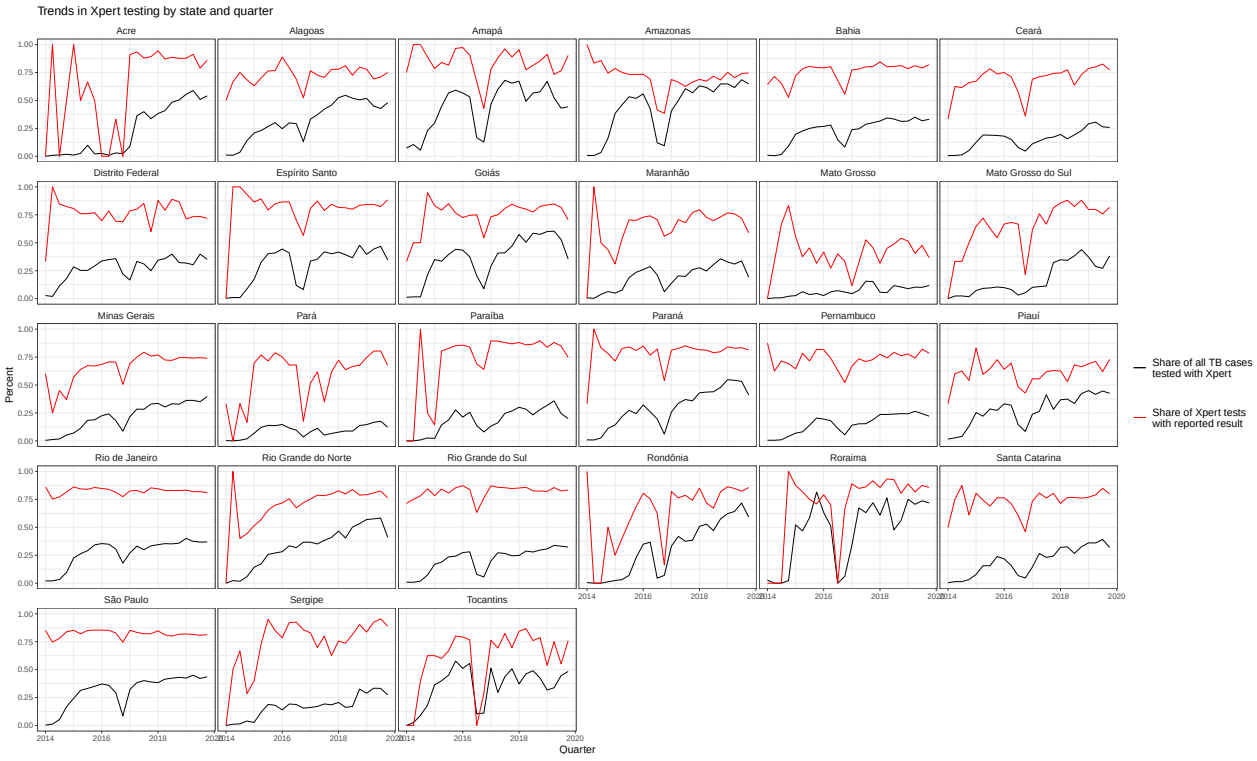
RR-TB Updates: September 28, 2023

Project Aim

- Back out trends in the prevalence of Rifampicin resistant TB (RR-TB) over time using Xpert testing data in Sinan
- Develop a relatively simple model that accounts for variation in roll-out of Xpert over time and across geographies (e.g. by state), as well as potential bias in who is getting tested with Xpert

Helpful context: Trends in Xpert testing overtime



- As of 2019:
  - ~ 40% of cases were being tested with Xpert, compared to ~ 3% in 2014 and 23.5% in 2015, on average
  - Mato Grosso, Pará, and Pernambuco had the lowest average testing coverage
  - Roraima, Amazonas, and Rondônia had the highest average testing coverage

