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Abstract: Short-term climate conditions may affect crop yields and vintage quality and, as a consequence, wine prices and vineyards' earnings. In this paper, we use a CGE model for Chile, which incorporates detailed information about the value chain of the wine sector in the country. Using information for the 2015-2016 harvest, we calibrate climate shocks associated with a bad year for the wine industry in Chile, when premature rains occurred in important wine regions, reducing the area harvested and leading to wines with less concentrated flavors, particularly for reds. We model the climate shocks as a technical change in the grape-producing sector (quantity effect). Moreover, we model quality effects as a shift in the foreign demand curve for Chilean wine. Given the specific economic environment in the model and the proposed simulation, it is possible to note the reduction of Chilean real GDP by about 0.067%. By decomposing this result, we verify that the quality effect has a slightly greater weight compared to the quantity effect.

Keywords: Climate, viticulture, wine, computable general equilibrium, Chile

JEL Codes: C68, Q13, Q54

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1. Introduction

It is a well-known fact that viticulture is particularly sensitive to climatic conditions. Climate is a factor that influences both the suitability of a region to ripen a specific variety of grapes and the resulting wine style (Jones, 2006). While longer term changes in climate have the potential of shifting patterns of agricultural land use as well as wine quality in wine grape-producing regions (Hannah et al., 2013; van Leeuwen and Darriet, 2016), , short-term climate conditions may affect crop yields and vintage quality. As a consequence, the latter conditions affect wine prices (Oczkowski, 2016) and vineyards' earnings (Ashenfelter and Storchmann, 2010), also compromising the reputation of a wine region.

Overall climate structure determines largely the grape varieties that grow in a region. Projected climate change scenarios point to potential impacts leading to growing season warming trends, increasing water stress, and increasing frequency and intensity of extreme climatic events. Despite the uneven geographic impacts on wine producing regions, the effects on quantity (yields) and quality will likely have important economic implications to the wine industry (Jones et al., 2005; Webb et al., 2008; Hannah et al., 2013; Mozell and Thach, 2014; van Leeuwen and Darriet, 2016; Ashenfelter and Storchmann, 2016).

While average climate conditions determine wine styles and varieties planted across the globe, different studies have shown that weather conditions define the characteristics of the vintages in the wine regions, with implications for wine prices and vineyard profitability (Schamel and Anderson, 2003; Ramirez, 2008; Webb et al., 2008; Ashenfelter, 2010; Ashenfelter and Storchmann, 2010; Oczkowski, 2016). Climate variability is one of the main environmental causes of losses to the agricultural sector, with lower crop yields or failure due mainly to drought, frost, hail, severe storms, and floods. Some of such driving climatic factors on the yield of grapevines include temperature, solar radiation and CO_2 concentration (Bindi et al., 1996).

Weather conditions that directly affect the cultivated and harvested area of grapevines also affect the quality of the associated wine vintages (Nemani et al., 2001; Jones, 2004; Ramirez, 2008; Ashenfelter, 2010; Oczkowski, 2016). From a wider perspective, climate is part of the notion of "terroir", with which viticulture and the production of fine wines have a very close association (Jones et al., 2005). This concept involves matching grapevine varieties to particular combinations of climate, landscape and soils, within specific cultural contexts, to produce unique wines of particular styles (Seguin, 1986). On the one hand, climate change will alter these terroirs and potentially affect the quality of wine grapes produced (de Cortazar and Seguin, 2004) and, on the other hand, wine production and quality are chiefly influenced by site-specific factors, husbandry decisions, and short-term climate variability (Jones and Hellman, 2003).

The aforementioned empirical literature on the impact of climate and weather on yield variability and quality of grapevine relies mainly on partial equilibrium reduced-form econometric estimations. There is a plethora of studies, some of them published in this journal, that successfully isolate the effects of climate events on a variety of outcomes related to the wine sector in different parts of the world. However, there are not many studies exploring the systemic economic impacts of climate shocks on the grape and the wine sectors. This wider view is essential in a context of an integrated approach of the production value chain of the wine sector. Backward and forward linkages affect, to different extents, local and external demand by the various economic agents. It is not different for the wine industry, in which sectoral linkages play an important role (Gillespie and Clarke, 2015).

