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Article

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Wine Economics and Policy

Provided in Cooperation with:

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Suggested Citation: Vlachos, Vasileios A. (2017) : A macroeconomic estimation of wine production in Greece, Wine Economics and Policy, ISSN 2212-9774, Elsevier, Amsterdam, Vol. 6, Iss. 1, pp. 3-13,
<https://doi.org/10.1016/j.wep.2017.03.001>

This Version is available at:

<https://hdl.handle.net/10419/194528>

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A macroeconomic estimation of wine production in Greece

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Received 21 July 2016; received in revised form 13 February 2017; accepted 7 March 2017

Available online 15 March 2017

Abstract

Unlike other south European Union countries with tradition in wine production, Greece has not yet exploited the industry's export potential. However, there are expectations that under certain policy orientations, a competitive industry with internationally recognized labels could emerge. This paper explores the drivers of wine production in Greece from a macro perspective and assesses their impact vis-à-vis international trade in order to contribute to these orientations for the development of a competitive industry that will assist Greece in the search for an exit from economic depression. The findings indicate that international trade impacts more on wine production in Greece than domestic consumption of Greek wine and that productivity boosts wine production at the same time as personnel costs are a significant impediment. Policy orientations based on the findings are discussed.

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Keywords: Greece; International trade; Panel data analysis; Wine production

1. Introduction

The history of Greek wine covers a very long period (dating back to ancient Greece), which with regard to the continued cultivation of vines and production of wines, it is the largest worldwide. This long tradition in the art of winemaking has been enriched with modern enological and technological methods. Notwithstanding its long history and tradition, Greek wine is still far from being internationally recognized and according to Greece's statistical indicators (e.g. Eurostat) vis-à-vis those of other south European countries, the Greek wine industry has not yet reached its export potential.

Considering the fact that the wine industry is a traditional industry which has been technologically upgraded into a high-growth activity that offers major opportunities for new entrants (Smith, 2007) and moreover that Greek wine has started to develop an increasing international awareness, it is time for Greek wineries to explore their potentials beyond the national borders. The prospect of igniting the exporting potential of the Greek wine industry is of great interest to government officials

since an achievement means an acceleration of full recovery from the devastating consequences of the economic crisis. Several countries in the European Union (EU) have not fully recovered from the recent economic crisis and their economic policies aim to improve the government budget balance and the productivity and competitiveness of certain industries. Within this picture, Greece strives to develop the competitiveness of industries (beyond tourism) in the quest to exit from economic depression.¹

This paper aims to explore the determinants of wine production in Greece from a macro perspective. The exploration intends to cover a gap in the literature concerning predicting factors (e.g. tax rates and international trade) of wine production in Greece and to develop future orientation since the literature on wine production in Greece concerns more wine tourism and consumption and employs primary data. Moreover, the exploration intends to address the importance of international wine trade (with respect to Greece),

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Peer review under responsibility of Wine Economics and Policy.

¹Eurostat data (<http://ec.europa.eu/eurostat/data/database>) reveals that GDP in Greece has been in decline since 2008 (except 2014): from 109.1 (chain linked volumes, index 2005=100) in 2007 to 80.5 in 2015.

whose evolution is currently considered a key research question in the field (see Pomarici, 2016).

The paper is organized as follows. The next section gives a background to the study of wine production by discussing wine production in south EU countries, giving a general profile of the Greek wine industry, reviewing the findings of business and economic studies about Greek wine, and discussing empirical applications on wine production not covered by the literature about Greece. The third section describes the research aim and questions and method of analysis. The fourth section presents the findings. The fifth and final section discusses the findings and puts forward conclusions and limitations to the study.

2. Background

This section gives a background on the subject. Section 2.1 discusses the trends of wine production in Greece and other south EU countries. Section 2.2 gives an overview of the Greek wine industry. Section 2.3 reviews the business and economics literature on Greek wine production and trade. Section 2.4 presents empirical applications on wine production not discussed in Section 2.3.

2.1. Wine production in south EU: A brief overview of statistics

GAIN 2015 report has information about wine production in the EU. The EU is the world's leader in wine production

(France, Italy and Spain being the major producers) and leading wine importer and exporter with the United States being the leading EU export market (GAIN, 2015, p.1 & 3). Extra-European producers have seen their EU market shares rising at the same time as EU exports have been decreasing (GAIN, 2015, p.13–14).

Greece ranks seventh in the EU in terms of volumes produced (approximately 2 percent of total production), while Greece's annual per capita wine consumption stands at 25 l, with Greeks consuming less and opting for cheaper wine (GAIN, 2015, p.10).

Table 1 presents data about wine production and consumption in four south EU countries for the period 2003–2013. Wine production has increased in 2013 vis-à-vis its initial volume in 2003 only in Greece. Domestic demand (consumption) is approximately equal to wine production also only in Greece, whereas it is a lot less in the other three countries. Exports are approximately 50–60 percent of wine production in Italy, Portugal and Spain and approximately 10 percent in Greece. The sum of exports and domestic demand has been well over the quantity produced in Portugal during 2003–2013 (except 2006) and the same has been occurring in Greece during 2010–2013. The sum of exports and domestic demand has been less than the quantity produced in Spain and Italy throughout the whole reference period (not for Italy in 2012).

The number of enterprises reveals that each enterprise in Greece, Portugal and Spain produced on average up to 10,000 hl in 2013 (approximately 6000 hl in Portugal, 8000 hl in Greece and 10,000 hl in Spain) and approximately 23,000 hl in Italy in

Table 1
Wine production in Greece, Italy, Portugal and Spain.
Source: Eurostat (<http://ec.europa.eu/eurostat/data/database>).