Model Specification

Overview

- State-level hierarchical generalized additive model (GAM) that models the prevalence of RR-TB positive cases per quarter among incident TB cases between 2014-2019
- Fit smoothing functions to reduce the noise we were seeing in previous models
- Models risk of positivity by characteristics of patient and municipality where they reside
  - Note: Between 2014-2019, ~3,300 cases diagnosed outside of patient's state of residence; ~88,000 cases diagnosed outside patient's municipality of residence
- Separate models for new TB cases, re-entry cases, and relapsed cases

Set Up

```
result ~ s(state, bs = "re") + s(time) + s(time, by = state, id = 1) + age_cat +
  hiv_status + sex + health_unit + bf_cat + urban_cat + has_prison
```

- Random intercept for each state (patient state of residence)
- A different smooth function for time by state with a shared smoothing parameter
- Each state-level smoothing parameter varies around a grand smooth function for time to allow for pooling across states
- Fixed effects for patient-level characteristics:
  - Age
  - HIV status
  - Sex
  - Level of health unit of diagnosis - Based on CNES merge
- Fixed effects for municipality-level characteristics:
  - Urbanicity (cat) - Percent of the population in urban setting (2010 census)
  - Bolsa Familia coverage (cat) - Percent of the population benefiting from BF (BF: SAGICAD, 2018 - earliest year available; Denominator: 2010 Census)
  - Presence of prison during year (SISPEN)
  - FHS Coverage - Number of health teams per 4,000 people (Forthcoming)

