Vienna 2019 Abstract Submission

Title
Wine Grape Prices in Mendoza: Implications for Replanting Policies

I want to submit an abstract for:
Conference Presentation

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Keywords
Argentina, wine, grape, price, distributed lag model, hedonic model

Research Question
How is the price of wine grapes influenced in Mendoza and what are the implications for replanting policies?

Methods
Model combining the inverse form of the partial equilibrium adjustment autoregressive distributed lag model and the hedonic model.

Results
The final results of this research will be available by May 2019.

Abstract
1. Background
In 2017 the Argentinean wine industry was responsible for generating almost USD 2 billion in value added for Argentina and 374,000 jobs (Argentinean Wine Corporation, 2018). Accounting for 71% of the country's total wine grape production, Mendoza is the main wine production province of Argentina.
Viticulture in Mendoza is focused on wine grapes, with more than 99% of the total grape production used for making grape juice or wine. High-quality red varieties like Malbec attract a farm gate price higher than most red varieties as well as most high-quality white varieties. The three main rosé varieties (i.e. Cereza, Criolla Grande and Moscatel Rosado) are always among the cheapest grapes, and these varieties are primarily used for producing grape juice or generic white wine. Other low-quality white varieties such as Pedro Gimenez are also used for making grape juice or generic white wine.
Wine prices in the domestic market are correlated with the price of the grapes used for producing each wine; and

wines made from high-quality red varieties like Malbec, on average, sell for higher prices than wines made from other red varieties, and from high-quality white varieties. Further, the price for generic red wine is, on average, higher than for generic white wine; and grape juice is, on average, less expensive than generic white wine.
The observed price differences for wine can in part be explained by changes in demand. In Argentina, domestic consumption has shifted towards high-quality wine, especially red wine (Argentinean Wine Corporation, 2016). Foreign demand has also favored red wine of high-quality varieties like Malbec. Demand for grape juice, a product made with low-quality grape varieties that is mainly exported, has also shown a downward trend over recent years. In Mendoza, there have been substantial changes in the variety mix, with an increase in plantings of high-quality red varieties like Malbec, and a reduction in the area planted devoted to low-quality white and rosé grapes (Maclaine Pont and Thomas, 2012). However, these changes in the varietal share have not been sufficient to adapt to the fast phase of the changes in demand.
The price premium to generic red wine over generic white wine is now so high that it has motivated an increase in the area planted to the Aspirant Bouchet variety. A unique feature of Aspirant Bouchet is that the red color index for the variety is so high that small quantities of the variety can be blended with generic white wine, and the resulting blend can then be officially classified and sold as generic red wine.
As a consequence of the low prices of low-quality white and rosé grapes, the profitability of the farmers that produce these varieties is low, and in some years negative (Abihagle et al., 2015). To assist farms currently growing low-quality white and rosé grapes, the Argentinean government has an active vineyard replanting program that provides zero interest credit to growers with vineyards smaller than 20 hectares, to help them pull out existing vines and replant with higher quality varieties (Government of Mendoza, 2017).

2. Aims and contributions

The aim of this study is to identify the factors that influence the price of wine grapes in Mendoza, and articulate the implications of the findings for the Argentinean government replanting program. The proposed research will provide a more complete understanding of the relationship between grape prices, by variety, at the sub-region level, and also provide information on the way grape prices adjust to supply-demand imbalances.
While the aim of this study is not to determine the best replanting policy, the information generated can be used by policy-makers to conduct sensitivity analysis around different replanting strategies at a whole of region level. Given the replanting program is in its initial stage, it is especially timely to review the program.
Beyond its practical significance, this study will provide a significant contribution to the academic literature. A search of the literature has failed to identify any peer reviewed research on the determinants of grape prices in Argentina. There are studies that have analyzed grape markets and prices in other countries (see Oczkowski (2006) in Australia, Fuller and Alston (2012) and Volpe et al. (2012) in California, and Tomsik et al. (2016) in Czech Republic for examples). However, the academic literature on grape prices, rather than wine prices, is limited, and the econometric approaches that have been followed in other studies are different to the econometric approach proposed for this study.