Country/Indicator/Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Greece	Number of enterprises	400	403	421	432	445	488	520	521	528	428	406
	Number of persons employed	2722	2876	2795	2642	3130	2897	3151	3363	3215	3056	2980
	Official production (1000 hl)	3098	3804	4295	4027	3937	3511	3869	3366	2950	2750	3115
	Total exports (%)	9.9	9.1	6.7	7.5	8.2	9.3	6.9	10.3	12.5	11.0	9.6
	Gross human consumption (%)	79.6	80.8	74.7	88.2	81.7	97.0	72.7	96.5	96.7	106.8	98.5
Italy	Number of enterprises	1771	1769	1767	1768	1765	1785	1775	1795	1829	1829	1843
	Number of persons employed	15,777	16,382	15,825	16,605	17,649	16,571	15,865	15,933	16,521	16,939	17,228
	Official production (1000 hl)	44,604	44,086	53,135	50,566	49,631	42,514	46,245	45,800	46,734	42,705	–
	Total exports (%)	31.4	30.5	28.1	32.4	38.8	42.4	41.0	48.2	51.1	51.8	–
	Gross human consumption (%)	65.8	51.0	50.8	54.1	47.7	50.6	41.3	47.2	41.0	53.2	–
Portugal	Number of enterprises	309	341	426	461	526	714	749	746	781	798	1022
	Number of persons employed	6728	7374	7247	7154	7391	8234	8100	8146	7984	7991	8739
	Official production (1000 hl)	6677	7340	7481	7267	7542	6073	5620	5894	7148	5622	6308
	Total exports (%)	43.6	43.6	38.4	33.9	43.7	50.6	42.5	43.4	40.5	57.8	52.2
	Gross human consumption (%)	79.6	66.9	65.5	64.7	60.0	75.3	81.0	84.7	67.2	88.8	66.1
Spain	Number of enterprises	3649	3489	3550	3551	3697	3704	3428	3613	3705	3724	3656
	Number of persons employed	23,617	23,413	24,113	23,755	24,442	24,863	23,559	24,290	25,146	24,506	23,927
	Official production (1000 hl)	39,419	48,620	50,062	41,119	43,676	42,140	41,583	39,259	40,892	38,633	35,778
	Total exports (%)	27.8	29.0	28.6	34.9	33.3	37.9	35.5	40.5	51.3	59.7	48.6
	Gross human consumption (%)	34.8	28.6	27.7	33.2	30.7	28.9	26.6	26.5	25.3	25.6	27.5

Notes: "Total exports" and "gross human consumption" are percentages of official production. "Number of persons employed" is the total number of persons who work in the observation unit (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it (e.g. sales representatives, delivery personnel, repair and maintenance teams).

2012. Average production per enterprise has declined significantly in Portugal due to new entrants. The average number of persons employed per enterprise ranged in 2013 from 6 (Spain) to 9 (Italy) and has been reduced significantly since 2003 in Portugal. The average production per person employed in 2013 was less than 1000 hl in Portugal, 1000 hl in Greece and 1500 hl in Spain and the average production per person employed in 2012 was 2500 hl in Italy. The average production per person employed has been greater in the beginning of the 2003–2013 period in all countries.

2.2. Greek wine industry

The Greek wine industry is a traditional industry of the Greek primary sector with significant contributions to the economy, given its contribution to the development and promotion of Greek traditional products in foreign markets. The following discussion is based on data from ICAP (<http://www.icap.gr/Default.aspx?id=1869&nt=149&lang=1>) about the performance of the Greek wine industry in 2014.

The wine industry in Greece includes a few large firms/wineries, many medium-sized and small (local) firms/wineries and associations of agricultural cooperatives. The large firms/wineries control a significant share of the domestic market of bottled wine, offering their products through extensive distribution networks throughout the country. Wine imports account for a very small part of the domestic market, and there is a small number of import firms. The largest share of exports belongs to Germany and France, with 49.7 and 13.2 percent respectively.

The main factors that influence the demand for wine is the price in conjunction with disposable income, the dietary habits of consumers, seasonality, tourism and local traditions/festivities. Changes on the level of price and disposable income affect overall demand and cause consumers to purchase cheaper bottled products, and/or cask wine. Economic depression has led to a reduction in the consumption of wine and beverages in general, leading to a decrease of both on- and off-trade sales. The sales of bottled wine are between 36–40 percent of total volume and approximately 58 percent of total value of wine sold. From 2010 onwards, the average annual wine production has dropped considerably (approximately 20 percent) and more than 60 percent of wine produced is without specific indication of origin (Protected Denomination of Origin or Protected Geographical Indication). A sample of 45 wine producers revealed that although in 2014 total sales increased marginally by 0.5 percent and gross profits increased by 8.7 percent as a result of cost containment, operating loss was not avoided.

2.3. Wine production in Greece: A review of business and economic studies

The business and economics literature on Greek wine can be distinguished between studies focusing on export determinants and performance, tourism and consumer research. Nonetheless, altogether give insights about the demand side of wine economics.

Several empirical studies have shown that wine export growth explains a significant proportion of wine output growth (for example, see Wittwer and Anderson, 2001). For that reason, the Hellenic Ministry of Rural Development and Food decided to allocate €44 million during 2014–2018 for varietal conversion, vineyard relocation, and the improvement of vineyard management techniques in order to boost the competitiveness of the Greek wine market and promote the exports of quality wine to third countries. Moreover, the Ministry has allocated €16 million for the period 2015–2018 for Greek wine promotional activities (e.g. public relation campaigns and participation in events or trade shows) in the United States, Canada, Russia, China, and Switzerland (GAIN, 2015, p. 26).

Karelakis et al. (2008) explore the export performance determinants of Greek wine firms through primary data and find that the factors shaping their export competence (i.e. operating efficiency, research and development, personnel experience and training, and assessment of export market growth) and export channel knowledge² (to assess the characteristics and requirements of each market) are the most important drivers. In a more recent study, Koutroupi et al. (2015) also explore Greek wine exports and find via a gravity model that wine trade dynamics in the EU market are determined by the size of the economy, geographical distance, common borders and language and the size of per capita wine consumption. However, it is not only the EU market that indicates potential for Greek wine exports. There is a fast growing awareness of Greek wine in the United States and many in the media identify it as a serious competitor to popular wines like pinot grigio.³

Another strand of the literature explores the demand side of Greek wine economics through wine tourism. Alebaki and Iakovidou (2011) revisit the discussion of previous studies about the characteristics of wine tourists in Greece, France, Italy and Spain. The authors stress that a winery tour is a collateral activity for international visitors and that domestic travelers constitute more than 2/3 of total winery visitors in Greece. This implication about international visitors is also supported by recent research. For example, Alamanos et al. (2016) focus on wine consumers from the United Kingdom (UK) who have holidayed in Greece (and emphasize on the limited knowledge of UK wine consumers about wine from Greece) and find that visiting a region with territorial certifications in wine production does not seem to be important for consumers when visiting a foreign country.