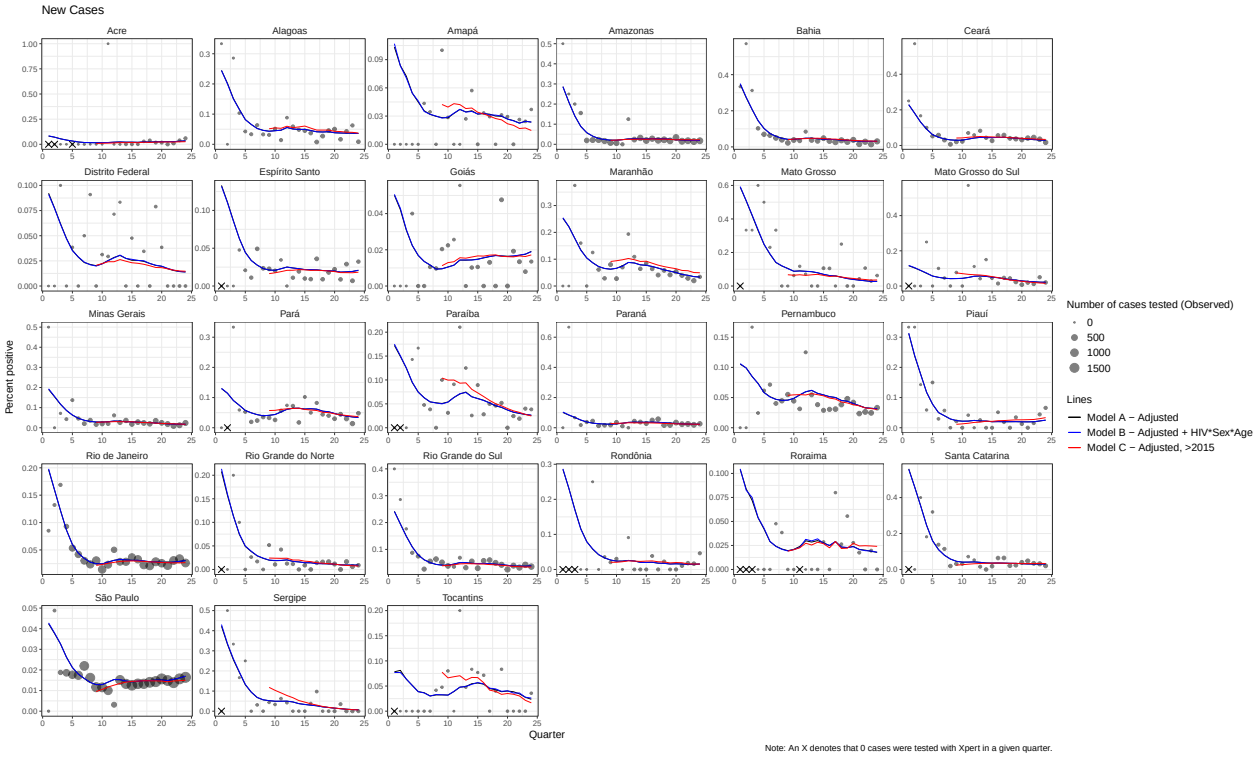
Specifications

- Model 1 - Adjusted:
  - Patient-level: HIV status, sex, age, health unit level
  - Municipality: BF coverage, urbanicity, presence of prison
- Model 2 - Adjusted; Restricted $>$ 2015
- Run separately by case type (e.g. new, relapse, re-entry) and for all cases

Model Output

New cases

- Model A - Adjusted:
  - Patient-level: HIV status, sex, age (cat), health unit
  - Municipality: Pct average BF coverage (cat), pct pop in urban area, presence of prison
- Model B - Model A + interaction term (HIV, sex, age)
- Model C - Model A, restricted to >2015

