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A "Sideways" Supply Response in California Winegrapes

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Abstract

This paper explores growers' supply response to the 2005 "*Sideways* effect" demand shock (Cuellar, Karnowsky, and Acosta, 2009) triggered by the 2004 release of the movie *Sideways*. We use a modified difference-in-difference approach to evaluate the supply response in California and regional supply response differences within California. We use U.S. Department of Agriculture data for the period 1999–2012 and find evidence of a supply response in the post-release period that is consistent with the "*Sideways* effect" on wine demand. The positive supply response for Pinot Noir is stronger than the negative response for Merlot and concentrated in lower value Central Valley vineyards. (JEL Classifications: D25, Q12)

Keywords: California, grapes, Merlot, Pinot Noir, supply response, wine.

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I. Introduction

A motif in the 2004 film *Sideways* is the lead character's preference for Pinot and his vehement denigration of Merlot. *Sideways* grossed about $109M in total worldwide box office sales (The Numbers, 2004), won the Academy Award for Best Adapted Screenplay, and was nominated in a number of other categories. Cuellar, Karnowsky, and Acosta (2009) find that the *Sideways* film contributed to a measurable decrease in Merlot sales and stimulated consumer demand for Pinot, and increased its price.

This "*Sideways* effect" serves as the starting point for our analysis: we test for a supply response observed through changes to acreage and tons crushed of Pinot and Merlot winegrapes and induced by the wine demand shock found by Cuellar, Karnowsky, and Acosta (2009). We restrict our analysis to California winegrape production. In 2006, California made up 90% of the value of U.S. wine production, with 80% of the wine produced in the United States consumed domestically (Goodhue et al., 2008). Consumer preference trends have naturally triggered supply responses from producers in the United States, including impacts on production location and relative acreages of winegrape varieties (Alston, Lapsley, and Sambucci, 2020). The short-run supply of winegrapes of a particular variety is inelastic (e.g., Alston, Lapsley, and Sambucci, 2020). Winegrape vines are a perennial crop that spends two years in a nursery before being sold to winegrape growers, where they stand for another three years in the field prior to bearing marketable fruit (Smith et al., 2017). Thus, the duration from planting through the production of wine takes five years. The decision to produce wine with a certain variety of winegrapes is often made years prior to the onset of wine production. Because of this lag between production decisions and outcomes, variations in market prices for wine have little effect on the quantity of wine supplied in that same year. This lag, which is characteristic of perennial crops, introduces a host of challenges to the empirical estimation of structural supply functions. In this paper, we instead take a reduced-form approach that leverages the natural experiment created by the exogenous shock of the release of *Sideways* to characterize the dynamics and dimensions of growers' subsequent supply response.

We find that growers responded to the *Sideways* consumer demand effect by expanding their production of Pinot in the years following the release of the film. This *Sideways* supply response is thus long-lasting and is particularly pronounced in Central Valley locations. The supply response we document is multifaceted and suggests that growers can adjust production relatively quickly along several margins even though wholesale vineyard replacement takes several years. Naturally, wine producers face strong incentives to respond as quickly as possible to (perceived) changes in consumer preferences, especially those that imply prolonged shifts toward or away from different varieties or attributes of wine. Sumner et al. (2010) predicted that due to changing future global population and income patterns, the demand for wine into the year 2030 would decline; such a scenario would likely reward grower responsiveness.

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II. Conceptual Framework: Winegrape Supply Response

Depending on the location and characteristics of a demand shift trend, a grower has several options to adjust winegrape supply in response to a demand shock. The production lags implied by these different options have important implications for the dynamics of growers' supply responses. Growers may immediately respond to a demand shock by adjusting harvesting methods that have a direct effect on the volume of winegrapes harvested. The harvesting decision is based on the profitability of the harvesting method relative to winegrape demand. This supply response allows for an increase (decrease) in yield per acre when there is a positive (negative) demand shock, rendering the share of production harvested at least partly endogenous.

In addition to reducing the grapes crushed of a disfavored variety in the first year, more drastically and with longer response lags, a sustained demand shock may lead growers to rogue and replace existing vines with more popular varieties in the case of vineyards that are due to be replaced or, more aggressively, that are prematurely replaced in order to capitalize on anticipated market trends. Such a grower response could manifest itself as a wholesale replacement of vines or a top graft, where only the tops of the wine grapevines are replaced via grafting.

