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The relative weight of weather risks in crop production volatility in Austria

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Agricultural production is affected by various sources of risks, among them natural ones (weather, pests and diseases), technological ones (farming practices and management) and economic ones (output and input prices). All these risks are destabilizing farm incomes in different ways. The objective of this paper is to explain crop production volatility in Austria and to quantify the share of weather risks relative to other risk sources.
The method we use is the analysis of variance (ANOVA) in which the observed variance of crop production (total sum of squares: $SUM(Yt - y)^2$) is broken down to weather risks and market risks (explained sum of squares: $SUM(\hat{Y}t - y)^2$), and the unexplained residual (residual sum of squares: $SUM(Yt - \hat{Y}t)^2$):

$$SUM(Yt - y)^2 = SUM(\hat{Y}t - y)^2 + SUM(Yt - \hat{Y}t)^2$$

where Yt is the agricultural crop production activity in the period from 2000 to 2009, y is the mean of the Yt-distribution, $\hat{Y}t$ is the estimated crop production by the regression model, and t is the time index for the period from 2000 to 2009. The linear regression model estimating the crop production includes time series data on agricultural outputs (crop yields) as well as input and output prices:

$$\hat{Y}t = b0 + b1*Mt + b2*OPt + b3*IPt + \varepsilon t$$

where $\hat{Y}t$ is the estimated distribution of crop production, Mt describes the agricultural crop yields depending on weather, OPt the output prices and IPt the input prices; b0, b1, b2, b3 are the regression coefficients, and εt are the residuals. Thus, the coefficient of determination R^2 provides the contribution of each parameter to the total variance of crop production by:

$$R^2 = SUM(\hat{Y}t - y)^2/[SUM(\hat{Y}t - y)^2 + SUM(Yt - \hat{Y}t)^2].$$

We analyze the volatility of crop production (the product of quantities and output prices) at the level of the agricultural sector using detailed regional data.
Among the explanatory variables for average regional crop yields (Mt) are monthly weather parameters (e.g. mean maximum/minimum temperature, absolute maximum/minimum temperature, precipitation sum, and days without precipitation), and data on extreme weather events (e.g. hail). By accounting for changing acreages and output prices we are able to explain up to 90% of volatility of the Austrian crop production.