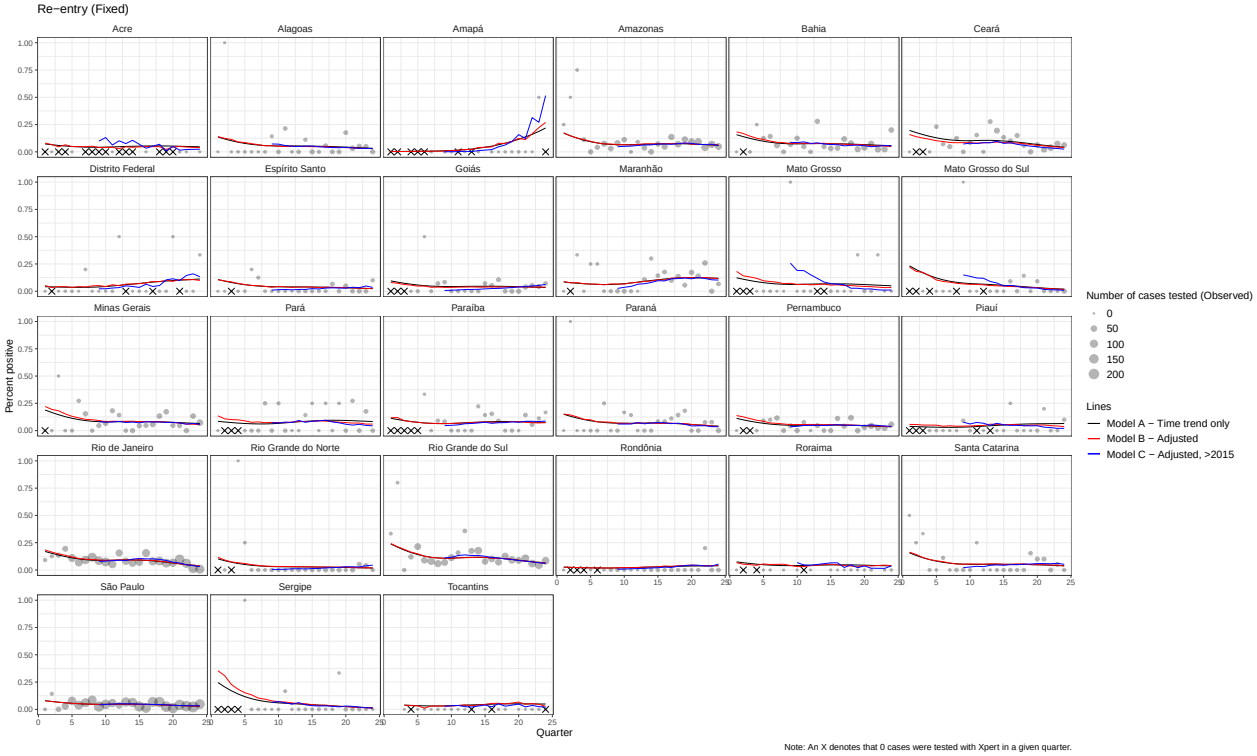


- Time trends in RR-TB positivity (Model A - Adjusted):
  - 2017:
    - Average: 0.0404
    - Range: 0.0146 (Sao Paulo) - 0.0894 (Maranhão)
    - São Paulo: 0.0146
  - 2018:
    - Average: 0.033
    - Range: 0.0118 (Rio Grande do Norte) - 0.0682 (Maranhão)
    - São Paulo: 0.0149
  - 2019:
    - Average: 0.026
    - Range: 0.009 (Sergipe) - 0.0455 (Maranhão)
    - São Paulo: 0.0158

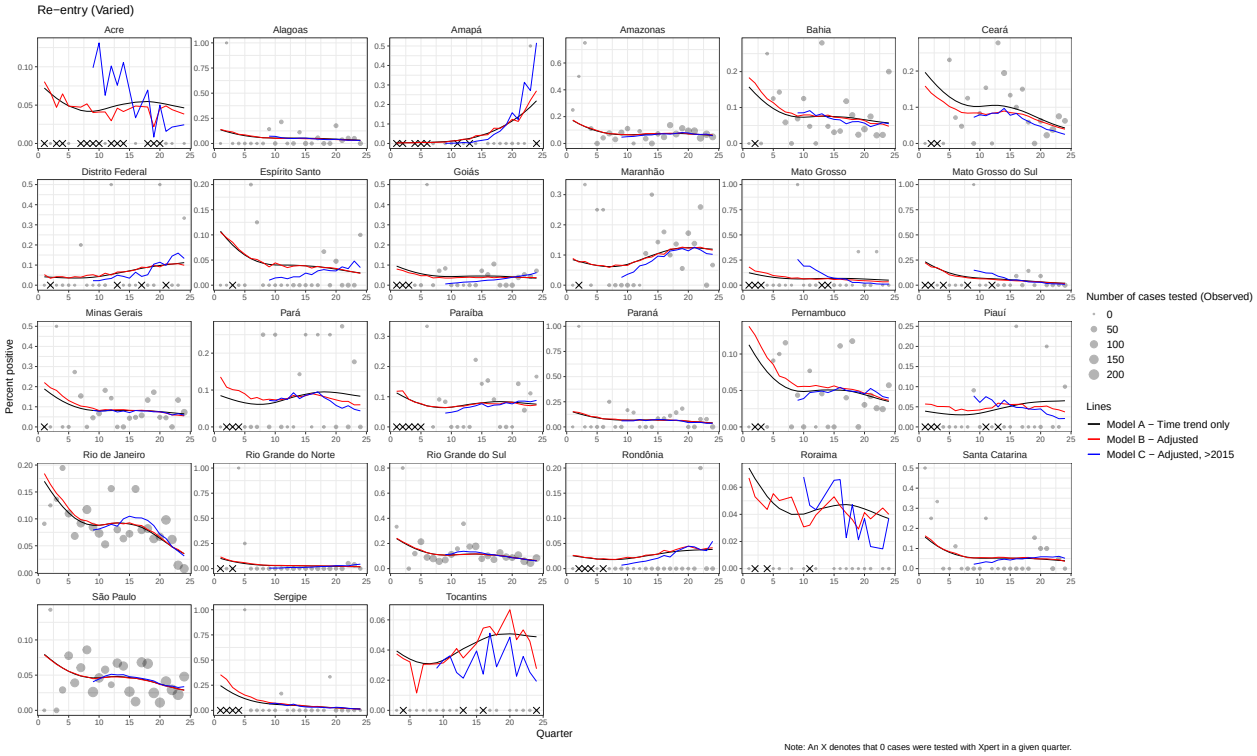
Re-Entry Cases

Note: The following figures show the same model output, only the Y axis changes to show variation within each state.

