Transformative ways to study transformative bioeconomies

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Objective(s)

Our objective is to predict availability of raw materials for biobased products. We challenge existing prediction approaches by confronting them with machine-learning techniques. Doing so, we aim to develop a methodology that benefits the reliability of forecast assessments of transformative bio-economies.

Main (Key) Result

Machine learning techniques improve classical paneldata models

We combined a traditional mixed effects panel data model with a random forest algorithm, and we found the following:

- The combination of methods provided better predictions than the traditional model without the random forest algorithm
- The random forest algorithm included additional variables that were found to be insignificant in the traditional model
- The random forest algorithm remains a black box, which makes this component difficult to interpret
- The model could well capture the heterogeneity among countries

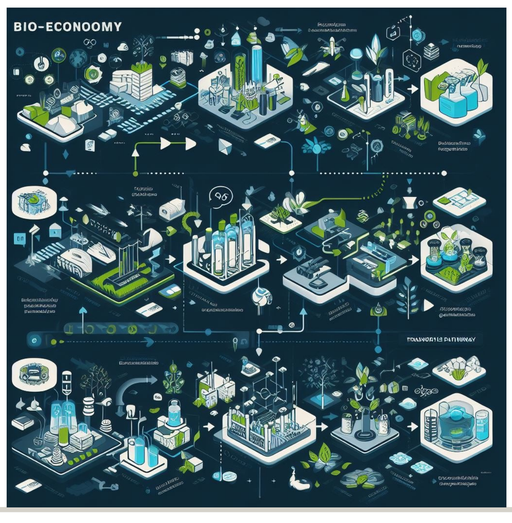

Figure 1. Transformative ways

Readiness

Where we are

The methodology of the traditional mixed effects model follows already existing procedures. This is also the case for the mixed effects model with a random forest algorithm (MERF). This makes the comparison of the two models fair. We believe that the technology readiness is at the technology demonstration level (6), and the the societal readiness is at the level of co-operation with relevant stakeholders (5).

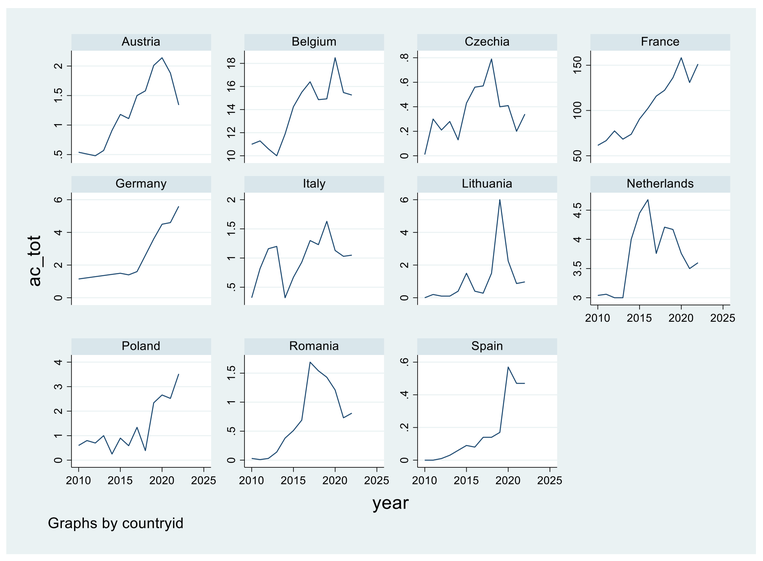

Figure 2. Acreage of flax and hemp together (1000 ha)

Lessons learned

(nonlinear) Relations in small data sets matter

Prediction on the transformation of bioeconomies face two fundamental challenges: the often nonlinear growth path, and heterogeneity among units, for example countries. We learned that in small datasets, traditional models often indicate that interrelations among variables are insignificant. Including these variables to a random forest component that is added to the model gives extra predictive power. So, there seems to be relevant relationships in the data which are not captured with traditional estimation techniques.

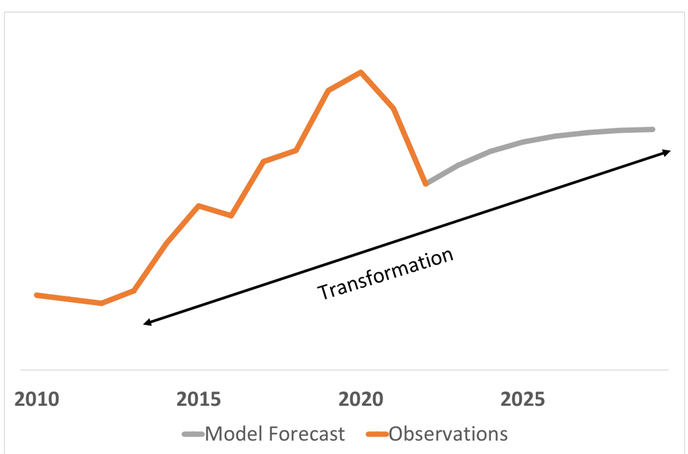

Figure 3. Illustration of a transformative market

Next steps

Generalizing the findings

We would like to generalize our findings in the following ways:

- Apply the methodology to other datasets
- Change the convergence levels of the random forest algorithm to better understand its robustness
- Trying to make the random-forest blackbox more interpretable by comparing the forecastibility of more model variants

$$y_{i,t} = f(X_{i,t}) + b_i Z + e_{i,t}$$

Figure 4. The Mixed Effects Random Forest model

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TRANSFORMATIVE Bioeconomies

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