From a regional perspective (and with reference to the Macedonia region) Alebaki and Iakovidou (2011) emphasize on

²Marketing activities have been found to be more important than other with respect to internationalization in the wine industry (Olmos, 2011).

³For example, see New York Times articles at <http://www.nytimes.com/2013/05/29/dining/reviews/white-wines-as-greek-as-the-sea.html?pagewanted=all> and <http://www.nytimes.com/2015/08/05/dining/wine-school-assyrtiko.html> (accessed on 24 May 2016). Moreover, international awareness is also evident from the inclusion of three Greek wineries in the 2013 "100 Wineries of the Year" selection of the Wine & Spirits magazine: <http://www.top100wineries.com/> (accessed on 2 July 2016).

the importance of the winery's proximity to the domestic visitor's residence and distinguish between four types of visitors: wine lovers, neophytes, occasional wine tourists and hangers-on.⁴ More recent research (Alebaki et al., 2015) attempts to encompass the multidimensionality of what visitors seek when engaging in wine tourism and highlights six motivational components of wine tourism: three primary, namely vineyard esthetics, wine tasting and wine knowledge, and three secondary, which are familiarity, reputation and novelty, and socializing.

All things considered, wine tourism is expected to expand the demand for wine and studies have been focusing on the factors shaping its supply (see Stavrinoudis et al., 2012) and demand (see Nella and Christou, 2014). A great element of wine tourism is that of wine routes connecting several wine estates and wineries, which have been developed for its promotion (see Tzimitra-Kalogianni et al., 1999). For example, the Association of Wine Producers of Vineyards of Northern Greece (Macedonia, Thrace, Epirus and Thessaly) has been created for developing local wine tourism, among other goals (for a discussion see Karafolas, 2006). Karafolas (2007) found that although the Association impacted positively on the number of tourist visits it had no effect on employment in the industry. Vlachvei and Notta (2009) found that the most significant benefits from wine routes for wine producers are improved reputation, promotion and publicity, and increased sales. They also found that younger wine route estates grow faster than mature firms, larger wine route estates exploit economies of scale in order to achieve high growth rates, and internal financial resources drive sales growth.

Another strand of the literature focuses on the characteristics of wine consumers, which evolve along with the production of quality wines. The number of wine varieties (both single and blend) produced in Greece has been growing throughout the years and certification, geographic association and traceability have become important in the winemaking process. More than a decade ago, Dimara and Skuras (2003) identified the socio-economic and demographic characteristics of Greek consumers for whom these quality cues exert a significant effect on their evaluation process. Fotopoulos et al. (2003) highlighted that wine produced by organic grapes is also important for this evaluation process. Skuras and Vakrou (2002) found that an average Greek consumer would pay more for a bottle of Greek wine if its place of origin guaranteed. In a more recent study about consumer preferences for cask wine, Chrysochou et al. (2012) find that the most important attributes are price, quality and convenience packaging, and that brand, grape variety and origin are the least important ones.

In conclusion, the relevant business and economics literature discussed in this section focuses on exports performance, tourism and the characteristics of wine consumers, which altogether represent the demand for Greek wine produced. Prior to discussing the econometric method adopted in this study, elements of the key empirical applications on wine production are briefly discussed in the next section.

2.4. Empirical applications and evidence regarding the determinants of wine production

A great part of the literature on wine production concerns production frontiers or technical efficiency (optimal scale of production and efficient allocation) for wine growers. Sellers-Rubio et al. (2016, p. 3) specify that the particular strand concerns productivity growth in the winery sector and distinguish the findings between technical efficiency (transformation of inputs into wine outputs volume) and economic efficiency (transformation of inputs into wine outputs value). Sellers-Rubio et al. (2016) review previous papers on this topic and indicate that the efficiency of wine producers has been analyzed through several parametric and non-parametric techniques, based on firm-level data and relating in some cases efficiency levels with farms characteristics (e.g. size and labor).

Other studies focus on further factors (e.g. taxes, quantity supplied and expected demand) affecting the quantity and quality of wine produced and move away from the efficiency concept. For instance, Goodhue et al. (2009) consider the impact of taxes on the quantity and quality of wine produced and find that although tax increases reduce the quantity of wine produced, the reduction in quality is not always the case. Another example is Volpe et al. (2010) who estimate econometrically the supply elasticity of California wine grapes and in the process of doing so, they model wine grape supply. Volpe et al. (2010) assume that California wine grape producers maximize their incomes through acreage and crush decisions and that grape production is independent across growing regions. They model output through a crush equation, where the tons crushed for variety x in region y depend among other things on other tons crushed, wages and expected prices.

A strand of the literature on wine production seems to develop on the concept of the resource-based view of the firm. Alonso and Bressan (2016) review the limited contributions adopting the resource-based view of the firm in the wine entrepreneurship literature and carry out a SWOT analysis to identify owners/managers' perceptions of internal and external factors affecting their wineries. Alonso and Bressan (2016) find that product and service quality, managerial/staff capabilities, knowledge, reputation and the territory/region emerge as most important resources, and that competitive advantage is threatened by factors such as the firm's finances, competition, red tape and the complexity of increasing sales.