In this paper, we will examine the wider impacts of the unfavorable weather conditions that prevailed in the 2015-2016 season in Chile, reducing the volume and the quality of the grapevines. In what follows, we discuss in Section 2 the climatic conditions in Chile associated with higher quality vintages. As shown in Ashenfelter (2010) for Bordeaux wines, weather conditions are a good predictor of a "good year", explaining quality and prices of mature wines of a vintage. We then highlight in Section 3 some of the structural features of the Chilean wine-industry value chain embedded in our database. Section 4 describes our empirical strategy, and Section 5 discusses the main results. Concluding remarks follow.

2. What Makes a Good Year in Chile?

A "good vintage year" in Chile, assuming it implies high productivity combined with high quality wine grapes, is similar to a good vintage year in places of comparable latitude. The most important factors are rainfall distribution and temperature. Grapevines require hot, dry, rainless summers and cool winters. Berry development and ripening require a dry atmosphere, moderate temperatures (15-40 degrees Celsius) and plenty of sunshine (Patil et al., 1995). While the temperature difference between night and day (thermal oscillation) is key for wine grape development, this factor is a necessary condition for growing high-quality grapevines conditional on putting the right variety in the right soil (choosing the right terroir). Another key factor for a good vintage year is the absence of rainfall at critical times, for example, when fruit is ripen or when stems start to grow after pruning (Patil et al., 1995).

Geographically, Chile is composed of fifteen regions. Eighty nine percent of wine grape production is concentrated in the central zone of the country, from the V region of Valparaíso to the VII region of Maule (SAG, 2017). This area has a Mediterranean climate with well-defined seasons. This climate is characterized by a long-dry season with an average annual temperature of 14-15 degrees Celsius and an average accumulated rainfall of 400mm per year, ranging from 260 to 700mm. Temperatures and rainfall vary from the coast to the Andes mountains (west to east) and from north to south. Temperature decreases from north to south while rainfall increases (INE, 2016; Asociación Nacional de Ingenieros Agrónomos Enólogos de Chile, 2016).

In Chile, the vintage (harvest) period goes from February to May depending on variety and location. Rainfall late in these months is detrimental for productivity as it promotes the rise of fungus. In general, cloudy weather, high humidity, low temperatures and rainfall during flowering and berry development are prone to spread diseases (Patil et al., 1995).

The 2015-2016 season was classified as complex by the National Association of Oenologists 2016 Vintage Report due to climatic factors that affected wine grape health, ripening delay, and a productivity decrease of 30% on average. Climatic conditions were greatly influenced by the El Niño phenomenon, which was associated to abnormally low rainfall during the 2015 winter and spring, and very intense rainfall starting on mid-April of 2016, around the middle of the vintage period. This rainfall episode and subsequent rainfall later in April exceeded a normal year and had a detrimental effect over grape health and productivity in Chile's central zone. Furthermore, a colder 2015 spring delayed budding, contributing to a ripening delay. These lower temperatures affected grape sugar content making it difficult to reach the 24 degrees Brix needed to produce a wine with 13 percent of alcohol by volume (Asociación Nacional de Ingenieros Agrónomos Enólogos de Chile, 2016). The most affected varieties were Carménère, Petit Syrah, Malbec, Cabernet Sauvignon, Cabernet Franc, and Merlot. However, for grapes harvested before mid-April (mainly white grapes and some red grapes), acidity and freshness were high, resulting in high quality grapes for varieties that benefit from these characteristics (Wines of Chile, 2016).

Consequently, due to the particular climatic conditions on the 2015-2016 season, many localities resulted with lower quality grapevines affected by diseases and lower productivity, especially those areas with grapes harvested after mid-April (Asociación Nacional de Ingenieros Agrónomos Enólogos de Chile, 2016).

3. Grape and Wine Sectors in Chile

We use the 2014 input-output system published by the Chilean Central Bank as the basis to calibrate a computable general equilibrium (CGE) model. The model is very detailed in its sectoral disaggregation, identifying 111 different sectors and 179 goods and services. This database represents the structure of the Chilean economy in 2014, just before the climate shock we want to analyze.

