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Title
A fractional econometric approach applied to wine exports: evidence from Portugal

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Conference Presentation

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Keywords
Globalisation; International trade; Differentiated products; Market share; Two-part FRM

Research Question
Macroeconomic determinants of export market share in wine imports of different countries.

Methods
One- and two-part fractional regression model, using data from Portuguese wine exports to a panel of 96 countries during the period of 2006-2016.

Results
GDP per capita has a positive effect on the probability of importing Portuguese wine, but the effect is inversely related to the market share.

Abstract
In a globalised economy, the competitiveness of a country is more and more dependent on the ability of industries to participate in the game of international trade. This issue has been studied since the publication of the seminal works of Ricardo's theory of comparative advantages, Heckscher-Ohlin and Krugman's new trade theory. This trade theory suggests that critical factors in determining international patterns of trade are the economies of scale and network effects that can occur in key industries under monopolistic competition.
Wine is a good example of a globalised product having a diversified geography of production and consumption and fierce competition between countries, and even wine regions. Commonly, this international competitiveness is quantified through proxies such as the market share of the exports of one country as a proportion of the total wine imports of the other countries. On one hand, this picture highlights the importance of trade agreements, transport costs, purchasing power, cultural proximity, among other determinants, to explain international trade patterns. On the other hand, the sector has specific issues, particularly the maintenance of production in volume and the

increase in value during this century, as well as the difficulties in matching consumer satisfaction with low-priced wines in a market with oligopolistic characteristics, but with market power compromised by a large number of small firms offering differentiated products, typical of a monopolistic competition environment.
The dynamics of international trade in general and of wine in particular have been accompanied by a wave of research estimating macroeconomic determinants regularly using the gravity framework to explain trade flows in value or volume. However, generally, such analyses do not take into consideration the contribution from the exporting countries to total imports in the destination country, a measure indicating the competitiveness in that market. The main goal of the paper is the application of a fractional regression model to the macroeconomic determinants that influence the market shares in importing countries, using data on wine exports from Portugal, a traditional exporting country.
Given the characteristics of the explained variable, bounded by the interval [0,1], an approach capable of dealing with a bounded and fractional response variable is required. Specifically, the fractional regression model (FRM) developed by Papke and Wooldridge (1996) is recommended because it presents advantages in relation to linear methods or other common solutions of the literature such as logit, probit and Tobit. The FRM is a non-linear model that does not require transformations for values at the bounds, accounting for the non-linearity in the data, while being fully robust under generalized linear model assumptions (Gallani et al., 2015). Observations at the extremes of the distribution are included based on the assumption that $E(Y|X)=G(X\beta)$, where fitted values are guaranteed within the unit interval by $0<G(\bullet)<1$. Based on Papke and Wooldridge (1996), estimations are done through maximization of the Bernoulli log-likelihood function $LL(\beta)\equiv y \log[G(X\beta)]+(1-y) \log〖[1-G(X\beta)]〗$.
Since there is a higher concentration of observations at the boundary 0 than seems to be consistent with a simple model, it is advisable to consider a two-part FRM (2P-FRM) otherwise the boundary values of the fractional response variable will not be defined. The 2P-FRM is constituted of a binary model for the discrete component and a fractional model for the continuous component.
Following Ramalho et al. (2011), the first part estimates the probability of the wine of country j being imported by a certain country, , and can be defined as
$〖〖share〗_{ijt}〗^*=\{\begin{matrix}0 \text{ for } 〖share〗_{ijt}=0 \\ 1 \text{ for } 〖share〗_{ijt}\in(0,1)\end{matrix}$
$Pr(〖〖share〗_{ijt}〗^*=1|X_{ijt})=E(〖〖share〗_{ijt}〗^*|X_{ijt})=F(X_{ijt}\beta_1)$
where share_ijt is the market share of country j's exports as a proportion of the total of country i's imports in year t, F(•) is a non-linear conditional mean specification and β_1 is a vector of coefficients for the covariates in X_ijt (GDP per capita of the importing country, real exchange rate of the importer's currency vis-à-vis the exporter's currency, ad valorem equivalent tariff imposed by the importer, distance between the exporter and the importer and landlockedness or not of the importer). The second part of the model considers only the observations where country j's wine was imported to estimate the parameters and it can be represented as
$E[〖share〗_{ijt}|X_{ijt}, 〖share〗_{ijt}\in(0,1)]=M(X_{ijt}\beta_2)$
where in $M(X_{ijt}\beta_2)$ the regressors X_{ijt} are the same as the first part (despite not being required) and M(•) is also a non-linear conditional mean specification but not necessarily the same specification as F(•).
The model is applied to the Portuguese wine industry, focusing on 96 trade partners which represents around 98% of Portuguese bottled wine exports during the period 2006-2016. Regarding the explained variable, data for the exports of Portuguese wine are from the Comext database and for total wine imports of each destination country the source is the International Trade Center (ITC). Relative to the explanatory variables, the sources are: World Development Indicators (WDI) database for GDP per capita at constant prices of 2010, collected in US dollars and converted into euro using the nominal exchange rate; WDI also for the nominal exchange rate of euro vis-à-vis US dollar and the consumer price index used to compute real exchange rate; and GeoDist database (Centre d'Études Prospectives et d'Informations Internationales) for distance and landlockedness.
In order to assess the robustness of the results, one- and two-part FRM are estimated assuming five alternative non-linear conditional mean specifications (Cauchit, Logit, Probit, Loglog and Complementary Loglog) for F(•) and M(•) suggested in Ramalho et al. (2011).
Based on the RESET, Goodness-of-functional-form, Generalized Goodness-of-functional-form and P tests (Ramalho et al. 2011, 2014), the results suggest adopting a 2P-FRM, where the 1st part has a Complementary Loglog specification and the 2nd part has a Loglog specification. Moreover, the sign and significance of the parameters show that GDP per capita positively influences the probability of a certain country to be an importer, but the market share tends to evolve inversely to the purchasing power of the destination country. The real exchange rate also has a positive effect on the probability of Portugal being an exporter, notwithstanding the fact that distance, tariffs and landlockedness have negative effects. Although the effect of these variables on the market share seems not to be statistically significant.

