The role of climate and trade policies in the wine sector

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Abstract. New production and trade patterns due to climate change and policy interventions are increasingly affecting the wine sector. This paper investigates how patterns of production and trade in main wine producing regions respond to changes in climate and policy interventions. An approach based on a combination of Ricardian trade and climate models suggests that higher temperatures in the main producing regions of wine benefit both production and trade of wine. A gravity-based analysis shows that the effects of policy interventions on the global trade of wine are heterogeneous and dependent on the specific objective of the intervention.

1 Introduction

Over the last decades, trade in the wine sector at the global level faced considerable changes due to new productive scenarios induced by climate change and to new types of policy interventions.

As for the effect of climate change, the existing literature demonstrated that trade of wine is affected by climate change (e.g., [1, 2]) but with significant differences across producing regions of wine (e.g., [3, 4]). However, the effect of climate change on wine production and trade patterns seems to have not been identified at global level. As for policy interventions, previous studies have quantified the effects of tariffs and non-tariff measures (NTMs) (e.g., [5]), and evaluated the role of specific NTMs, i.e., technical measures such as Sanitary and Phytosanitary measures and Technical Barriers to Trade (e.g., [6, 7]). But studies deepening on the relationship between new productive scenarios induced by climate change and new types of policy interventions (i.e., tariff, NTMs, environment-related policies) are rather scant.

The gap in the empirical literature calls for more investigation to understand if climate change may affect the production and trade of wine, and if policy interventions (tariffs, NTMs, environment-related policies) differently affect trade patterns because of changing productive scenarios. We deepen on these research questions, to understand which the impacts of climate change on global production and trade of wine are, and what the reactions of trading partners to new production and trade dynamics, due to climate change, are in terms of new types of policy interventions.

The aim of the paper is two-fold. First, it would understand the effects of climate change on global production and trade of wine. A vast literature deepens on the nexus between climate change, production, and trade (for a review see [8]), but evidence for the wine sector are limited (e.g., [1]. The existing studies assumes that, for open economies, the impacts of climate change on agriculture move from one region to the other, thus they are likely to affect differently all regions in the world [9]. This assumption implies that within regions (through production patterns) and between regions (through trade patterns) adjustments contribute to differentiate the impacts of climate change [10, 11]. This conceptual framework is applied to the wine sector in this paper.

Second, the paper would investigate the reaction of trade partners to new policy interventions, due to climate change, in terms of trade dynamics. As argued in Randhir and Hertel [12], climate change and agricultural trade policies are connected and policy interventions have consequences on global welfare in the context of climate change.

2 Methods

To understand the effects of climate change on global production and trade of wine, we propose an econometric approach, based on a combination of methods used in Ricardian trade (e.g., [13]) and climate (e.g., [14, 15]) studies.

To understand how climate change affects their production and trade capacity, we estimate the following:

$$Supply_{it} = \boldsymbol{\lambda}_m + \boldsymbol{\lambda}_t + \boldsymbol{Climate}_r\,\theta + \varepsilon_{it} \quad (1)$$

where the wine supply of country i at time t ($Supply_{it}$) is regressed on region- and time-specific determinants (e.g., [2]), proxied by macro-region and time fixed effects ($\boldsymbol{\lambda}_m$ and $\boldsymbol{\lambda}_t$), region-specific (r) climate variables ($\boldsymbol{Climate}_r$). θ is the vector of regression coefficients of interest and ε_{it} is the error term.

As dependent variable, $Supply_{it}$, we use alternatively the volume of countries' wine production, to investigate the responsiveness of production patterns, and the value of countries' wine exports, to capture the effects on the trade patterns.

In line with climate literature (e.g., [16]), climate variables, $\boldsymbol{Climate}_r$, include climatologies (i.e., 30- years rolling averages) of temperature and precipitation, and their squares.

To investigate the reaction of trade partners to new policy interventions, due to climate change, in terms of trade dynamics, we adopt a gravity-type approach (e.g., [17, 18]).

We explain how bilateral trade reacts to changes in specific determinants of trade (i.e., trade regulations, climate-induced changes in productivity), net to the effect of country-specific characteristics of trading partners

Table 1. Summary description of data.

Timeframe: 1996-2015
Countries: 14 countries covering 70% of the volume of wine production in 2016 (Global Wine Markets, 1860 to 2016 database)

- **Old World Producers**: France, Germany, Italy, Spain, United Kingdom
- **New World Producers**: Argentina, Australia, Brazil, Canada, China, New Zealand, Russian Federation, South Africa, United States
- **Selected main producing regions**: Italy (i.e., Piemonte, Veneto, Toscana, Puglia, Sicilia), France (i.e., Alsace, Champagne, Bordeaux, Burgundy, Languedoc- Roussillon, Provence), Spain (i.e., Andalucia, Castilla-La Mancha, Castilla y Leon, Catalonia, Galicia, Rioja), and Germany (i.e., Baden, Mosel, Pfalz- Rheinhessen, Rheingau), Australia (i.e., Victoria, New South Wales, South Australia), the United States (i.e., California, Oregon, Washington, New York)

Data:

- **Climate**: country-specific monthly weather data, collected from the Climatic Research Unit (CRU) of University of East Anglia, and aggregated in annual and seasonal climatologies (i.e., rolling 30- years averages) of temperature (in °C) and precipitation (mm); seasonal climatologies adjusted for reverse seasonality. Daily weather data collected from the Datasets of the MARS Crop Yield Forecasting System and Software, developed by Agri4Cast of the European Commission, for the main wine producing regions of Italy, France, Spain, Germany, and aggregated in annual climatologies of temperature (°C) and precipitation (mm). Monthly weather data collected from the National Oceanic and Atmospheric Administration (NOAA) of the National Centers for Environmental Information (NCEI) for the main wine producing States of the US and from the Bureau of Meteorology of the Australian Government, both aggregated in annual climatologies of temperature (°C) and precipitation (mm).
- **Productivity**: country-specific annual data on wine production and excess of production (in 1000 hl) derived from the OIV database.
- **Trade**: bilateral annual imports and exports (in 1000 US$) for each country- pairs in the sample, collected from the UN Comtrade database; trade data aggregated the four-digit level of the Harmonised System classification for the category wine of fresh grapes (HS 4-Digit 1996: 2204).
- **Non-tariff measures:** country-pair specific number of bilateral and multilateral NTMs in force (modelled also as dummies), aggregated at the HS 4-digit level, collected from the UNCTAD's global database on NTMs; details available for each type of NTM (e.g., TBT) and sub-category of NTM (e.g., Restricted use of certain substances, TBT regulations on transport and storage).
- **Tariffs**: country-pair specific average tariffs (simple and trade weighted), aggregated at the HS 4-digit level, collected from the World Bank's World Integrated Trade Solution (WITS) database; details available for each type of tariff (e.g., Most Favoured Nation, effectively applied rate).

(e.g., [19, 20]) estimating the following:

$$X_{ijt} = \boldsymbol{\beta}_{it} + \boldsymbol{\beta}_{jt} + \boldsymbol{\beta}_{ij} + \mathbf{T}_{ijt}\,\gamma + \upsilon_{ijt} \quad (2)$$

where trade between the trading partners i and j at time t (X_{ijt}) is regressed on importer-time and exporter- time fixed effects ($\boldsymbol{\beta}_{it}$ and $\boldsymbol{\beta}_{jt}$) controlling for multilateral resistances (e.g., [21, 22]), country-pair fixed effects ($\boldsymbol{\beta}_{ij}$) capturing bilateral time-invariant determinants of trade (e.g., [23, 24]), time-varying determinants of trade ($\mathbf{T}_{ijt}$). γ is the vector of regression coefficients of interest and υ_{ijt} is the error term.

$\mathbf{T}_{ijt}$ include the log of ad valorem tariffs, dummies proxying the presence of technical measures such as Technical Barriers to Trade (TBT). We control, alternatively, for the presence of at least a TBT (as general category), for the presence of environment- related TBT (i.e., TBT pursuing a specific objective), for the presence of TBT addressing a specific environmental issue (e.g., authorisation requirement for environmental reasons).

In a sensitivity analysis, the model in Eq. (2) also controls for the effect of countries' excess of production due to long-run changes in climate (i.e., the prediction of countries' supply from Eq. (1)).

Our empirical application considers a sample of 14 countries observed over two decades (from 1996 to 2015). The selected countries account for more than two- third of the volume of wine production [25].

Table 1 provides a synthesis of data used for the empirical investigation and data sources.

3 Main results and concluding remarks

Our results confirm that climate change impacts on both production and trade of wine. Higher annual temperatures in the main producing regions of wine tend to expand the volume of wine production. As for precipitation in the main producing regions of wine, the volume of wine production increases at a declining rate up to a threshold level after which it declines (non-linear relationship, Table 2).

The beneficial impact of higher temperatures on the production levels of main wine producing regions are observed also on countries' trade, i.e., export capacity (Table 2).

The results also reveal the impact of policy interventions on bilateral trade relationships in the wine sector (Table 3).

Table 2. Responsiveness of wine production and trade to climate.

	Production	Trade
Temperature	+	+
Temperature-squared	-	n.s.
Precipitation	-	n.s.
Precipitation-squared	+	n.s.
Macro-region fixed effects	yes	yes
Time fixed effects	yes	yes
Latitude	yes	yes
Longitude	yes	yes

Notes: Pooled least square estimates of the model in Eq. (1). The dependent variables are in log. Regional annual temperature is in degrees Celsius and regional annual precipitation is in units of mm per year. "+" indicates a positive significant relationship, "-" indicates a negative significant relationship, "n.s." stands for not significant; opposite signs of climate variables in level and squared indicate a non-linear relationship.

Table 3. Responsiveness of bilateral trade to environment-related measures.

	TBT	Environmental TBT	TBT B14	TBT B15	TBT B21
TBT	n.s.	-	n.s.	n.s.	n.s.
Specific TBT		+	+	n.s.	-
Importer fixed effects	yes	yes	yes	yes	yes
Exporter-time fixed effects	yes	yes	yes	yes	yes
Country-pair fixed effects	yes	yes	yes	yes	yes
Tariffs	yes	yes	yes	yes	yes

Notes: Gamma Pseudo Maximum Likelihood estimation of the gravity model in Eq. (2). The dependent variable is the value of bilateral trade (in level). The TBT-related explanatory variables are modeled as dummy variables. B14 and B15 consist, respectively, in authorization requirement and in registration requirement for importers for TBT reasons (including environmental protection); B21 are tolerance limits for residues of or contamination by certain substances. All specifications include a constant, importer, time, exporter-time, and country-pair fixed effects, tariff levels. "+" indicates a positive significant relationship, "-" indicates a negative significant relationship, "n.s." stands for not significant.

The impact of policy interventions on bilateral trade of wine highly depends on the objective of the measure set by countries implementing technical measures. Overall, TBT are barriers to trade of wine. This is in line with previous empirical evidence [5, 7, 26]. Differently, policy interventions regulating environmental issues are catalysts to trade of wine, although differences in the impacts are observed across specific interventions. For instance, TBT B14which provides for authorisation requirement limits less wine trade than TBT B21 which provides for tolerance limits for residues of or contamination by certain substances. In fact, different measures tend to pursue specific objectives [27] with consequent differential impacts on trade [28].

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