aawe American Association of Wine Economists

Vienna 2019 Abstract Submission

Title
Persistent and transient inefficiency of Austrian wine (grape) growers

I want to submit an abstract for:
Conference Presentation

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Keywords
wine, persistent and transient inefficiency, Austria

Research Question
How efficient are Austrian wine farms and what determines their efficiency?

Methods
4-components stochastic frontier model, which distinguishes between persistent and transient efficiency, farm heterogeneity and exogenous shocks. Our sample includes 862 observations of 103 farms between 2003 and 2016

Results
We find transient and permanent inefficiency to be equally important and being influenced by similar factors. There is some indication that business oriented farms are more efficient.

Abstract
Persistent and transient inefficiency of Austrian wine (grape) growers
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JEL: C23, D24, L66

Introduction
Fuelled by the wine scandal in the mid 1980ies and the EU accession in 1995 the wine sector in Austria has developed rapidly in the past three decades. The quantity of wine harvested has doubled from a low in 1985 to 2.3 million hectolitre (hl) in 2015. As a result of the strict laws passed in the aftermath of the wine scandal, Austria's wine sector nowadays has a clear focus on quality, with almost three quarters of the yield ending up in thoroughly controlled and specifically certified quality wines ("Qualitätswein"). Though still relatively small structured on an international scale, there is also severe structural change in the sector with the number of wine (grape) producers having fallen by about 30% to about 14.000 and the average vineyard area having risen by 42.5% to 3.22 ha between 2009 and 2015 (Österreich Wein 2018). According to BMNT (2018) the number of specialized wine farms is

4,200 or 6% of all Austrian farms, which in 2017 on average farmed 6.16 ha of vineyards, and employed 1.79 full-time employees (FTEs), 1.37 of which family labour. The average income of these specialized wine farms amounted to € 34,290 and subsidies received to € 9,037 or 7.3% of revenues. Anderson and Jensen (2016) estimate that in 2012 the Austrian wine sector had a production value of € 524 million (2.8 million hectoliters, 44,000 ha vineyards) and received subsidies worth € 100 million (about three quarters direct support and one quarter national support like investment subsidies). With € 1.704 per ha or € 0.37 per litre of wine this is by far the highest level among EU-27 countries.
This is the first study to investigate the efficiency of Austrian wine farms. Based on a four random components stochastic frontier model, we will distinguish between persistent (time-invariant) and transient (time-varying) efficiency. We will also investigate the impact of different farm and farmer characteristics on these two different sources of inefficiencies as well as the impact of subsidies on farm performance. While stochastic frontier analysis (SFA) is a method very frequently applied to farm data sets around the world, applications to wine (grape) farms are scarce. For example, in a recent study Coelli and Sanders (2013) identified only three previous studies applying SFA to wine farms.

Method
To empirically estimate technical efficiency, we use a SFA first developed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977) and first applied to panel data by Pitt and Lee (1981) and Schmidt and Sickles (1984). Since then a multitude of different models have been developed (Kumbhakar et al. 2015). Beside getting a reasonable representation of a complex production process through a relatively simple parametric representation (most often Cobb-Douglas or translog functional form), the main challenge in SFA is to disentangle firms' heterogeneity (in production conditions) from inefficiency. Models range from interpreting all time-invariant effects as inefficiency (Schmidt and Sickles 1984) to interpreting time-invariant effects as heterogeneity (Greene, 2005). Related to this is the question if inefficiency is time invariant (Schmidt and Sickle, 1984) or time-varying (Cornwell, Schmidt and Sickles, 1990). Recently Colombi et al. (2014), Kumbhakar et al. (2014) and Tsionas and Kumbhakar (2014) introduced a four-component stochastic frontier model which allows to control for random firm-effects, but also disentangles persistent from transient inefficiency. In particular,

$$y_{it}=a_0+f(x_{it};\beta)+b_i-u_i-u_{it}+e_{it}$$

where y_{it} is the log of output of firm i at time t; α_0 is a common intercept; $f(\cdot)$ is the production technology; x_{it} is a vector of inputs (in logs); β is a vector of parameters to be estimated; b_i are random firm effects; $-u_i$ and $-u_{it}$ are persistent and transient inefficiency, respectively; and e_{it} is a random two-sided noise term.
To implement this model we estimate the following translog production function:

$$y_{it}=a_0+\sum_{j=1}^{J}\beta_j x_{jit}+1/2\sum_{j=1}^{J}\sum_{k=1}^{J}\beta_{jk} x_{jit} x_{jit}+\sum_{t=2}^{T}\gamma_t D_t+b_i-u_i-u_{it}+e_{it}$$