Since the results provide information not only on the probability of Portugal being present in the main wine-importing markets, but also on the market share determinants, it can be used to define priority markets and marketing strategies.
Future research will incorporate and compare the leading countries' wine exports, following a benchmarking strategy in terms of macroeconomic determinants in international trade.

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A fractional econometric approach applied to wine exports: evidence from Portugal

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One- and two-part fractional regression model, using data from Portuguese wine exports to a panel of 96 countries during the period of 2006-2016.

Results (30 words)

GDP per capita has a positive effect on the probability of importing Portuguese wine, but the effect is inversely related to the market share.

Abstract[1] **(800 to 2000)**

In a globalised economy, the competitiveness of a country is more and more dependent on the ability of industries to participate in the game of international trade. This issue has been studied since the publication of the seminal works of Ricardo's theory of comparative advantages, Heckscher-Ohlin and Krugman's new trade theory. This trade theory suggests that critical factors in determining international patterns of trade are the economies of scale and network effects that can occur in key industries under monopolistic competition.

[1] This is a provisory version.

Wine is a good example of a globalised product having a diversified geography of production and consumption and fierce competition between countries, and even wine regions. Commonly, this international competitiveness is quantified through proxies such as the market share of the exports of one country as a proportion of the total wine imports of the other countries. On one hand, this picture highlights the importance of trade agreements, transport costs, purchasing power, cultural proximity, among other determinants, to explain international trade patterns. On the other hand, the sector has specific issues, particularly the maintenance of production in volume and the increase in value during this century, as well as the difficulties in matching consumer satisfaction with low-priced wines in a market with oligopolistic characteristics, but with market power compromised by a large number of small firms offering differentiated products, typical of a monopolistic competition environment.

The dynamics of international trade in general and of wine in particular have been accompanied by a wave of research estimating macroeconomic determinants regularly using the gravity framework to explain trade flows in value or volume. However, generally, such analyses do not take into consideration the contribution from the exporting countries to total imports in the destination country, a measure indicating the competitiveness in that market. The main goal of the paper is the application of a fractional regression model to the macroeconomic determinants that influence the market shares in importing countries, using data on wine exports from Portugal, a traditional exporting country.