The grape and the wine sectors are fully integrated in the model. In 2014, the grape-growing sector was responsible for 0.33% of national GDP and 1.04% of total exports. Table grape was its primary output (71.0% of total sectoral output), but the sector also produced wine grape (28.6%), and other products (0.4%). Most of the table grape's output was exported to other countries (85.5%), while the remaining part went to household consumption (11.8%), and a smaller share to other users (2.7%). Grapevines were destined either to the wine production (90.7%) or to piscos and liquors production (9.3%).

From a cost perspective, intermediate consumption was responsible for 45.0% of total costs of grape production, with the remaining 55.0% allocated to payments to primary factors and production taxes. The sector paid 81.1% of total intermediate inputs costs to domestic suppliers, with the main items being support activities for agriculture (26.6% of total materials cost – only produced domestically); diesel (16.5% of total – 27.2% from domestic sources); and fertilizers and pesticides (15.6% of total – 75.3% domestic). Value added generated by the grape sector was relatively labor-intensive, with 53.7% of payments to primary factors accruing to labor, and 46.3% to capital.

The wine sector contributed with 0.30% of Chilean GDP in 2014, and was responsible for 2.30% of national exports. In addition to the production of wine (98.5% of total output), there was a secondary production of piscos and liquors (1.5%). The wine production was mainly exported (73.7% of total output), with the remaining part almost fully destined to household consumption (23.9%) and to supply hotels and restaurants (2.4%); piscos and liquors were directed to domestic consumption by households (80.8%) with smaller shares sold to hotels and restaurants (6.8%) and abroad (6.6%), and the remaining share to the pisco sector.

The cost structure of the wine industry was divided into payments to intermediate inputs (69.0%) and to primary factors and production taxes (31.0%). The main input, wine grapes (21.2% of total intermediate input costs), was fully supplied by the domestic grape sector. Other relevant input costs included glass (11.8% of total – 98.2% from domestic sources); paperboard (10.6% of total – only produced domestically); and different professional services: other business services (8.9%), marketing services (5.6%) and personnel supply, cleaning, security and other support services (4.7%). Storage and deposit costs were also relevant (4.2%), as well as the use of other wood products (3.3% of total intermediate input costs – 80.5% from domestic sources) and imported other metal products (0.6%). Value added in the wine sector was capital-intensive, with 59.9% of payments to primary factors accruing to capital, and 40.1% to labor.

4. The Model

We use a national CGE model in order to evaluate the wider economic impacts of climate variability on the wine industry in Chile. The model's structure represents a variant of the well-documented ORANI-G model (Horridge, 2000), calibrated for the Chilean economy. The ORANI-G model – and its variants – has been applied to many countries. It qualifies as a Johansen-type model in that the solutions are obtained by solving the system of linearized equations of the model, following the Australian tradition. A typical result shows the percentage change in the set of endogenous variables, after a policy is carried out, compared to their values in the absence of such policy, in a given environment. The schematic presentation of Johansen solutions for such models is standard in the literature. More details can be found in Dixon and Parmenter (1996).

The Chilean version of the ORANI model allows capturing economy-wide effects through an intricate plot of input-output relations. We calibrate the climate shocks defining two main channels to translate physical variables into economic inputs to the CGE models. Because we do not estimate econometrically the direct links between the climate scenario and the economic variables, we build narratives based on the expert literature to quantify the stylized exogenous scenarios to feed the CGE model.

The first channel – quantity channel – is derived from a decrease in productivity of the grape sector. We use information for the 2015-2016 grape harvest, which is usually associated with a bad year for the wine industry in Chile, since premature rains occurred in important wine regions, reducing the area harvested, and leading to wines with less concentrated flavors, particularly for reds, as perceived by consumers (Wine Spectator). According to data from the USDA Foreign Agricultural Service, grape production reduced by -10.59% in the period. The varieties Cabernet Sauvignon, Carménère and Petit Verdot in the Metropolitan Region of Santiago, O'Higgins and part of the Maule region were the most affected. The climate, characterized by heavy rains followed by high temperatures, was favorable for the development of Botrytis fungus that causes fruit rot. In addition, many fruits were still in the vines when heavy rains began, making the losses even more substantial (USDA, 2016). We model this channel of climate shocks as a technical change in the grape-producing sector (quantity effect), decreasing overall sectoral productivity by -10.59%.