Fixed Axes



Varied Axes

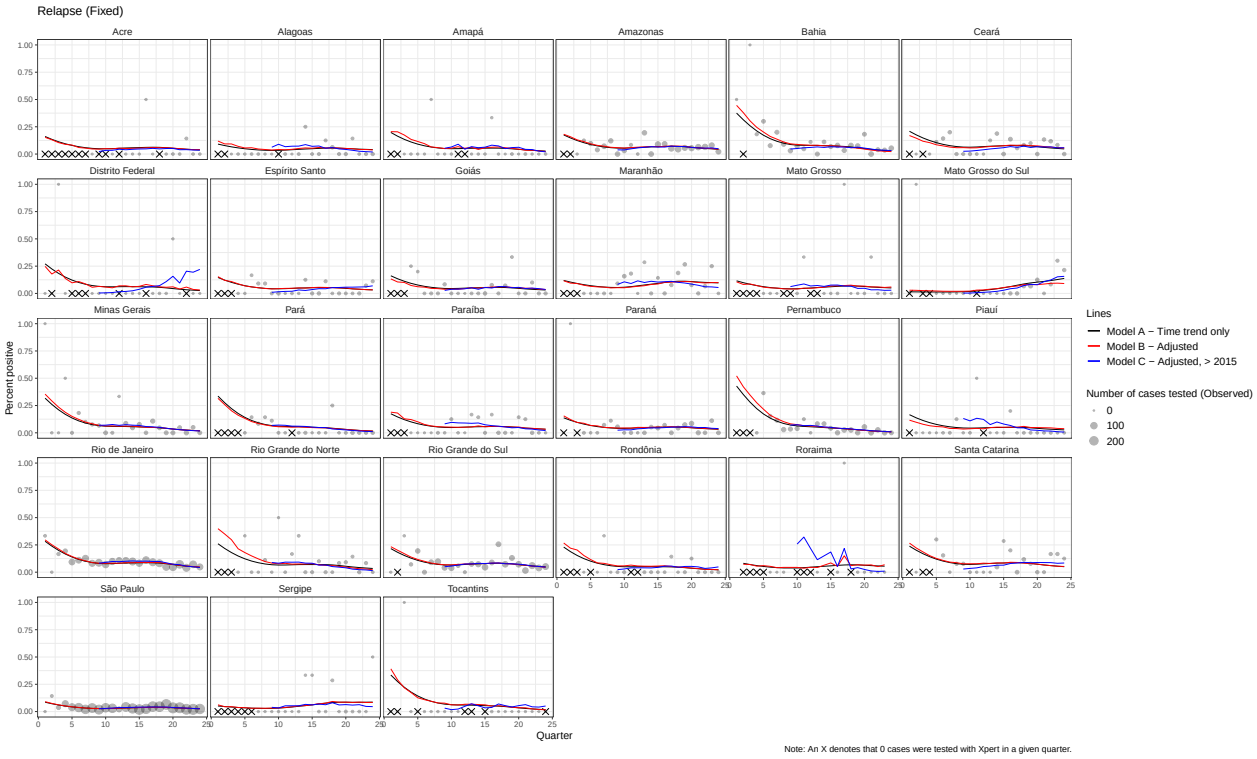


- Time trends in RR-TB positivity (Model A - Adjusted):
  - 2017:
    - Average: 0.0609
    - Range: 0.0289 (Rio Grande do Norte) - 0.1138 (Rio Grande do Sul)
    - São Paulo: 0.0405
  - 2018:
    - Average: 0.0601
    - Range: 0.0268 (Rio Grande do Norte) - 0.1222 (Maranhão)
    - São Paulo: 0.0464
  - 2019:
    - Average: 0.0543
    - Range: 0.0162 (Sergipe) - 0.1925 (Amapá)
    - São Paulo: 0.0315