Finally, there are several studies about how wine production adopts a cross-border focus and the industry becomes more competitive and thus export-oriented. For instance, Gwynne (2006) discusses how both for developing and developed economies, the shift to a more outward-oriented production paradigm and the development of a resource-based wine industry with increasing value-added activities assist regions which have the climatic and soil prerequisites for the production of certain grapes to become truly global in terms of both production and branding. Accordingly, Gergaud and Ginsburgh (2010, p. 11) who explore the effects of natural endowments and technology on quality of wine produced, indicate that "wine-making technology has become so sophisticated that it

⁴Of similar content and/or findings are also the works of Alebaki and Iakovidou (2010a, 2010b).

can completely shade the effect of terroir” (i.e. as long as weather permits and the right combination of vines is made, they can be grown in almost any place). [Giuliani et al. \(2011\)](#) who discuss several cases of innovation and technological catch-up in the wine industry emphasize that scientific and technological knowledge and institutions devoted to wine production and diffusion are key ingredients for making the wine industry highly competitive and for catching up in the global market. Several countries (e.g. Chile and New Zealand) have succeeded by following a different trajectory from the long standing leading countries (e.g. France), in which innovation, science and research play a prominent role.

3. Method

The aim of the study is the exploration of the economic factors influencing wine production in Greece from a macro perspective. The literature discussed in the previous section indicates several of the factors influencing wine production in Greece and highlighted the major elements of the empirical applications on wine production. The study fills a gap in the literature by investigating factors influencing wine production in Greece such as production costs and international trade.

The basis for setting the estimating equation in this study is a typical production function. For example, the Cobb-Douglas production function is:

$$Y = AL^\beta K^\alpha \quad (1)$$

where Y is total production, A is total factor productivity L is labor input, K is capital input, and α, β (with $\alpha + \beta = 1$) are constants determined by available technology. Motivated by this production function and considering the factors determining wine production discussed in the previous section, and the availability of macro-level data, wine production is explored via the following equation:

$$Y_{it} = A_{L_{it}, K_{it}} + T_{it} + C_{it} + XM_{it} \quad (2)$$

where Y is total production of country i at time t expressed by value added; A is total factor productivity of labor and capital plus the cost of employing each of these units and it is expressed either by the combination of personnel costs, apparent labor productivity and the investment rate, or the combination of the latter with wage adjusted labor productivity; T is the total tax rate; C is consumption of wine produced domestically (Greek wine quantity demanded) expressed by gross human consumption minus imports; XM is the effect of international trade on wine quantity demanded and it is expressed either by imports and exports (of wine respectively) or net exports.⁵ All variables are presented on [Table 2](#).⁶

⁵Exports (and net exports) represent an extra component of wine demanded and they are expected to have a positive relationship with value added (and imports having a negative). It is assumed that exports (and net exports) influence wine production and not vice versa (producers respond to market demand).

⁶The combinations lead to 4 model specifications. The findings on [Table 4](#) are about each one of them.

Total factor productivity of labor and capital is expected to have a positive effect on value added and personnel costs the opposite. The tax burden is included in the model because it has increased significantly in Greece and other countries that experience economic adjustment programs due to the recent economic crisis. The tax burden is expected to have a negative effect on value added and its role becomes even more important under the consideration that wine producers cannot relocate their activities in neighboring EU countries without affecting the quality and characteristics of their product. The variables about international trade and consumption are included in the model because they represent the demand for wine. All are expected to have a positive effect on value added, except from imports which represent demand met from production abroad.

[Table 2](#) indicates the characteristics of the data at their source. Prior to the analysis all values are expressed in millions of €, including per head values.⁷ As such, the values of all variables measured in hl are estimated in monetary terms. Imports, exports, net exports and consumption are estimated in monetary terms by multiplying their value with the quotient of a fraction with value added as numerator and official production as denominator.

The four hypotheses to be tested are based on comparisons between the effects of predictors:

- 1) production costs impede wine production in Greece more than taxes;
- 2) productivity improvements boost wine production in Greece;
- 3) exports impact less on wine production in Greece than domestic consumption of Greek wine;
- 4) imported wine impacts less on wine production in Greece than domestic consumption of Greek wine.

Hypotheses 1 and 2 are derived from current economic policy orientation in Greece towards austerity, where all costs are minimized and lower labor costs are expected to increase competitiveness. Hypothesis 3 is based on data about exports and consumption presented on [Table 1](#) and reflects the notion that Greek wine lacks international recognition. Hypothesis 4 explores the strength of Greeks' preference for domestic wine. Hypothesis 1 is tested via personnel costs and the total tax rate, hypothesis 2 is tested via labor productivity and the investment rate, hypothesis 3 is tested via exports and domestic consumption, and hypothesis 4 is tested via imports and domestic consumption.

The data sample consists of observations for the above-mentioned variables during the period 2003–2013. The exploration takes place via a panel due to data limitations concerning the exploration of data from Greece alone. The panel consists of Greece, Cyprus, Portugal, Italy and Spain. All countries share a climate with similar characteristics and have a wine-making tradition. Moreover, Cyprus shares similar cultural characteristics with Greece (and with regard to wine consuming habits)

⁷Except from wage adjusted labor productivity and total tax rate, which are percentages.

Table 2
Description of variables.

Sources: Eurostat (<http://ec.europa.eu/eurostat/data/database>), structural business statistics metadata available at http://ec.europa.eu/eurostat/cache/metadata/en/sbs_esms.htmunit_measure1442303345860; World Development Indicators from the World Bank for "total tax rate as percentage of commercial profits (<http://data.worldbank.org/indicator/IC.TAX.TOTL.CP.ZS>).

Variables	Description
Value added at factor cost	Gross income from operating activities after adjusting for operating subsidies and indirect taxes. Value adjustments (such as depreciation) are not subtracted.
Personnel costs	Total remuneration, in cash or in kind, payable by an employer to an employee (regular and temporary employees as well as home workers) in return for work done by the latter during the reference period. Personnel costs also include taxes and employees' social security contributions retained by the unit as well as the employer's compulsory and voluntary social contributions. Personnel costs are made up of wages and salaries and employers' social security costs. Source: Eurostat.
Apparent labor productivity	Gross value added per person employed. Source: Eurostat.
Wage adjusted labor productivity	Apparent labor productivity divided by average personnel costs (%). Source: Eurostat.
Investment rate	Investment/value added at factors cost (%). Source: Eurostat.
Total imports	Measured in 1000 hl. Source: Eurostat.
Total exports	Measured in 1000 hl. Source: Eurostat.
Net exports	Measured in 1000 hl. Source: Eurostat.
Gross human consumption	Measured in 1000 hl. Source: Eurostat. Although the variable name does not change, total imports are deducted from gross human consumption to get consumption of Greek (domestically produced) wine.
Total tax rate	The amount of taxes and mandatory contributions payable by businesses after accounting for allowable deductions and exemptions as a share of commercial profits. Taxes withheld (such as personal income tax) or collected and remitted to tax authorities (such as value added taxes, sales taxes or goods and service taxes) are excluded. Measured in percentage of commercial profits. Source: World Bank.