According to the model's analytical structure, the quantity channel can be decomposed into two different channels. First, a price change channel: as productivity declines, this represents, on one hand, increases in the prices of grapes (both table grapes and wine grapes), increasing production costs to the wine sector and raising the costs for domestic and foreign consumers, which lower both domestic and external demand. This creates room for decreasing firms' output – destined for both domestic and international markets – which requires less inputs and primary factors. Decreasing demand puts pressure on the factor markets for price decreases, with a concomitant expectation that the prices of domestic goods would decrease. Second, the reduction in overall productivity is also associated with an increase in the inputs and primary factors requirements per unit of output in the grape sector (technical change channel). This creates an upward pressure on input prices, wages and capital rentals, which are passed on in the form of higher prices.

The second channel – quality channel – is associated with an expert perception of a lower quality vintage of Chilean wines in 2016. The climatic adversity in 2015-2016 also brought about implications for the quality of the wines produced in Chile in 2016. Climate conditions in this "bad year" generated wines with slightly different characteristics from those more commonly found in Chilean wines (USDA, 2016). Table 1, withdrawn from the Wine Spectator magazine, shows the average vintage ratings for Chilean red wines for the period 2012 to 2016. It is possible to see that the rating for 2016 dropped five points in one year, passing from a score of 92, in 2015, to 87, in 2016.

[Insert Table 1 here]

Lower scores in vintage ratings may be associated with lower prices (premium). In a study by Schamel and Anderson (2003), the authors estimated hedonic price functions for premium wine from Australia and New Zealand, differentiating implicit prices for sensory quality ratings over the vintages: the parameters for vintage rating were all significant and stable over time. The price premium was 3.1% on average and varied between 2.3% and 4.1% for one-point increase in the vintage rating for the 1992-2000 vintages.

Thus, given these two pieces of information, and considering the strong exposure of Chilean wines to international markets (almost ¾ of the output are exported), we model the quality channel as a downward parallel shift in the downward-sloping constant-elasticity export demand curve for Chilean wine in the model. We parameterize the size of the shock by applying Schamel and Anderson's estimates to a five-point decrease in the vintage rating in 2016, leading to an approximate -14.16% price reduction associated with the same benchmark level of foreign demand for Chilean wine. Given the structure of the model, lower international demand for Chilean wines puts extra pressure on prices through the decrease in export activity.[1]

Figure 1 summarizes the transmission mechanisms associated with first-order and second-order effects in the adjustment process underlying the model's aggregate results in the context of the major channels through which the shocks operate. Second-order prices changes go in both directions – decrease and increase. The net effect is determined by the relative strength of the countervailing forces.

[Insert Figure 1 here]

5. Results

To measure the wider impacts of the prevailing climatic conditions that affected grape and wine production in Chile in 2016, we run the model under a short-run macro-

[1] The relative strength of this channel is directly related to the magnitude of the short-run export demand elasticity for Chilean wines, calibrated with the value -0.334. We run sensitivity analysis for this parameter, choosing alternative values up to twice higher.

adjustment closure. The adopted closure is adapted from the standard ORANI short run closure (Horridge, 2000). In the standard closure, on the supply-side, we make the capital stock, technology, and the real wage exogenous. With the real wage given, the model can determine aggregate employment. With employment, technology and capital determined, the model can determine aggregate output (GDP). On the demand side, aggregate household consumption, investment, and other demands (and inventories) are fixed. With GDP determined from the supply side and domestic absorption (household consumption, investment, government consumption and inventories) given, the trade balance must act as an endogenous 'swing' variable to satisfy the GDP identity. That is, if as a result of our shock GDP increases/decreases relative to domestic absorption, the trade balance must move toward surplus/deficit. We make the standard closure more flexible in our simulations by (i) allowing government consumption to move with tax revenue, and (ii) allowing household consumption to move with factor income.