Although our focus is on the production responses of winegrape growers, it is worth noting that their access to popular planting material hinges on the upstream responsiveness of vine nurseries that must adapt to shifting producer demand for specific varietals or even clonal types by diversifying and growing out material in their mother blocks. If a demand shock is expected to be long-lasting, new vines of a favored variety may be placed in nurseries in the first year. After two years of expanded nursery stock, new acreage of a favored variety can be planted in the field, and data will indicate larger non-bearing acreage for three years. After five years, grape crush data by variety will then show more of the favored variety. These upstream production lags can introduce further delays in the responsiveness of growers to demand shocks. For this analysis, we choose to evaluate supply response variables of winegrape quantities in our reduced-form approach under the assumption that the expected winegrape price effect is derived from the *Sideways* demand shock. We seek to analyze the supply response of winegrape growers to a demand shock, as characterized earlier, which is detectable in quantity variables.

III. Data

A. Grape Crush and Acreage Reports

We utilize California Grape Crush Reports and Grape Acreage Reports for our analysis, both of which are published annually by the California Department of Food and Agriculture (CDFA) in cooperation with the U.S. Department of Agriculture (USDA). The Grape Crush Reports are published based on mandatory survey responses by winegrape processors and contain information on grape tonnage crushed by variety and district (USDA, 1995–2015b). The Grape Acreage Reports are supplied by self-reported surveys of California grape growers who fulfill the basic reporting requirements (USDA, 1995–2015a). These reports include estimated grape acreage (bearing, non-bearing, and total acreage) by variety, district, and county. While these reports provide the best available data on California grape production acreage, they also have shortcomings. The data in the Grape Acreage Reports are voluntarily reported by a limited number of producers via mailed questionnaires, and there is no penalty for misreporting. Therefore, completeness and accuracy are not verified by independent audits. Despite the fact that it is mandatory for processers to provide crush data, the Grape Crush Reports have been found to understate the true total value of the crush (Sambucci and Alston, 2017), and the aggregation of the district-level data is not entirely consistent with the state totals.

We analyze grape crush and acreage data at the district level to maintain consistency throughout the analysis, as the Grape Crush Reports do not provide data at the county level. District designations in both the California Grape Crush and the Grape Acreage Reports are provided by the USDA. We include districts 1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, and 17 in our analysis. Districts 2, 9, 15, and 16 were excluded because individually these districts produced less than 500 tons of Pinot on average (USDA) and are therefore not of particular relevance to this analysis.

B. Supply Response Variables

Grower supply response is estimated using the following explanatory variables: volume of grape tons crushed, volume share of grape tons crushed relative to other varieties produced in the district, total acres, and non-bearing acres. We utilize data from the California Grape Crush Reports and Grape Acreage Reports for years spanning from 1999–2012 (i.e., six years before and eight years after the film was released). We limit the window to ensure that the analysis is not sensitive to the presence of the drastic increase in total acreage added and tons crushed in the 1990s or other factors beyond 2012, by which time any direct *Sideways* effect had likely faded.

To calculate the volume share of a variety to the whole market, we aggregate crush data by district and compute each district's crush volume as a share of its total winegrape crush volume in a given year. To test for growers' more immediate supply response, we also use non-bearing and total acreage by variety to capture their planting and replacement decisions. Descriptive statistics for supply response variables are included in Table 1. The tons crushed serves as a strong indicator for adjustments in harvesting techniques.[1]

[1] While it is possible to calculate the average grape crushed per bearing acre, which could be a conceptually compelling indicator, this requires the combination of the Grape Crush Reports and Grape Acreage Reports. Since grapes grown in one district are not always crushed in that same district, the results from such a constructed variable could be misleading.