Where j indicates the different inputs and D_t are T-1 time dummies. We assume μ_i and ν_{it} are iid $N(0,\sigma_u^2)$ and $N(0,\sigma_\upsilon^2)$, respectively, while u_i and u_{it} are iid $N^+(\mu_i,\sigma_\eta^2)$ and iid $N^+(\mu_{it},\sigma_u^2)$, respectively, with μ_i and μ_{it} depending on a set of covariates, i.e. exogenous determinants of inefficiency. While Colombi et al. (2011) utilize a ML method and Tsionias and Kumbhakar (2014) Bayesian methods to estimate equation (2), we follow Kumbhakar et al. (2014) and apply a three step procedure. In a first step we estimate a common random effects model, while in step 2 and 3 persistent and transient inefficiency are derived via decomposing the predicted random effects and the predicted error term from the first step utilizing a standard SFA technique. While Kumbhakar et al. (2014) already mention that their model can be extended to include exogenous shifters of inefficiency, we are to our knowledge the first to apply this. Estimates of the persistent (PTE) and transient (TTE) technical efficiency components are derived using Jondrow et al. (1982) procedure, i.e. $PTE=\exp(-\hat{\mu}_i)$ and $TTE=\exp(-\hat{\mu}_{it})$, and overall technical efficiency (OTE) is OTE = PTE*TTE.

Data
Our study is based on a panel of specialized wine farms selected from data of Austrian bookkeeping farms, which are part of the Farm Accountancy Data Network (FADN). Wine farms included in our analysis generate revenues from wine of at least 70% of total farm revenues (including farm-related activities but excluding financial income) and are contained in the data set for at least three consecutive years. Hence, our sample consists of an unbalanced panel of 862 observations and 103 farms between 2003 and 2016, resulting in an average of 8.4 observations per farm and 61.6 observations per year.
Output is defined as the sum of revenues and inventory changes from farming and related activities (e.g. agri-tourism), excluding subsidies and financial revenues. Inputs are grouped in four categories: i.) capital (the farm's mean value of the beginning- and end-of-the-year capital stock); ii.) land multiplied by a yield-adjusted hectare

value to account for differences in land quality; iii.) labor (working days per year); iv.) intermediates (all expenditures connected to farming and related activities). In order to obtain constant-price quantity indices, output and all other monetary variables are deflated by the respective price indices as provided by the Austrian Ministry of Agriculture and Eurostat.
To explain differences in inefficiency we use several variables to describe the farm and its management. In particular, we use i.) hectares of wine area as a proxy for the absolute size of the farm; ii.) share of total revenues from grape and wine sales to indicate the specialization; iii.) share of revenues from grapes and wine associated with direct sales; iv.) share of rented land; v.) share of revenues (subsidies) from subsidies; vi.) dummy for full-time farming, being 1 if the off-farm working time of farm holder and spouse > 50% of total working time; vii.) the age of the farm manager and viii.) the sex of the farm manager. Descriptive statistics are given in Table 1. The average farm in our sample has about 7.4 ha of wine area, generates € 78,000 from farming and related activities, rents 20% of their vineyards and needs 560 days of labor inputs. About 88% of total revenues are from activities related to wine with direct sales accounting for up to 46% of revenues from grapes and wine. Most farm managers are male and on average 49 years old.