Table 2 presents the simulation results for GDP and its components. It breaks down changes in real GDP into the contributions of the main expenditure-side components, also decomposing the total impacts associated with the quantity and the quality channels. This enables us to verify how much of the change in real expenditure-side GDP is due, say, to a change in exports, associated with each channel. Table 2 also breaks down changes in real GDP from the income side, presenting the contributions to GDP due to primary factor usage, indirect taxes, and technical change. The combined effects of lower grape output and lower quality wine would lead to a reduction of Chilean real GDP by -0.067%, with similar contributions associated with the quantity channel (-0.031%) and the quality channel (-0.036%). Overall, a decrease in exports (negative impact on GDP of -0.052%), followed by a reduction in household consumption (-0.028%) made the main contributions to the aggregate GDP result. In the case of exports, lower productivity in the grape-producing sector (quantity channel) increases the price of both exported table grapes and domestically consumed wine grapes, in the latter case indirectly affecting prices of wine exports. As for the quality channel, the shift in export demand for Chilean wines directly impacts export volumes. Thus, exports results go in the same direction in both channels.

[Insert Table 2 here]

In the case of real household consumption, nonetheless, the results for its contributions to GDP, associated with the quantity and the quality channels, go in different directions. According to our model, with fixed capital stocks, the supply elasticity can be approximated by the expression that reflects its close connection with the elasticity of substitution between capital and labor, the shares of labor and capital in primary factor costs, and the share of primary factors in total costs. In other words, for given values of the substitution elasticity, supply is more elastic as either the labor/capital ratio is higher, or the share of materials in total cost is higher (Dixon et al., 1982). As seen in section 3, the grape sector is characterized as a labor-intensive sector. Within the quality channel, the technical change channel dominates primary factors market outcomes, generating higher labor absorption (positive impact on income-side GDP of 0.021%), and an increase in household consumption (positive impact on expenditure-side GDP of 0.027%). This creates an upward pressure on input prices, wages and capital rentals, which are passed on in the form of higher prices, as can be seen at the bottom estimates of Table 3.[2]

[Insert Table 3 here]

While the net effect of the quantity channel leads to real factor income increase, the outcome associated with the quality channel goes in the opposite direction, resulting in a decrease in household consumption. The initial decrease in economic activity associated with the foreign demand shift is accompanied by an overall reduction in employment and lower capital rentals, in a context of fixed capital stocks. Given that we set real wages exogenously, imperfect substitutability between labor and capital helps explaining the stronger effect on capital costs.

One last comment on the macroeconomic results presented in Tables 2 and 3 relates to balance of trade effects. Real devaluation, defined as the ratio between the CIF import price index in local currency and the GDP deflator, shows how foreign prices move compared to local prices. In this formulation, the overall impact on this variable, 0.071%, combines two different opposing forces. While the reduction in the productivity of the grape sector leads to overall higher domestic prices (-0.261%), promoting import penetration, the lower demand for Chilean wine changes relative prices in favor of less

[2] Table 3 also presents results for factor payments (including prices and use), GDP components and price indices.

expensive domestic goods (0.322%), which, together with an overall lower activity level, help decreasing import demand. Accordingly, for exports, the vintage effect on real devaluation makes Chilean products more attractive to foreigners, partially offsetting the effect of the decrease in wine exports.

Table 4 highlights the importance of the impacts on the main products of the grape sector (wine and table grapes) and the wine sector (piscos and liquors, and wine) for the simulation results, revisiting some of the macroeconomic effects previously described. It captures the relevance of forward linkages in the wine industry value chain, revealing features of each product's sales structures, as described in section 3. We focus on two main final users, namely households and exports. The reduction in the consumption of table grapes by households (-4.932%) and foreigners (-6.308%), its two main markets, is mainly associated with the rise in prices due to productivity changes. As a result, total output drops by -5.789%, a decrease mostly due to the quantity channel. Wine grapes, which supply exclusively to the wine sector, perceive an output decrease of -3.194%; roughly ¼ of this change due to the productivity effect in the grape sector and ¾ due to backward linkages associated with the vintage effect that affects wine exports.

[Insert Table 4 here]

The wine output, on its turn, decrease by -3.951%, with most of this outcome associated with the quality effect (-3.130%). Interestingly, despite a sharp reduction in sales to foreign markets (-4.788%), domestic sales to households increase 0.129%. The higher domestic consumption (1.145%), led by lower relative prices due to the shrinkage of sales to foreigners, offsets the negative local sales to final consumers when climate shocks harm yields of grape crops (-1.017%), raising local wine prices as domestic wine grapes, the main input of the wine industry, become more expensive. Piscos and liquor output decreases to a lesser extent (-0.793%). However, we see a shift of production of the wine sector from wine to piscos and liquors, as the former becomes less "attractive".[3]

[3] The specification of the sectoral composition of production is derived from the firm's maximization of revenue from all commodity outputs, subject to a constant elasticity of transformation (CET) production function. The model allows for secondary production, i.e. each sector can produce a mixture of all commodities. Given the CET specification, the output mix of each sector varies with the relative prices.