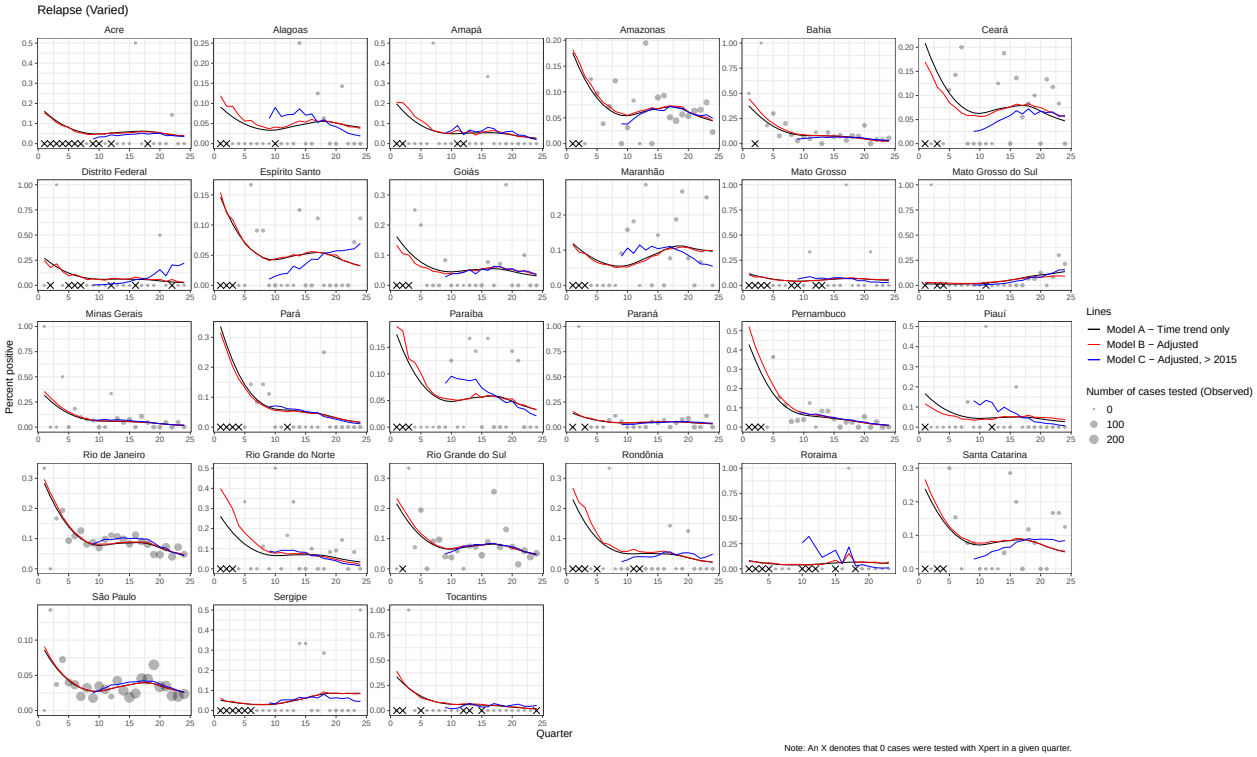
Relapse Cases

Note: The following figures show the same model output, only the Y axis changes to show variation within each state.

