Vienna 2019 Abstract Submission

Title
Are South African grape growers aware of their climatic comparative advantages for growing certain grape varieties? A hedonic approach applying machine learning

I want to submit an abstract for:
Conference Presentation

Corresponding Author
Britta Niklas

E-Mail
britta.niklas@rub.de

Affiliation
Institute of Development Research and Development Policy, Ruhr University Bochum

Co-Author/s

Name	E-Mail	Affiliation
Rinke, Wolfram	Wolfram.Rinke@fh-burgenland.at	FH Burgenland, Austria
Vink, Nick	nv@sun.ac.za	University Stellenbosch, South Africa

Keywords
South Africa, Weather Conditions, Grape Growing, Hedonic Models, Machine Learning, Artificial Neural Networks, Sensitivity Analysis

Research Question
Which regional climate is advantageous for which grape variety in SA?
Are South African grape growers aware of their regional climatic comparative advantages for growing certain grape varieties?

Methods
Hedonic Models, Machine Learning (Artificial Neural Networks), Sensitivity Analysis

Results
SA wine regions have different comparative advantages for growing certain grapes.
Uprooting and planting trends match by 63-67%.
Only in some regions, grape growers are aware of these comparative advantages.

Abstract
Changing climate as well as weather fluctuations have a particular importance for agricultural production. Especially the relationship between weather and wine is very close, as quantity and quality of grapes highly depend on weather. Hence, fine wine has characteristics, which makes it a very appealing topic for economic analysis against the background of changing weather conditions (Ashenfelter, O. and Storchmann, K., 2010).
For South African vineyards it is often stated that climate change will lead to warmer and drier conditions by 2050 and especially heat wave periods can have an important impact on the style of wine (Conradie et al., 2002; Bonnardot et al., 2005; White et al., 2006; Deloire et al., 2009, 2010; Vink et al, 2012).

But not only climate change, but as well vintage-to-vintage variation is an interesting factor (Jones, 2007). Both, long term climate changes and vintage to vintage variations and as well respective differing soil conditions will have an impact on the diversity of the South African wine industry, which is famous for the elaboration of different types and styles of wine (Vink et al., 2012). Here it is especially interesting to focus on different wine regions in South Africa, as there are tremendous differences between coastal and inland mountain areas (Midgley et al., 2015) with respective advantages and disadvantages for the growing of certain grape varieties.
Against this background we assume that each region has its own competitive advantage in growing certain grape varieties, as all varieties have different capabilities to cope with specific weather or climate conditions.
In this paper we first analyze the effects of annual weather changes on yields in order to find, which weather is advantageous for which grape variety. This analysis should lead to some kind of ideal weather scenario for each grape variety (like dry and sunny with small rain etc.).
In as second step the changing weather conditions in each region are reconciled with these scenarios in order to give recommendations where different grape varieties should be grown.
In the third step we compare our recommendations with the distribution of grape varieties in South African wine regions and the uprooting and planting behavior of grape growers.
We use daily weather data, taken respectively from local weather stations covering the South African wine regions Breedekloof, LittleKaroo, Malmesbury, Olifants River, Orange River, Paarl, Robertson, Stellenbosch and Worcester. Lecoque and Visser (2006) have argued that it might be suitable to only use data from one weather station, but here we included local weather stations as temperature and rainfall, but also hours of sunshine differ tremendously in the different South African regions.
The data on yields, ha distribution, uprooting and planting behavior comes from SA Wine Industry Information & Systems (SAWIS (2002-2014)). Here we focus on 10 different grape varieties, which are Chenin Blanc, Colombard, Sauvignon Blanc, Chardonnay, Semillon, Cabernet Sauvignon, Pinotage, Merlot, Shiraz and Ruby Cabernet and we cover the years 2001-2013.
We apply a hedonic approach and especially use artificial neural networks (Hornik, Stichcombe, 1990) to build the regression models and apply a sensitivity analysis on these models (Hashem, 1992; Rinke, 2015) for the first step. Based on the available data we build a regression model for each grape variety with “yields per ha (Yha)” as dependent variable and 9 independent variables including average climate parameters per season, a trend variable and the age of the vine. Here the emphasis is on the generalization of the model results, to avoid overfitting due to a limited number of samples (roughly about 96 samples per grape). Next, we calculate the average value of the partial derivatives for each region for each grape and model parameter to receive the sensitivity (comparable to the normal elasticity) of each independent variable related to yield per ha for each grape and region (Rinke, 2015). Finally, we calculate the slope of the regression line for each weather parameter and region in order to determine the trend of each weather variable and to so allow us to find advantageous weather scenarios for each grape.
For the second step we define a metric to count the number of matching trends between weather in a region and the sensitivities of each grape variety, as the goal is to give recommendations in which regions which grape varieties should be grown for maximizing the yield. We determine that at least more than half of the model parameters must match with the regional weather trends in order to give a recommendation to grow a certain grape variety in a specific region. Finally, we get a number of matched features per grape variety and region for increasing the yield per ha.
For the third step we match the ha distribution of each grape variety in each region with the suggested growing recommendations.
Our results regarding the first step show, that advantageous weather conditions differ not only for white and red grape varieties in general, but even for each single grape variety and we can show, that South African regions have comparative advantages and disadvantages for the growing of certain grape varieties. In Breedekloof for example, weather conditions are favorable for growing Colombard and Sauvignon Blanc, whereas Merlot and Chardonnay should not be grown there. Based on these results, we are able to give clear recommendations which grape variety should be grown in which region.
Finally, the analysis of planting and uprooting trends based on the ha distribution of grape varieties shows, that planting trends match by 63% and uprooting trends match by 67% with the recommendations based on our model. Here it is surprising that some regions are pretty much in line with these recommendations (Breedekloof, Malmesbury or Paarl), while others don´t seem to be aware of their comparative advantages for growing specific grape varieties (Orange River or Olifants River).

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