Finally, we have also calculated the impacts on sectoral output of the climate variability scenario that affected grape harvests in Chile. Figure 2 highlights those sectors that achieved the top and bottom performance. Sectors are ranked by the total effects. Backward and forward linkages play an important role in the picture that emerges.

According to Figure 2, in addition to the two sectors directly affected by the quantity and quality channels (grape vineyards and wineries), the sectors (indirectly) most affected by climate anomalies that hit grape yields are those related to the wine industry value chain.

[Insert Figure 2 here]

To better understand the sectoral results of the model, a brief analysis of the structure of the economy can be done (Haddad, 2009). A close inspection on the benchmark data base is necessary, conducted primarily on the relationships in the input-output data base. Understanding of disaggregated results may be achieved through econometric regressions on key structural coefficients. How important is the existing economic structure in explaining the sectoral results associated with climate anomalies in Chile? Do backward and forward linkages matter? To answer these questions, following Dixon et al. (1982, 2007), we regress the model results (sectoral activity level) against selected structural coefficients of the model, suggested by the previous discussion. The OLS regressions are shown in Table 5, and aim only at revealing some of the influence of the benchmark structure on the results. The selected structural indicators explain almost 50 percent of the variation across sectors in the CGE model results. Sectors that present higher decreases in their output tend to have an overall higher share of their sales to the wine sector, suffering from the effects in the production value chain. Also, sectors that face stronger negative effects tend to concentrate their sales to foreign consumers, and, to a lesser degree, to Chilean households. Thus, the extent to which climate anomalies faced by the grape-producing sector affect sectoral economic activity is conditioned by the structural characteristics of the productive system and macroeconomic outcomes.

[Insert Table 5 here]

6. Concluding Remarks

In this paper we have computed estimates of the economy-wide impacts of the special weather conditions that prevailed in Chile and affected the 2015-2016 grape harvests in the country, also affecting the quality of the wine produced. We have used a national CGE model calibrated for the Chilean economy using data for 2014. We evaluated two main transmission channels of the climate shocks to the economy, namely a quantity channel originated in the grape vineyards, and a quality channel accruing to the wineries. The general equilibrium approach adopted in this work allowed a broader understanding of potential responses of the wine industry in Chile to a specific climate scenario taking into account its whole value chain. It helped telling a story that takes into account the grape and wine sectors embedded in a national economic system.

The results revealed the relevance of backward and forward linkages to understand the systemic effects. Revisiting the main results of the paper, a quick back-of-the-envelope calculation using the estimates of the impacts on sectoral economic activity and structural coefficients computing sectoral shares in GDP shows that for each 1.00 CLP of reduction in the combined sectoral GDP of the grape and wine sectors, there is an additional 1.39 CLP reduction in other sectors' GDP.[4]

The results are not without limitations. In our simulation-based approach, results depend heavily on the analytical, functional and numerical structures of the model. The usual issue of model pre-selection (Blaug, 1992), with its advantages and disadvantages for the purpose of this exercise, applies here. Moreover, in spite of taking a general equilibrium approach to understand the economic effects in the Chilean economy, the narratives we built to quantify the exogenous scenarios to feed the CGE model preclude how weather conditions may have affected other crops. Thus, in our attempt to isolate the main mechanisms that link physical (climate) shocks to economic shocks, we have focused our attention on those directly associated with the key players of the wine industry. As usual, additional research is needed to help providing further evidence to evaluate these issues more completely.

[4] We have compared the GDP effects (-0.067%) to the combined contributions of the grape and the wine sectors to this outcome, by multiplying their respective shares in GDP (0.33% and 0.30%) to the simulated impact on their activity levels (-5.062% and -3.800%, respectively).