Notes: Monetary data are expressed in millions of €. Per head values are expressed in thousands of € per head. Ratios of monetary variables are expressed in percentages. A hectoliter (hl) is 100 l (1000 hl is 100,000 l).

Table 3
Descriptive statistics per cross-sectional unit (sample period 2003–2013).

Unit/statistic/variable	Value added	Personnel costs	Apparent labor productivity	Wage adj. labor productivity	Investment rate	Total tax rate	Total imports	Total exports	Net exports	Gross human consumption	
Greece	Mean	120.75	68.12	0.04	1.52	0.18	0.48	6.29	11.21	4.92	107.36
	Median	122.20	67.60	0.04	1.52	0.19	0.47	6.00	10.13	3.98	101.53
	Max	164.70	84.00	0.05	1.68	0.25	0.54	9.86	18.12	11.03	158.94
	Min	97.00	53.60	0.03	1.37	0.10	0.44	3.46	6.48	1.99	72.43
	Sta	22.13	10.24	0.00	0.09	0.05	0.03	1.99	3.45	2.80	26.03
Spain	Mean	1529.76	675.58	0.06	2.09	0.30	0.55	21.15	600.86	579.72	437.59
	Median	1527.20	715.40	0.06	2.12	0.30	0.59	13.32	559.01	546.97	426.56
	Max	1743.30	771.40	0.07	2.34	0.43	0.61	83.80	946.18	922.97	532.05
	Min	1364.90	540.80	0.06	1.85	0.19	0.38	5.86	379.63	371.29	382.53
	Sta	110.21	75.26	0.00	0.17	0.08	0.08	20.70	182.19	173.64	46.49
Italy	Mean	1086.14	535.78	0.07	1.72	0.30	0.72	46.72	451.28	404.56	540.89
	Median	1023.90	543.80	0.06	1.78	0.30	0.73	39.29	399.75	363.79	552.79
	Max	1348.90	641.90	0.08	1.88	0.41	0.77	82.96	689.05	631.10	643.53
	Min	910.80	422.90	0.06	1.45	0.17	0.66	27.89	272.11	239.21	427.23
	Sta	141.50	70.91	0.01	0.12	0.07	0.04	18.12	148.88	134.74	63.75
Cyprus	Mean	22.18	16.74	0.04	1.46	0.23	0.21	4.54	9.00	4.46	14.04
	Median	24.60	21.30	0.03	1.36	0.17	0.21	4.67	5.57	0.89	12.77
	Max	35.60	25.20	0.05	2.29	0.74	0.23	7.26	24.42	22.53	23.52
	Min	8.30	3.70	0.03	1.11	0.11	0.21	1.40	1.06	-5.62	7.97
	Sta	10.00	8.73	0.01	0.34	0.17	0.01	1.69	8.24	9.58	4.26
Portugal	Mean	282.25	136.44	0.04	2.02	0.32	0.43	64.86	126.78	61.92	205.97
	Median	281.10	144.00	0.04	2.03	0.30	0.43	63.61	118.58	53.44	192.00
	Max	332.40	159.90	0.04	2.23	0.47	0.44	106.55	173.53	103.18	266.49
	Min	240.50	107.40	0.03	1.83	0.18	0.42	34.13	88.22	26.37	160.91
	St.dev.	27.85	14.86	0.00	0.10	0.08	0.01	20.45	27.69	23.99	37.48

Table 4
Panel unit root test.

Value added at factor cost	Personnel costs	Apparent labor productivity	Total imports
N,T = (5,10)	N,T = (5,10)	N,T = (5,10)	N,T = (5,10)
Im–Pesaran–Shin t-bar = -1.14961	Im–Pesaran–Shin t-bar = -1.16774	Im–Pesaran–Shin t-bar = -1.77648	Im–Pesaran–Shin t-bar = -1.14553
10% 5% 1%	10% 5% 1%	10% 5% 1%	10% 5% 1%
Critical values: -2.10 -2.28 -2.66	Critical values: -2.10 -2.28 -2.66	Critical values: -2.10 -2.28 -2.66	Critical values: -2.10 -2.28 -2.66
Total exports	Net exports	Gross human consumption	
N,T = (5,10)	N,T = (5,10)	N,T = (5,10)	
Im–Pesaran–Shin t-bar = -1.00698	Im–Pesaran–Shin t-bar = -1.27171	Im–Pesaran–Shin t-bar = -0.945213	
10% 5% 1%	10% 5% 1%	10% 5% 1%	
Critical values: -2.10 -2.28 -2.66	Critical values: -2.10 -2.28 -2.66	Critical values: -2.10 -2.28 -2.66	

Notes: The augmented Dickey–Fuller test is performed. The H₀ is that all groups have unit root.

and as such, it should be included in the panel even if it is not a wine producer of similar volume.

4. Findings

As already mentioned, Table 2 presents the variables explored by the model. Table 3 presents the descriptive statistics for the variables per cross-sectional unit (country). Table 4 presents the panel unit root test results. The Im–Pesaran–Shin test statistic is not significant and thus the hypothesis that all groups have unit root is rejected. An augmented Dickey–Fuller test for each cross-sectional unit also rejects the presence of a unit root. The variables are also tested for the presence of multicollinearity, prior to proceeding with the panel regressions.⁸

The findings presented on Table 5 are about the 4 model specifications discussed in the previous section. Each model is estimated via four different regressions:

- 1) pooled ordinary least squares (OLS) for the testing whether the data should be analyzed with fixed or random effects,
- 2) pooled weighted least squares (WLS) for heteroskedasticity correction of pooled OLS,
- 3) fixed (within) effects (FE) estimation, and
- 4) WLS for heteroskedasticity correction of the fixed effects.