Fixed axes by state

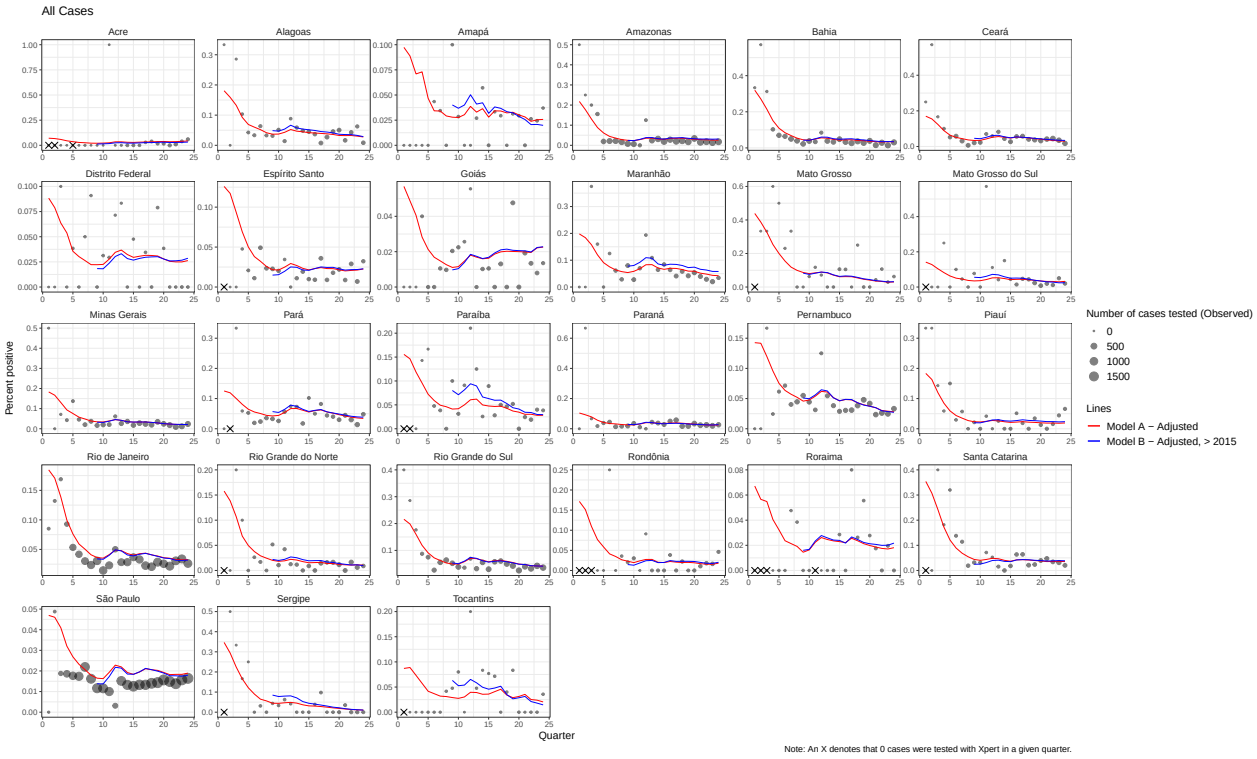


Varied axes by state



- Time trends in RR-TB positivity (Model A - Adjusted):
  - 2017:
    - Average: 0.0634
    - Range: 0.0264 (Mato Grosso do Sul) - 0.1176 (Roraima)
    - São Paulo: 0.0391
  - 2018:
    - Average: 0.0609
    - Range: 0.0326 (Pernambuco) - 0.1002 (Distrito Federal)
    - São Paulo: 0.0407
  - 2019:
    - Average: 0.0482
    - Range: 0.0092 (Roraima) - 0.1785 (Distrito Federal)
    - São Paulo: 0.03

All cases (e.g. Diagnoses types combined)



- Time trends in RR-TB positivity (Model A - Adjusted):
  - 2017:
    - Average: 0.0405
    - Range: 0.017 (Goiás) - 0.0796 (Maranhão)
    - São Paulo: 0.0195
  - 2018:
    - Average: 0.0358
    - Range: 0.0149 (Rio Grande do Norte) - 0.069 (Maranhão)
    - São Paulo: 0.0201
  - 2019:
    - Average: 0.0281
    - Range: 0.0118 (Rio Grande do Norte) - 0.0509 (Maranhão)
    - São Paulo: 0.0183

Going Forward:

- Add in FHS coverage
- Try aggregating data to health region (to overcome noise when working with small municipalities)