3. Data

The Chamber of Commerce of Mendoza has recorded information on all grape sales in the province since 2002, and there are 120,981 observations in the database. Information on grape sales includes: price, variety, sub-region and payment type (i.e. cash or financed). Information on the wine grape harvest for all varieties and the level of wine stocks has been provided by the Argentinean Wine Observatory and the Argentinean Wine Institute.

4. Methodology

The model will combine elements of the autoregressive distributed lag model (ARDL) literature and hedonic price model literature. The ARDL model is derived from a partial adjustment model as follows, formulating the model in an inverse demand form.
The price of grapes depends not only on the quantity of grapes harvested, but also on the volume of wine stocks held in wineries. As the first step in setting out the model, we abstract from the issue of variety for the moment. As such, the relationship between the equilibrium price of grapes, the quantity of grape harvested, and the stocks of wine is given by:

$$P_t^*=a+bQ_t^ +cW_t^ 〖+e〗_t^ . (1)$$

In the above expression P_t^* denotes the equilibrium price of grape at year t, given quantity harvested Q_t and wine stocks W_t, a, b and c are parameters to be estimated, and e_t is a zero mean random error term. Equation (1) expresses a theoretical relationship, since the equilibrium price of grapes (given current quantity harvested and wine stocks), P_t^*, is not observed. Instead, P_t (i.e. actual price of grape at year t) is observed.
Assuming that the process of adjustment depends on the difference between the price in the previous year and the equilibrium price in the current year gives:

P_t^ -P_(t-1)^ = 〖γ(P〗 _t^*-P_(t-1)^), (2)
where γ is the speed of adjustment parameter. Equation (2) states that the observed change in the price of grapes is proportional to the difference between the price of grapes in the previous year and the equilibrium price of grape in the current year. Values of γ are between zero (i.e. no adjustment) and one (i.e. complete adjustment). Thus, the name “partial adjustment model”. Rearranging equation (2) gives:
P_t^ =P_t^* γ+P_(t-1)^ (1-γ), (3)
which states that the price of grape in the current year is a weighted average of the price in the previous period, and the current equilibrium price.
Substituting equation (1) in equation (3) gives:
P_t^ =γa+γbQ_t^ +γcW_t^ +(1-γ) P_(t-1)^ + 〖γe〗 _t^ . (4)
The term γb in equation (4) describes the short-term effect of grape harvests on grape price. And γc describes the short-term effect of wine stocks on grape price. In the long-term, equilibrium changes. As such, substituting long-term equilibrium values into equation (4), and using P_ ^', Q_ ^' and W_ ^' to denote long-run equilibrium values gives:
P_ ^'=γa+γbQ_ ^'+γcW_ ^'+(1-γ) P_ ^', (5)
which can then be rearranged to give:
P_ ^'=a+bQ_ ^'+cW_ ^'. (6)
Equation (6) states that the long-term effect of the quantity harvested on the price of grape is given by b. And for wine stocks, by c.
The partial adjustment model equation is:
P_t=γa+γbQ_t+γcW_t+(1-γ) P_(t-1)+ 〖γe〗 _t^ , (7)
and the model output, which is estimated via least squares, is:
P_t=α+β_1 Q_t+β_2 W_t+β_3 P_(t-1)+e_t^'. (8)
Combining equations (7) and (8), it is possible to obtain the short-term and long-term effects of both, quantity of grape harvested and wine stocks, on grape price. The short-term effect of the quantity of grape harvested on grape price in equation (7) is given by γb, which is β_1 in equation (8). The long-term effect of the quantity harvested on grape price in equation (7) is given by b=γb⁄γ, which can be obtained as β_1⁄((1-β_3)) from the output of equation (8). A similar interpretation can be derived for the effect of wine stocks on grape price, where the short-term effect is β_2= γc, and the long-term effect is c=γc⁄γ=β_2⁄((1-β_3)).
The hedonic price literature states that the price of a good can be expressed as a function of underlying attributes. The general form of a hedonic price function for grapes can be written as:

P_vit=α+∑_k^K▒β_k z_kvit+e_vit (9)
where P_vit denotes the farm gate price of grapes at time t, z_kvit is a vector of observable characteristics at time t, β_k denote the various implicit prices those characteristics and interactions between them, and e_vit is a zero mean error term.
Based on the characteristics of the market for grape in Mendoza, the characteristics accounted for in z_kvit are: variety, sub-region and payment type. Variety and sub-region are dummy variables and an interaction between variety and sub-region is also considered. Payment type is the proportion of grape paid by cash, as opposed to installments, for variety v in location i at time t.
The final model, combining the inverse form of the partial equilibrium adjustment ARDL model and the hedonic model can then be written as:
P_vit=α+∑_k^K▒β_k z_kvit+γ_1 P_(vit-1)^ +γ_2 Q_vit^ +γ_3 W_vit^ +e_vit (10)
where the interpretation of the estimated parameters is as defined above. The model gives estimates of both the implicit price of grapes and price adjustment dynamics.
The Kwiatkowski-Phillips-Schmidt-Shin test introduced in Kwiatkowski et al. (1992) will be used to determine the order of integration. For this test the null is that each data series is stationary. If some of the data series are found to be non-stationary the modeling approach of Pesaran and Shin (1999) will be used. This model format is referred to as an unconstrained error correction mechanism model and the model is appropriate for estimation where there are a mix of I(0) and I(1) variables. The interpretation of coefficients, after appropriate transformations, is the same as under the ARDL model.

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Wine Grape Prices in Mendoza: Implications for Replanting Policies

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1. Background

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Wine prices in the domestic market are correlated with the price of the grapes used for producing each wine; and wines made from high-quality red varieties like Malbec, on average, sell for higher prices than wines made from other red varieties, and from high-quality white varieties. Further, the price for generic red wine is, on average, higher than for generic white wine; and grape juice is, on average, less expensive than generic white wine.

The observed price differences for wine can in part be explained by changes in demand. In Argentina, domestic consumption has shifted towards high-quality wine, especially red wine (Argentinean Wine Corporation, 2016). Foreign demand has also favored red wine of high-quality

varieties like Malbec. Demand for grape juice, a product made with low-quality grape varieties that is mainly exported, has also shown a downward trend over recent years.

In Mendoza, there have been substantial changes in the variety mix, with an increase in plantings of high-quality red varieties like Malbec, and a reduction in the area planted devoted to low-quality white and rosé grapes (Maclaine Pont and Thomas, 2012). However, these changes in the varietal share have not been sufficient to adapt to the fast phase of the changes in demand.

The price premium to generic red wine over generic white wine is now so high that it has motivated an increase in the area planted to the Aspirant Bouchet variety. A unique feature of Aspirant Bouchet is that the red color index for the variety is so high that small quantities of the variety can be blended with generic white wine, and the resulting blend can then be officially classified and sold as generic red wine.

As a consequence of the low prices of low-quality white and rosé grapes, the profitability of the farmers that produce these varieties is low, and in some years negative (Abihagle et al., 2015). To assist farms currently growing low-quality white and rosé grapes, the Argentinean government has an active vineyard replanting program that provides zero interest credit to growers with vineyards smaller than 20 hectares, to help them pull out existing vines and replant with higher quality varieties (Government of Mendoza, 2017).

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While the aim of this study is not to determine the best replanting policy, the information generated can be used by policy-makers to conduct sensitivity analysis around different replanting strategies at a whole of region level. Given the replanting program is in its initial stage, it is especially timely to review the program.

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$$P_t^* = a + bQ_t + cW_t + e_t. \quad (1)$$

In the above expression P_t^* denotes the equilibrium price of grape at year *t*, given quantity harvested Q_t and wine stocks W_t, a, b and c are parameters to be estimated, and e_t is a zero mean random error term. Equation (1) expresses a theoretical relationship, since the equilibrium price of grapes (given current quantity harvested and wine stocks), P_t^*, is not observed. Instead, P_t (i.e. actual price of grape at year *t*) is observed.