Across all 4 model specifications, the Durbin–Watson test statistic indicates that the residuals are not autocorrelated and the normality test results indicate that the residuals are normally distributed. The results of the FE and Breusch–Pagan tests performed in the pooled OLS indicate that both, fixed and random effect estimations depict the data better than pooled OLS. However, random effects estimation is not performed due to degrees of freedom restrictions. The results of the White and Wald tests of the pooled OLS indicate the presence of heteroskedasticity and for that reason a pooled WLS is performed. The results of the Wald test of the FE estimation

⁸The values of the variance inflation factors (VIF) for each variable are less than 8. The VIFs are produced with linear regressions in which all variables are treated as dependents respectively and for all 4 model specifications. The results, although not presented here, are available upon request.

indicate the presence of heteroskedasticity and for that reason a WLS is performed.

The significant coefficient estimates of regressions 2 and 4 (P. WLS and fixed effects WLS respectively) for each model specification⁹ on Table 5 reveal that an increase in wage adjusted labor productivity (values of 141.3 and 147 for the fixed effects WLS and P. WLS estimated coefficients, respectively),¹⁰ exports (maximum values of 1.7 and 1.5 for the P. WLS and fixed effects WLS estimated coefficients, respectively), net exports (maximum values of 1.5 for the P. WLS and 1.6 for the fixed effects WLS estimated coefficients) and consumption (maximum values of 0.7 and 0.8 for the P. WLS and fixed effects WLS estimated coefficients, respectively) increase the value added. On the contrary, an increase in personnel costs (maximum values of -2.2 for the P. WLS and -1.9 for the fixed effects WLS estimated coefficients), imports (maximum values of -3.6 for the P. WLS and -3.3 for the fixed effects WLS estimated coefficients), and the tax rate (maximum values of -247.5 for the P. WLS and -215.8 for the fixed effects WLS estimated coefficients)¹¹ decrease the value added. The insignificant coefficient estimates of fixed effects WLS for each model specification on Table 5, indicate that an increase in apparent labor productivity¹² and the investment rate¹³ increase the value added.

Considering that Spain and Italy are much larger than Greece, the concern that these countries could be driving the results presented on Table 5 has to be addressed. Table 6 presents the fixed effects WLS estimated coefficients of the 4 model specifications for panel A consisting of Greece and Portugal and panel B consisting of Greece and Cyprus. The limitation of available data does not allow for the analysis of data on Greece alone. Therefore, the analysis has been

⁹These coefficients are heteroskedasticity corrected.

¹⁰Data for wage adjusted labor productivity (percentage) is counted in decimals and as such, the coefficients' values reflect a 100 percent change. Therefore, 147/100=1.47 maximum for a percent increase of wage adjusted labor productivity.

¹¹Data is counted in decimals and as mentioned above, the effect is at maximum -0.25 for a percent increase of the tax rate.

¹²That is 625.4/1000=0.6 maximum for a thousand increase per person employed.

¹³That is 128.2/100=0.1 maximum for a percent increase of the investment rate.

Table 5
Panel regression estimates of wine production in Cyprus, Greece, Italy, Portugal and Spain for the period 2003–2013 (robust standard errors).