Given the characteristics of the explained variable, bounded by the interval $[0, 1]$, an approach capable of dealing with a bounded and fractional response variable is required. Specifically, the fractional regression model (FRM) developed by Papke and Wooldridge (1996) is recommended because it presents advantages in relation to linear methods or other common solutions of the literature such as logit, probit and Tobit. The FRM is a non-linear model that does not require transformations for values at the bounds, accounting for the non-linearity in the data, while being fully robust under generalized linear model assumptions (Gallani *et al.*, 2015). Observations at the extremes of the distribution are included based on the assumption that $E(Y|X) = G(X\beta)$, where fitted values are guaranteed within the unit interval by $0 < G(\cdot) < 1$. Based on Papke and Wooldridge (1996), estimations are done through maximization of the Bernoulli log-likelihood function $LL(\beta) \equiv y \log[G(X\beta)] + (1 - y) \log[1 - G(X\beta)]$.

Since there is a higher concentration of observations at the boundary 0 than seems to be consistent with a simple model, it is advisable to consider a two-part FRM (2P-FRM) otherwise the boundary values of the fractional response variable will not be defined. The 2P-FRM is constituted of a binary model for the discrete component and a fractional model for the continuous component.

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$$share_{ijt}{}^{*} = \begin{cases} 0 \; for \; share_{ijt} = 0 \\ 1 \; for \; share_{ijt} \in (0,1) \end{cases}$$

$$\Pr\left(share_{ijt}{}^{*} = 1 \middle| X_{ijt}\right) = E\left(share_{ijt}{}^{*} \middle| X_{ijt}\right) = F(X_{ijt}\beta_1)$$

where $share_{ijt}$ is the market share of country j's exports as a proportion of the total of country $i's$ imports in year t, $F(\cdot)$ is a non-linear conditional mean specification and β_1 is a vector of coefficients for the covariates in X_{ijt} (GDP per capita of the importing country, real exchange rate of the importer's currency vis-à-vis the exporter's currency, ad valorem equivalent tariff imposed by the importer, distance between the exporter and the importer and landlockedness or not of the importer). The second part of the model considers only the observations where country j's wine was imported to estimate the parameters and it can be represented as

$$E\left[share_{ijt} \middle| X_{ijt}, share_{ijt} \in (0,1)\right] = M(X_{ijt}\beta_2)$$

where in $M(X_{ijt}\beta_2)$ the regressors X_{ijt} are the same as the first part (despite not being required) and $M(\cdot)$ is also a non-linear conditional mean specification but not necessarily the same specification as $F(\cdot)$.

The model is applied to the Portuguese wine industry, focusing on 96 trade partners which represents around 98% of Portuguese bottled wine exports[2] during the period 2006-2016. Regarding the explained variable, data for the exports of Portuguese wine are from the Comext database and for total wine imports of each destination country the source is the International Trade Center (ITC). Relative to the explanatory variables, the sources are: World Development Indicators (WDI) database for GDP per capita at constant prices of 2010, collected in US dollars and converted into euro using the nominal exchange rate; WDI also for the nominal exchange rate of euro vis-à-vis US dollar and the consumer price index used to compute real exchange rate; and GeoDist database

[2] Harmonised system codes starting by 220421, correcting for re-exportation.

(*Centre d'Études Prospectives et d'Informations Internationales*) for distance and landlockedness.

In order to assess the robustness of the results, one- and two-part FRM are estimated assuming five alternative non-linear conditional mean specifications (Cauchit, Logit, Probit, Loglog and Complementary Loglog) for $F(\cdot)$ and $M(\cdot)$ suggested in Ramalho *et al*. (2011).

Based on the RESET, Goodness-of-functional-form, Generalized Goodness-of-functional-form and P tests (Ramalho *et al*. 2011, 2014), the results suggest adopting a 2P-FRM, where the 1st part has a Complementary Loglog specification and the 2nd part has a Loglog specification. Moreover, the sign and significance of the parameters show that GDP per capita positively influences the probability of a certain country to be an importer, but the market share tends to evolve inversely to the purchasing power of the destination country. The real exchange rate also has a positive effect on the probability of Portugal being an exporter, notwithstanding the fact that distance, tariffs and landlockedness have negative effects. Although the effect of these variables on the market share seems not to be statistically significant.

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Future research will incorporate and compare the leading countries' wine exports, following a benchmarking strategy in terms of macroeconomic determinants in international trade.