Assuming that the process of adjustment depends on the difference between the price in the previous year and the equilibrium price in the current year gives:

$$P_t - P_{t-1} = \gamma(\mathrm{P}_t^* - P_{t-1}), \quad (2)$$

where γ is the speed of adjustment parameter. Equation (2) states that the observed change in the price of grapes is proportional to the difference between the price of grapes in the previous year and the equilibrium price of grape in the current year. Values of γ are between zero (i.e. no adjustment) and one (i.e. complete adjustment). Thus, the name "partial adjustment model". Rearranging equation (2) gives:

$$P_t = P_t^*\gamma + P_{t-1}(1-\gamma), \quad (3)$$

which states that the price of grape in the current year is a weighted average of the price in the previous period, and the current equilibrium price.

Substituting equation (1) in equation (3) gives:

$$P_t = \gamma a + \gamma b Q_t + \gamma \mathrm{c} W_t + (1-\gamma)P_{t-1} + \gamma e_t. \quad (4)$$

The term γb in equation (4) describes the short-term effect of grape harvests on grape price. And $\gamma \mathrm{c}$ describes the short-term effect of wine stocks on grape price. In the long-term, equilibrium changes. As such, substituting long-term equilibrium values into equation (4), and using P', Q' and W' to denote long-run equilibrium values gives:

$$P' = \gamma a + \gamma b Q' + \gamma c W' + (1-\gamma)P', \quad (5)$$

which can then be rearranged to give:

$$P' = a + bQ' + cW'. \quad (6)$$

Equation (6) states that the long-term effect of the quantity harvested on the price of grape is given by b. And for wine stocks, by c.

The partial adjustment model equation is:

$$P_t = \gamma a + \gamma b Q_t + \gamma c W_t + (1-\gamma)P_{t-1} + \gamma e_t, \quad (7)$$

and the model output, which is estimated via least squares, is:

$$P_t = \alpha + \beta_1 Q_t + \beta_2 W_t + \beta_3 P_{t-1} + e_t'. \quad (8)$$

Combining equations (7) and (8), it is possible to obtain the short-term and long-term effects of both, quantity of grape harvested and wine stocks, on grape price. The short-term effect of the quantity of grape harvested on grape price in equation (7) is given by γb, which is β_1 in

equation (8). The long-term effect of the quantity harvested on grape price in equation (7) is given by $b = \gamma b/\gamma$, which can be obtained as $\beta_1/(1-\beta_3)$ from the output of equation (8). A similar interpretation can be derived for the effect of wine stocks on grape price, where the short-term effect is $\beta_2 = \gamma c$, and the long-term effect is $c = \gamma c/\gamma = \beta_2/(1-\beta_3)$.

The hedonic price literature states that the price of a good can be expressed as a function of underlying attributes. The general form of a hedonic price function for grapes can be written as:

$$P_{vit} = \alpha + \sum_{k}^{K} \beta_k \, z_{kvit} + e_{vit} \tag{9}$$

where P_{vit} denotes the farm gate price of grapes at time *t*, z_{kvit} is a vector of observable characteristics at time *t*, β_k denote the various implicit prices those characteristics and interactions between them, and e_{vit} is a zero mean error term.

Based on the characteristics of the market for grape in Mendoza, the characteristics accounted for in z_{kvit} are: variety, sub-region and payment type. Variety and sub-region are dummy variables and an interaction between variety and sub-region is also considered. Payment type is the proportion of grape paid by cash, as opposed to installments, for variety *v* in location *i* at time *t*.

The final model, combining the inverse form of the partial equilibrium adjustment ARDL model and the hedonic model can then be written as:

$$P_{vit} = \alpha + \sum_{k}^{K} \beta_k \, z_{kvit} + \gamma_1 P_{vit-1} + \gamma_2 Q_{vit} + \gamma_3 W_{vit} + e_{vit} \tag{10}$$

where the interpretation of the estimated parameters is as defined above. The model gives estimates of both the implicit price of grapes and price adjustment dynamics.

The Kwiatkowski-Phillips-Schmidt-Shin test introduced in Kwiatkowski et al. (1992) will be used to determine the order of integration. For this test the null is that each data series is stationary. If some of the data series are found to be non-stationary the modeling approach of Pesaran and Shin (1999) will be used. This model format is referred to as an unconstrained error correction mechanism model and the model is appropriate for estimation where there are a mix of

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