Dep.: Value added	Model 1				Model 2				Model 3				Model 4			
	<i>P. OLS</i>	<i>P. WLS</i>	<i>FE</i>	<i>WLS</i>	<i>P. OLS</i>	<i>P. WLS</i>	<i>FE</i>	<i>WLS</i>	<i>P. OLS</i>	<i>P. WLS</i>	<i>FE</i>	<i>WLS</i>	<i>P. OLS</i>	<i>P. WLS</i>	<i>FE</i>	<i>WLS</i>
<i>Predictors coef. & test statistics</i>																
Constant	91.5 (60.8)	0.4 (38.1)	−132.7 (76.9)	−23.5 (40.9)	−427.4* (239.5)	−235.9*** (73.5)	33.4 (127.8)	−256.2*** (83.4)	−455.0 (329.6)	−132.7 (79.3)	39.9 (125.0)	−154.1** (75.7)	−19.5 (42.1)	−8.1 (24.8)	−79.1 (85.3)	−29.6 (20.1)
Personnel costs	−2.0*** (0.1)	−1.8*** (0.1)	−0.4*** (0.1)	−1.9*** (0.2)	−	−	−	−	−	−	−	−	−2.2*** (0.1)	−2.2*** (0.1)	−0.4*** (0.1)	−1.9*** (0.2)
Apparent labor productivity	1188.7* (674.1)	368.5 (624.8)	4070.5 (2824.4)	402.2 (924.8)	−	−	−	−	−	−	−	−	1230.5 (998.7)	490.8 (601.7)	4211.8 (2889.0)	625.4 (494.6)
Wage adj. labor productivity	−	−	−	−	232.6** (102.3)	147.0*** (43.8)	18.5 (37.0)	141.3*** (45.7)	182.3 (140.4)	27.6 (40.9)	20.9 (35.4)	59.8 (40.6)	−	−	−	−
Investment rate	98.9 (88.1)	49.1 (45.1)	30.1 (22.8)	24.8 (42.8)	184.1 (131.7)	117.2 (112.4)	26.0*** (9.0)	128.2 (105.1)	158.3 (324.9)	67.8 (97.8)	27.5*** (10.5)	54.1 (95.8)	60.3 (92.2)	−9.6 (42.4)	36.5* (19.9)	10.0 (22.2)
Total imports	−1.5* (0.7)	−0.1 (0.2)	−1.0*** (0.3)	−0.2 (0.3)	−4.5*** (0.6)	−3.6*** (0.5)	−0.9** (0.3)	−3.3*** (0.5)	−	−	−	−	−	−	−	−
Total exports	0.1 (0.1)	0.2** (0.1)	0.4*** (0.1)	0.1 (0.1)	1.5*** (0.6)	1.7*** (0.1)	0.7*** (0.1)	1.5*** (0.1)	−	−	−	−	−	−	−	−
Net exports	−	−	−	−	−	−	−	−	1.7*** (0.1)	1.5*** (0.1)	0.7*** (0.1)	1.6*** (0.1)	0.0 (0.1)	0.0 (0.1)	0.5*** (0.1)	0.2 (0.1)
Gross human consumption	0.4* (0.2)	0.1* (0.1)	0.5** (0.2)	0.1 (0.1)	0.8** (0.3)	0.7*** (0.2)	0.6** (0.2)	0.8*** (0.2)	0.2 (0.3)	0.7*** (0.1)	0.6*** (0.2)	0.6*** (0.1)	0.1 (0.2)	0.1 (0.1)	0.5** (0.2)	0.1 (0.1)
Total tax rate	−259.0* (151.1)	−70.3 (51.2)	−365.1*** (71.1)	−39.0 (57.7)	−242.3 (244.4)	−75.4 (111.5)	−439.7** (205.5)	−115.6 (126.1)	−547.8* (324.9)	−247.5** (98.8)	−427.5** (195.5)	−215.8** (103.6)	−180.7 (136.5)	−102.7** (42.0)	−329.7*** (85.2)	−33.0 (36.8)
Adjusted R ²	0.85	0.78	−	0.86	0.73	0.76	−	0.73	0.85	0.75	−	0.87	0.88	0.90	−	0.90
F (p-value)	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Durbin–Watson	1.82	−	2.02	−	2.01	−	1.89	−	1.94	−	1.85	−	1.86	−	1.88	−
White test	0.05	−	−	−	0.02	−	−	−	0.01	−	−	−	0.01	−	−	−
Wald test	0.00	−	0.00	−	0.00	−	0.00	−	0.00	−	0.00	−	0.00	−	0.00	−
Normality test	0.47	−	0.36	−	0.40	−	0.30	−	0.44	−	0.43	−	0.68	−	0.25	−
Fixed effects (between units) test	0.01	−	−	−	0.00	−	−	−	0.00	−	−	−	0.00	−	−	−
Breusch–Pagan test	0.01	−	−	−	0.01	−	−	−	0.00	−	−	−	0.00	−	−	−
<u>Constant per cross-section unit</u>																
Greece	−	−	−308.52	−	−	−	−190.36	−	−	−	−186.12	−	−	−	−281.60	−
Spain	−	−	227.67	−	−	−	506.75	−	−	−	522.55	−	−	−	349.24	−
Italy	−	−	−179.57	−	−	−	69.86	−	−	−	85.47	−	−	−	−74.53	−
Cyprus	−	−	−211.04	−	−	−	−104.67	−	−	−	−105.41	−	−	−	−206.44	−
Portugal	−	−	−192.28	−	−	−	−114.67	−	−	−	−116.67	−	−	−	−182.20	−

Notes: 55 observations and 5 cross-sections in all models (balanced panels). Estimated coefficients are rounded to the first decimal (standard errors in parentheses).

- *Levels of significance: 10%,
 **Levels of significance: 5%,
 ***Levels of significance: 1%.

Table 6

WLS (heteroskedasticity correction of the fixed effects) estimates of wine production in Greece and Portugal (Models A) and Greece and Cyprus (Models B) for the period 2003–2013.

Dep.: Value added	Model 1A	Model 2A	Model 3A	Model 4A	Model 1B	Model 2B	Model 3B	Model 4B
Constant	−115,6* (65,3)	−102,5 (117,8)	−74,7 (95,0)	−175,6*** (56,6)	−39,2*** (10,3)	−3,0 (9,3)	−0,7 (6,1)	−41,3*** (8,8)
Personnel costs	−1,5*** (0,3)	−	−	−1,9*** (0,3)	−1,2*** (0,2)	−	−	−1,2*** (0,2)
Apparent labor productivity	1737,2* (923,9)	−	−	455,2 (535,7)	735,7*** (213,2)	−	−	740,4*** (207,8)
Wage adj. labor productivity	−	69,9** (29,0)	80,6** (35,2)	−	−	7,3* (3,5)	7,0** (3,0)	−
Investment rate	11,6 (35,5)	8,8 (61,9)	57,9 (61,3)	1,5 (37,2)	3,2 (6,3)	8,2 (6,7)	7,5 (5,2)	2,4 (5,8)
Total imports	−0,2 (0,4)	−0,2 (0,4)	−	−	−0,8 (0,7)	−0,7 (1,0)	−	−
Total exports	0,5** (0,2)	0,7*** (0,2)	−	−	0,4** (0,2)	1,0*** (0,2)	−	−
Net exports	−	−	0,8** (0,3)	0,3* (0,2)	−	−	1,0*** (0,1)	0,5*** (0,1)
Gross human consumption	0,0 (0,2)	0,2 (0,2)	0,6*** (0,2)	0,3** (0,1)	0,2** (0,1)	0,8*** (0,1)	0,8*** (0,1)	0,2** (0,1)
Total tax rate	−125,9 (114,5)	−231,659 (188,5)	−15,6 (175,5)	−249,3** (88,9)	−47,9** (18,7)	−99,8** (35,9)	−92,3** (33,0)	−50,9*** (16,8)
Adjusted R ²	0,98	0,96	0,95	0,98	0,99	0,98	0,98	0,99
F (p-value)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Notes: 22 observations and 2 cross-sections in all models (balanced panels). Estimated coefficients are rounded to the first decimal (standard errors in parentheses).

*Levels of significance: 10%.

**Levels of significance: 5%.

***Levels of significance: 1%.

performed on data consisting of two cross-sectional units corresponding to countries with similar conditions (e.g. culture, size of the economy and economic conditions). Although, the descriptive statistics on Table 3 indicate that several mean values in Portugal are greater than those corresponding to Greece, both countries have been facing an economic crisis rooted in the viability of their sovereign debt. The opposite is the case for Cyprus, where the country's mean values are lower but the cultural similarities are greater. The findings on Table 6 indicate that the signs of the estimated coefficients are similar to those presented on Table 5. There is no focus on their size due to the small data set of both panels.¹⁴

The findings on Table 5 indicate that hypotheses 1 (personnel costs vs. tax rate) and 2 (wage adjusted labor

productivity only) are true. Hypothesis 3 (exports or net exports vs. gross human consumption) is rejected since the variation of exports can impact more on value added than the variation of consumption. Hypothesis 4 (imports vs. gross human consumption) is also rejected since in absolute values, imports impact more on value added than consumption.

