Vienna 2019 Abstract Submission

Title
Planting New Varieties in Response to Climate Change: A Real-Options Approach

I want to submit an abstract for:
Conference Presentation

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Keywords
grape varieties, investment under uncertainty, real options

Research Question
How are wine makers' investments into new grape varieties affected by stochastic climate warming?

Methods
dynamic optimization, Wiener process, real-options model

Results
Time until switch is reduced by drift paremeter and increased by delay after replanting. Effect of uncertainty needs to be determined.

Abstract
Climate change leads to warmer summers in many wine-growing regions. This has predominantly been good for cool-climate wines because vintages producing thin and sour wines have been gone by and large. Harvests and wine quality have been getting more stable and yields more reliable. Sugar contents of grapes has increased and many wines have benefitted from higher alcohol contents and better balanced: "There are no bad vintages any more, " is a quote often heard by wine makers in the cooler wine regions, e.g. in Germany, Austria, Burgundy, and Champagne. However, in hot years like 2003 and 2018, the high temperatures had adverse effects on many wines, predominantly on those that the consumer expects to be lean, crisp, and elegant, but that then turned out too full-bodied and alcoholic. German and Austrian Rieslings were good examples, but white wines from Northern Itally had similar problems. Part of the problem can be solved by careful foliage which, however, comes at a cost since such work is very labour intensive. And if additional work in the vineyard does not suffice, wine makers in the longer term may lose their reputation as they are no longer able to produce the lean and elegant wines their customers are used to. This will be more costly or even disastrous.
In the long term, if climate change and warming continue, the only response – except leaving the business – is to switch from the typical cool-climate varieties like Riesling and Pinot Noir to varieties that are more suitable to

warmer weather conditions, e.g. Roussanne, Assyrtiko, Grenache and Syrah. Syrah and other varieties are already being grown in warmer locations within German wine regions for example. The paper looks at this decision in the framework of a model of investment under uncertainty. Climate change will be introduced as a Wiener process
$dx=adt+\sigma xdz$,
where x is temperature, a a constant drift parameter, ▯ the variance parameter, and z the Wiener process. The wine maker maximizes the present value of her profits given an initial endowment with cool-climate grapes. As x increases, the profit declines. There is the possibility to clear the vines and plant a new variety that generates higher profits at higher temperatures. The problem is to find the optimum switching date from the cool-climate to the warm-climate variety. A particular problem in wine-making is that the new variety will become profitable only with a delay of several years. Thus the objective function is
$\int_0^T e^{-rt} \pi_c (x)dt - e^{-rT} C + \int_{T+\delta}^{\infty} e^{-rt} \pi_w (x)dt$,
where ▯ stands for profits and the subscripts c and w for the cool and the warm-climate varieties, respectively, C is the cost of replanting and ▯ the delay.
The analysis is carried out for the non-stochastic version of the model first and then for the model with the Wiener process. In contrast to other real-options models, we are formally not looking at an optimal stopping rule, but at a starting rule. In the non-stochastic model, results are very clear-cut. The speed of climate change will accelerate the switching from the cool to the warm-climate grape. A long delay has the opposite effect. These results carry over to the stochastic model. The interesting questions are how the switching date is influenced by the drift and the variance of the Wiener process. The impact of the drift parameter is clear: faster climate change will demand an earlier move from the old to the new variety. The impact of the delay parameter is into the opposite direction. The longer the delay between the planting and the first profitable harvest, the later the critical point in time.
The impact of the variance remains to be determined and this will be done until July such that the complete set of results can be presented at the AAWE conference in July 2019.
The results are meant to improve the understanding of winemakers' decision problems in the presence of climate change and global warming. In extensions of the model, one could look at impacts of these changes on the market as a whole, one could move from the arithmetic to the exponential Wiener process. Another option would be to look at the possibility to out of business as an alternative to switching to grape varieties that are considered as alien species and may be difficult to sell to the consumer. Why should consumers buy a Syrah grown in Germany when the can get the "real stuff" from the Rhone valley or Australia? Finally a problem to consider is capital-market imperfection. What if the winemaker has difficulties financing the replanting of large vineyards? In the case of a perfect capital market, there should be no problems and the investment decision should not be affected by the necessity of borrowing. This will be different in the case of limited access to capital markets, which will be worthwhile considering.

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Planting New Varieties in Response to Climate Change: A Real-Options Approach

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Climate change leads to warmer summers in many wine-growing regions. This has predominantly been good for cool-climate wines because vintages producing thin and sour wines have been gone by and large. Harvests and wine quality have been getting more stable and yields more reliable. Sugar contents of grapes has increased and many wines have benefitted from higher alcohol contents and better balanced: "There are no bad vintages any more, " is a quote often heard by wine makers in the cooler wine regions, e.g. in Germany, Austria, Burgundy, and Champagne. However, in hot years like 2003 and 2018, the high temperatures had adverse effects on many wines, predominantly on those that the consumer expects to be lean, crisp, and elegant, but that then turned out too full-bodied and alcoholic. German and Austrian Rieslings were good examples, but white wines from Northern Itally had similar problems. Part of the problem can be solved by careful foliage which, however, comes at a cost since such work is very labour intensive. And if additional work in the vineyard does not suffice, wine makers in the longer term may lose their reputation as they are no longer able to produce the lean and elegant wines their customers are used to. This will be more costly or even disastrous.

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$$\int_0^T e^{-rt}\pi_c(x)dt - e^{-rT}C + \int_{T+\delta}^{\infty} e^{-rt}\pi_w(x)dt,$$

where π stands for profits and the subscripts c and w for the cool and the warm-climate varieties, respectively, C is the cost of replanting and δ the delay.

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