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Tables and Figures

Table 1. Vintage Ratings – Chile: Reds (all regions)

Vintage	Score	Description
2016	87	Untimely rains in key regions such as Colchagua, Maipo and Casablanca cut yields and led to less concentrated flavors, particularly for reds
2015	92	A warm growing season and good harvest weather delivered powerful Cabernet Sauvignons and crisp, fruity Pinot Noirs; average quality for whites
2014	89	Spring frost cut crop; good quality fruit harvested; crisp reds, savory whites
2013	90	Cool vintage, delivering fresh, well-structured wines with good balance in terms of concentration and flavor
2012	91	Warm summer weather resulted in an early harvest, with clean, disease-free fruit and yields 15 percent above average; late-ripening Carmenère performed well

Source: Wine Spectator

Table 2. Decomposition of the Impacts on Chilean GDP (% contribution)

	Total	*Subtotal*	
		Quantity	*Quality*
Real GDP from expenditure side	***-0.067***	*-0.031*	*-0.036*
Aggregate real investment expendiutre	0.000	0.000	0.000
Real houselhold consumption	-0.028	0.027	-0.055
Export volume	-0.052	-0.035	-0.017
Aggregate real government demands	-0.001	0.001	-0.001
Import volume	0.014	-0.024	0.037
Real GDP from income side	***-0.067***	*-0.031*	*-0.036*
Use of capital	0.000	0.000	0.000
Use of labor	-0.006	0.021	-0.028
Indirect taxes	-0.004	0.004	-0.009
Technical change	-0.057	-0.057	0.000

Table 3. Impacts on Selected Macroeconomic Variables (in percentage change)

	Total	*Subtotal*	
		Quantity	*Quality*
Aggregate primary factor payments	**-0.143**	0.233	-0.376
Aggregate payments to capital	**-0.164**	0.224	-0.388
Aggregate payments to labor	**-0.115**	0.246	-0.361
Index of factor cost (excludes tech change)	**-0.136**	0.209	-0.345
Average capital rental	**-0.164**	0.224	-0.388
Average nominal wage	**-0.099**	0.190	-0.288
Aggregate primary factor use (excludes tech change)	**-0.007**	0.024	-0.031
Aggregate capital stock, rental weights	**0.000**	0.000	0.000
Aggregate employment, wage bill weights	**-0.017**	0.056	-0.073
Real GDP from expenditure side	**-0.067**	-0.031	-0.036
Aggregate real investment expendiutre	**0.000**	0.000	0.000
Real houselhold consumption	**-0.044**	0.043	-0.088
Export volume index	**-0.159**	-0.107	-0.052
Aggregate real government demands	**-0.006**	0.005	-0.011
Import volume index, CIF weights	**-0.043**	0.075	-0.119
Average real wage	**0.000**	0.000	0.000
Real devaluation	**0.071**	-0.261	0.332
Consumer price index	**-0.099**	0.190	-0.288
Exports price index, local currency	**0.045**	0.269	-0.223
Government price index	**-0.099**	0.179	-0.277

Table 4. Impacts on Household Consumption, Exports and Output of Selected Products (in percentage change)

	Household consumption			*Exports*			*Output*		
	Total	*Quantity*	*Quality*	*Total*	*Quantity*	*Quality*	*Total*	*Quantity*	*Quality*
Wine grapes	**0.000**	0.000	0.000	**0.000**	0.000	0.000	**-3.194**	-0.751	-2.443
Table grapes	**-4.932**	-4.717	-0.215	**-6.308**	-6.289	-0.019	**-5.789**	-5.749	-0.040
Piscos and liquors	**-0.450**	-0.414	-0.036	**-0.329**	-0.514	0.186	**-0.793**	-0.951	0.157
Wine	**0.129**	-1.017	1.145	**-4.788**	-0.644	-4.143	**-3.951**	-0.822	-3.130
Total in Chile	**-0.044**	0.043	-0.088	**-0.159**	-0.107	-0.052	**-0.048**	-0.012	-0.035

Table 5. Structural Analysis of Sectoral Activity Results

Dependent Variable: ACT_SECT

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	0.15765	0.07722	2.04	0.000
WINE_SH	-9.78990	1.24443	-7.87	0.001
EXP_SH	-0.71295	0.20120	-1.66	0.100
HH_SH	-0.27417	0.16516	2.04	0.044
R-squared	0.48541			

ACT_SECT = percentage change in sectoral activity level; WINE_SH = share of total sales to the wine sector; EXP_SH = share of total sales to exports; HH_SH = share of total sales to households.