Finally, the constant per cross-section unit (Table 5) can be useful for assessing the differentiated impact of these coefficients on each country in the panel. For example, in Spain and for half of the model specifications in Italy, the constants are above zero. This may reflect that wine production would still take place even if all predictors were zero. Greece's lowest constant term in the panel across all model specifications may indicate that the positive impact of each predictor would require more time to produce results vis-à-vis the other countries in the sample.

5. Discussion and conclusions

This study explores the determinants of wine production in Greece from a macroeconomic perspective. The paper adds to the literature of Greek wine economics by expanding the research area from consumers' preferences, wine tourism and export performance to the other factors determining wine

¹⁴If the size of the data set is neglected there are three main issues. The impact of wage adjusted labor productivity on value added is much greater in panel A than B. This may be determined by the much greater mean size of personnel costs and wage adjusted labor productivity in Portugal vis-à-vis Greece and Cyprus (for descriptive statistics see Table 3). As such, a reduction in personnel costs would have a much greater effect in Portugal. Accordingly, an increase in exports would have a much greater effect on value added of Greece and Cyprus (their mean exports values are much smaller than Portugal's). Finally, the tax rate has a greater effect on the value added of Greece and Portugal, since it is much lower in Cyprus.

production such as productivity, taxes and international trade. The findings on the effects of the predictors on the level of wine production are used for the formulation of relative policy orientations.

The dependent variable and the predictors of the estimating equation are motivated from a typical production function form. The statistically significant coefficients indicate imports, personnel costs, exports, productivity, consumption and the total tax rate (presented in order of their absolute value) as the main factors determining the value added of wine production in Greece. The findings reveal that the effect of production costs (i.e. personnel costs) on value added is greater than the effect of (wage adjusted) labor productivity. This implies that improvements in wage adjusted productivity¹⁵ have not overshadowed the tax social security burden of personnel costs.

The findings also reveal that international trade impacts more on wine production in Greece than domestic consumption of Greek wine. An explanation for this finding may be the less stable fluctuation of both imports and exports in the data sample (2003–2013), vis-à-vis the consumption of domestically produced wine. For example, imports in the data sample rise over 200,000 hl every four years (2004, 2008 and 2012), after which they follow a decreasing trend. Exports on the other hand, fall under 300,000 hl every four years (2005, 2009 and 2013), after which they follow an increasing trend.

Considering the discussion about Greeks' wine consumption in [Section 2](#) on their preference for cheaper wine, more research is needed in order to determine whether wine imports concern cheaper products (e.g. from south America), or varieties not found in Greece, or both. The preference for cheaper wine may not necessarily mean (due to economic depression) that Greeks do not opt for quality wine. Firstly, because the literature indicates that the Greek consumer would pay more for a wine with a guaranteed place of origin and secondly, due to the rising volume of wine bars, which play an educational role and have turned out to become more than a trend.

Moreover, the discussion in [Section 2](#) on Greek wines that gain top marks from influential critics indicates that Greek wines have been on an upward quality trajectory in the last decade. This is an opportunity to expand the Greek wine industry by exploiting a seemingly promising export potential. As such, Greek wineries have to concentrate their efforts on capitalizing on the distinctiveness and diversity of Greek varieties and be aware that the relatively small size of Greek wines produced compared to global production leads directly to the demanding niche markets.

With regard to policy orientations, the findings indicate that primarily exports and labor productivity to a lesser extend should be prioritized in order to boost the levels of Greek wine production and as such, see the Greek wine industry grow and assist the country to exit from economic depression.

The discussion in [Section 2](#) on the initiatives of the Hellenic Ministry of Rural Development and Food concerning the promotion of Greek wine to third countries and the improvement of vineyard management techniques are certainly to the right direction. However, the question remains whether the initiative will be a success since the amount dedicated for that target is small (2–3 percent of mean value added per annum) and whether competitiveness will improve without reducing production costs. Considering the statistically significant negative impact of personnel costs (includes taxes and employees' social security contributions) and the total tax rate, there should be initiatives aiming to reduce the tax and social security contribution burden. For example, a policy initiative that would not alter the current tax rates and as such would not jeopardize the targets of Greece's economic adjustment program, could allow for new Greenfields to be income tax free for a certain period in order to compensate for personnel costs and moreover, attract investors.

The inevitable shift of the Greek economy to a more export-oriented production paradigm can be achieved through the development of value-added activities of the wine industry regarding production and branding. Critical point for the generation of an export-oriented strategy is the generation of awareness. The lack of brand recognition for Greek wine abroad requires for immediate action to ensure that Greek wines will be presented by country of origin. Prerequisite for the latter is to develop a jointly (Hellenic Ministry of Rural Development and Food and industry) financed international promotion/distribution channel to endorse a bulk of Greek wine varieties with famous Greek diet products. The direct access of the bulk of Greek wine varieties abroad will decrease the handling of wine inventory (especially white wine which has a short life span). Another promotional element is the development of wine tourism at an international level, by promoting Greek holiday destinations, their traditional Greek products and their wine varieties.

The limitations regarding the findings of this study concern mainly data availability, regarding production, consumption and international trade, which should also be produced in monetary terms. These limitations concern time range (which reduces the degrees of freedom and as such, the methods for statistical analysis) and grape varieties. Another limitation, which is also a proposal for further research, is the breakdown of aggregate data into firm-level. Since most studies are based on primary firm-level data, the availability of secondary microdata would allow for international comparisons.

Conflicts of interest

The authors declare no conflict of interest.

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¹⁵The fluctuation of the value added in the data sample (2003–2013), has a greater impact on apparent labor productivity than the fluctuation of employment.

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