Results
Regression results are summarized in Table 2. In regard to the results of the random effects estimation we find all first order effects to have the expected positive sign and are significant at the 99% level except land. Second order effects are jointly significant based on a likelihood-ratio test (LR = 79.6, χ_0.99^2 = 23.21) and hence confirm the predominance of the translog specification over Cobb Douglas. Yearly dummies are also jointly significant (LR = 234.75, χ_0.99^2 = 27.69). Average production elasticities sum to 1.124 indicating increasing returns to scale. Technical efficiency scores are summarized in Table 3 and depicted as a Kernel density function in Graph 1. Mean (Median) persistent technical efficiency is on average 88.4% (91.5%). Similar values are derived for the transient efficiency (88.7%, 91.8%) implying an overall mean (median) efficiency of 78.8% (82.8%). The correlation coefficient between TTE and PTE is 0.486. The kernel density function reveals a high efficiency for most of the farms with a few outliers.
Results for the inefficiency effects models reveal the following: transient as well as persistent inefficiency significantly decreases with increasing specialization (share of revenues from wine), share of rented land and the farmers age. To farm more rented land probably also indicates more professionalism. The effect of the age can be explained by experience. On the contrary both inefficiencies increase significantly with the hectares of wine area farmed and the share of direct sales. The first effect is puzzling at this stage, the second may be due to high labor requirements. Moreover, the pertinent inefficiency increases with the importance of subsidies for income. Hence, this may indicate that subsidies decrease the effort to get more efficient and productive. The effect of family labor on efficiency is ambivalent: it increases persistent inefficiency, but decreases transient inefficiency. This may indicate that family farms in general may pursue goals other than efficiency and profit maximization in the long-run (e.g. working together and handing over the farm to the next generation), but are better suited to cope with exogenous shocks.

Conclusions
This is one of very view studies on the technical efficiency of wine farms and the first ever for Austria. We find transient and permanent inefficiency to be equally important and being influenced by similar factors. There is some indication that business oriented farms (more specialized in wine production, more rented land, less family labor, less direct sales) are more efficient. Moreover, we find subsidies to decrease the efficiency of wine farms.
Table 1: Descriptive statistics of wine farms

Table 2: Results of the SFA model
Coef. Std. Err. Prob.
Inputs
Constant -0.277 0.047 0.000
Capital 0.174 0.034 0.000
Land 0.070 0.047 0.134
Labor 0.376 0.056 0.000
Intermediates 0.530 0.041 0.000
Capital^2 0.018 0.016 0.259

Land^2 0.023 0.047 0.632
Labor^2 0.004 0.060 0.949
Intermediates^2 0.085 0.017 0.000
Capital*Land -0.048 0.040 0.235
Capital*Labor 0.092 0.045 0.040
Capital*Interm. -0.012 0.036 0.744
Land*Labor -0.091 0.074 0.219
Land*Interm. -0.041 0.052 0.429
Labor*Interm. -0.057 0.055 0.298
Time Dummies not depicted here
R^2 within 0.362 sigma_u 0.223
R^2between 0.937 sigma_e 0.250
R^2overall 0.883 rho 0.441
No. Cross-sections 103 No. Obs. 862
Factors affecting persistent inefficiency
Constant -9.185 1.563 0.000
Area Wine (ha) 0.216 0.039 0.000
Share of Rev. from Wine -1.483 0.186 0.000
Share of Rev. from Direct Sales 4.395 1.815 0.015
Share of Rented Land -2.103 0.633 0.001
Share of Rev. From Subsidies 1.633 0.785 0.038
Share of Familiy Labor 5.762 1.563 0.000
Fulltime Farming 0.140 0.209 0.505
Age of Farmer -0.037 0.010 0.000
Sex of Farmer -0.637 0.502 0.204
Factors affecting transient inefficiency
Constant -2.288 1.096 0.037
Area Wine (ha) 0.202 0.036 0.000
Share of Rev. from Wine -1.823 0.250 0.000
Share of Rev. from Direct Sales 6.928 2.258 0.002
Share of Rented Land -0.532 0.462 0.250
Share of Rev. From Subsidies 0.727 0.676 0.282
Share of Familiy Labor -3.563 0.979 0.000
Fulltime Farming -0.049 0.210 0.814
Age of Farmer -0.026 0.010 0.008
Sex of Farmer 0.251 0.657 0.702

Table 3: Transient, persistent and overall efficiency
TTE PTE OTE
Mean 0.88 0.89 0.79
Median 0.92 0.92 0.83
Maximum 0.99 1.00 0.97
Minimum 0.33 0.55 0.23
Std. Dev. 0.09 0.10 0.14

Graph 1: Kernel density functions of Transient, persistent and overall efficiency

References
(see PDF)

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