Figure 1. Causal Relations Underlying the Simulation Results

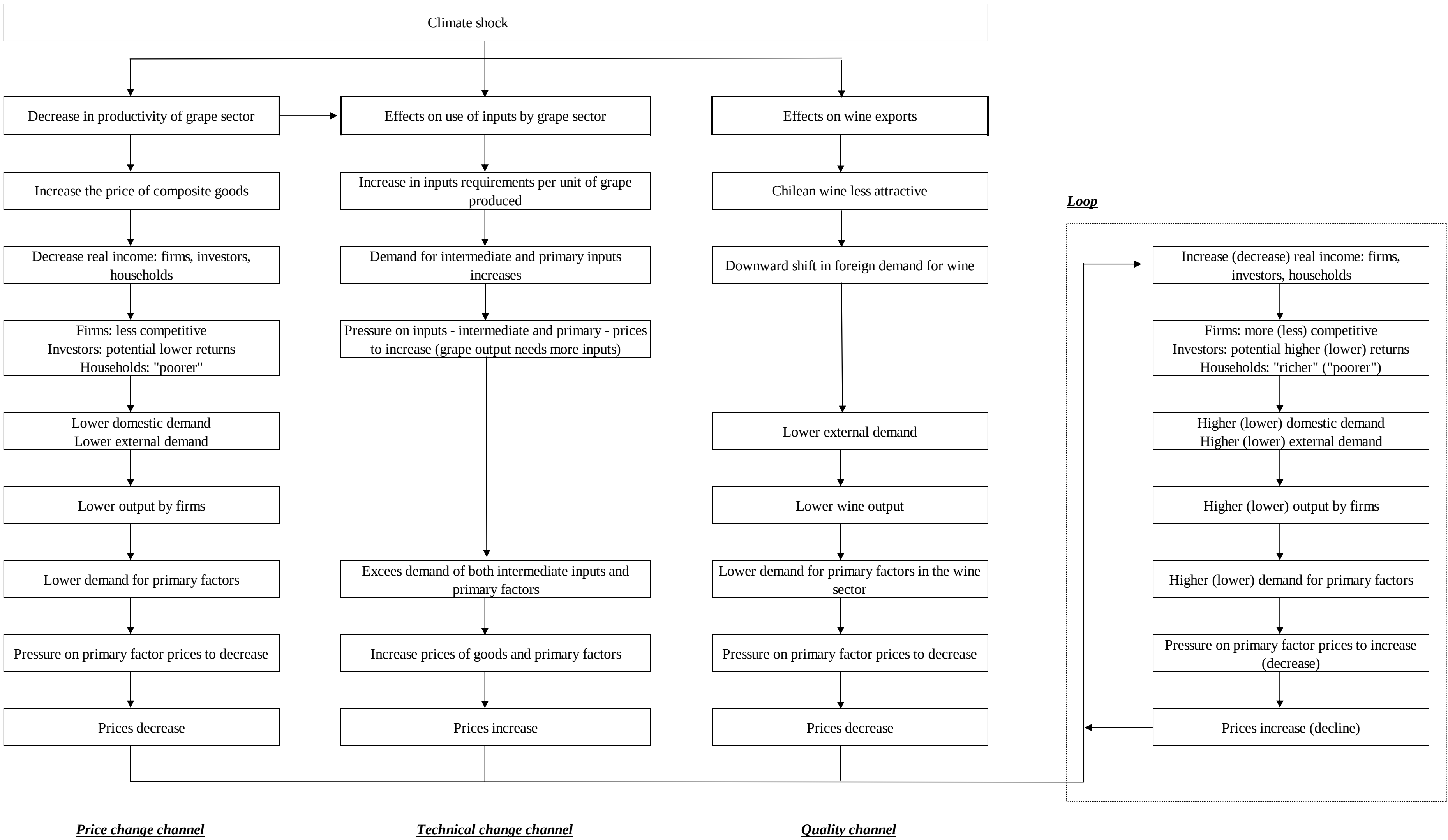

Figure 2. Impacts on Sectoral Activity (in percentage change)