Frost exposure can predict national apple prices

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Background

Apples constitute the third most consumed fruit in the world and thus contribute to global food security and a healthy diet. Early season frost events hitting blooming apple trees can cause substantial production shocks putting apple supply at risk. Currently, farmers, policy makers, apple processors, and producers have a limited understanding how exactly single frost events change national production quantities and prices.

Objective

In this paper, we estimate the impact of frost exposure on national crop yields and prices based on a global panel of national prices and yields. We deliver important decision support for policy makers, farmers and stakeholders along apple value chains to predict end of the season apple yields and prices based on early season frost. This can enable early action to secure a healthy diet and make vitamin supply more resilient to extreme weather.

Method & Data

We use the fixed effects specification as proposed by Auffhammer et al. (2013), Blanc & Schlenker (2017), and Kolstad & Moore (2020) to quantify the impact of a deviation in the frost exposure of a country, i.e. a frost shock, on the deviation in yields and prices compared to average prices, and yields in the respective country. We thus create a random and exogenous frost shock variable that allows us to causally interpret our estimates.

$$LOG(y_{it}) = \beta_k F_{itk} + \alpha_i + \delta_k Y + \varepsilon_{itk}$$

We use FAO data on 2'677 yield[hg/ha] and 1'837 national average price observations[USD/tonne] from 1991 to 2019 as by provided by 95 and 78 countries respectively. In addition, we create different proxies of frost exposure during the growing season at a countries centroid location from 0°C to -9°C.

Results 1 – all countries included

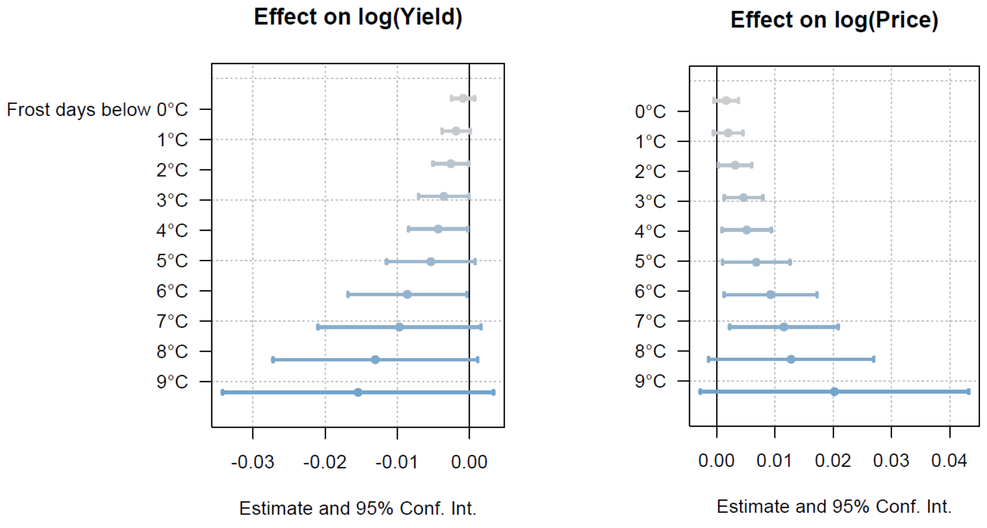

Figure 1: ***Relative impact of frost exposure in the growing season on national apple yields and prices.*** Dots and horizontal bars show point estimates, as well as 95% confidence intervals (clustered by country and year) of the marginal effect of one additional frost day on the national apple price. Different bars use models with different frost thresholds in the range between 0°C and -9°C the top (0°C) to the bottom (-9°C). All models are estimated separately with adjustments in the temperature thresholds for the computation of frost days.

Results 2 – Top 10 Apple producing countries

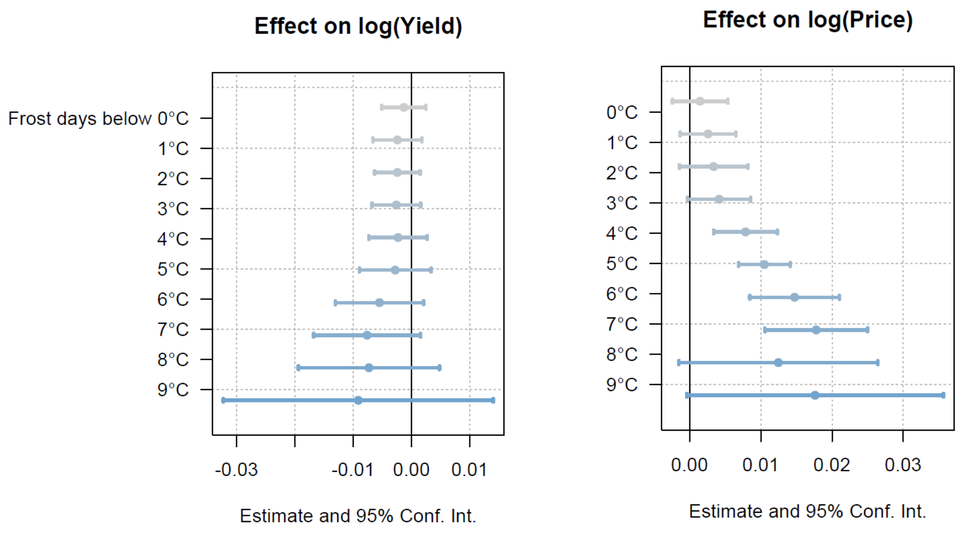

Figure 2: ***Relative impact of frost exposure in the growing season on national apple yields and prices - subsampling the Top 10 Apple producing countries.*** Dots and horizontal bars show point estimates, as well as 95% confidence intervals (clustered by country and year) of the marginal effect of one additional frost day on the national apple price. Different bars use models with different frost thresholds in the range between 0°C and -9°C the top (0°C) to the bottom (-9°C). All models are estimated separately with adjustments in the temperature thresholds for the computation of frost days..

Discussion

We find no significant impact of frost exposure on national apple yields and price using our full sample *(Figure 1).* For a subsample including only the ten largest producers, we find a significant impact of frost exposure on apple prices *(Figure 2).* We are thus able to predict food price spikes from early season frost exposure in these countries, which can trigger and support early action to adapt to these price increases.

While we expected that the frost effect on prices is more pronounced in those markets that contribute considerably to the global supply of apples, the non-significance of the effect in the overall dataset is also likely due to measurement error in the frost exposure.

We consciously use a very simple frost proxy at one central location of a country. This can certainly be improved by measuring temperature at those locations at which apples are grown. We are however not aware of time varying land use data that allows us to implement this. Therefore, future research can likely improve our model with such data as soon as it becomes available

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