Table 1

Descriptive Statistics for Level Values of Supply Response Variables for the Period 1999–2012

		All Included Districts				*Coast*				*Valley*			
		Mean	*St. Dev.*	*Min.*	*Max.*	*Mean*	*St. Dev.*	*Min.*	*Max.*	*Mean*	*St. Dev.*	*Min.*	*Max.*
Pinot	Tons crushed	7,936.74	10,001.15	0	54,147.3	12,791.29	11,606.1	265.5	5,4147.3	3,775.69	5,786.16	0	26,431.3
	Share of tons crushed	0.05	0.05	0	0.22	0.08	0.04	0.01	0.20	0.03	0.04	0	0.22
	Non-bearing acres	358.38	643.50	0	3,966	639.67	832.39	7	3,966	117.28	229.31	0	1,128
	Total acres	2,174.99	3,075.95	0	12,195	4,302.20	3,433.31	116	12,195	351.65	539.65	0	1,921
Merlot	Tons crushed	22,729.62	21,851.35	542.9	113,855.1	17,695.14	11,055.47	1,393.6	49,612.3	27,044.9	27,306.14	542.9	113,855.1
	Share of tons crushed	0.11	0.05	0.02	0.22	0.13	0.03	0.07	0.22	0.08	0.05	0.02	0.18
	Non-bearing acres	229.34	377.17	0	1,786	302.82	430.76	0	1,786	166.35	313.04	0	1,390
	Total acres	3,719.04	2,638.88	219	8,995	4,446	2,481.95	497	7,533	3,095.93	2,621.66	219	8,995

C. Coastal and Valley Delineation

Growers' supply responses and their impacts on the subsequent wine market can vary based on the location of the vineyard. This is particularly true when consumer preferences include higher-order attributes that are based not just on winegrape variety but also the attribute expression that derives from interactions between varietal and growing environment (Kelley et al., 2017; Alston, Anderson, and Sambucci, 2015). To construct our analysis, we delineate the districts into two groups: "coastal" and "valley" districts. Specifically, "coastal" includes districts 1, 3, 4, 6, 7, and 8, which contain Mendocino, Napa, Sonoma, Monterey, San Luis Obispo, and Santa Barbara counties. Whereas, "valley" describes all other districts included in our analysis (i.e., districts 5, 10, 11, 12, 13, 14, and 17, which contain Sacramento, San Joaquin, Merced, Madera, and Fresno counties). The valley label includes non-coastal locations primarily in the Central Valley, with some districts in the foothills located on the periphery. USDA district definitions are provided in Section A.4 of the online Appendix.

We modified the regional delineations set out by Volpe et al. (2010b) by combining their two coastal regions into one. These region delineations were made based on industry insight of production trends of all varieties, climate characteristics of the district, and geographic location. This is of particular relevance to Pinot, which thrives in a cooler climate as it allows for the full expression of its variety flavor profile. However, the coastal region has been planted to near full capacity with about a 5.8% change in total winegrape acreage from 2005 to 2012. This limits the addition of Pinot acreage as a supply response by growers from the coastal region. The regional price premium and limitation on acreage led to the coastal region's supply responses to be characterized by adjusting harvesting techniques and increasing the share of acreage of Pinot grapes to reflect the increase in demand for Pinot wine. In response to a demand shock, a grower in the valley will not only be able to adapt their harvesting methods, but it also may be feasible to add new acreage of a particular varietal, giving the region's capabilities to increase their total volume of production.

IV. Empirical Approach

We adopt a modified difference-in-differences (DiD) estimation approach that compares pre-post *Sideways* release supply outcomes for Pinot to those for Merlot. Like Cuellar, Karnowsky, and Acosta (2009), we use 2005 as the year that initiates the demand shock and expect planting and replacement decisions to quickly respond to this shock. Any changes in acreage will take at least three years to reach full production, and thus we use 2008 as the "Post" year for tons crushed variables.[2] We first

[2] For comparison, we also include results using 2005 as the "Post" year for tons crushed variables in the online Appendix (Tables A4 and A5) to capture immediate supply responses, such as harvest intensity, that could occur prior to 2008. We also include in the analysis Cabernet Sauvignon as a control

estimate a standard DiD specification that pools together Pinot and Merlot (denoted by subscript *j*) and takes the following form:

$$log(Y_{ijt}) = \alpha_0 + \alpha_1 t + \alpha_2 Post_t + \alpha_3 Pinot_j + \alpha_4[Post_t \times Pinot_j] + \delta_i + \varepsilon_{ijt}, \qquad (1)$$

where *i* indicates a California grape pricing district; districts included are 1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, and 17; *t* is a linear time variable representing the years 1999–2012 (i.e., 6 years before and 8 years after the film was released); Y_{ijt} is our supply response outcome variables described in the data section (i.e., total acres, total non-bearing acres, total tons crushed, and share of tons crushed); $Post_t$ is a dummy variable equal to 1 if post-period and 0 otherwise, where 2005 marks the beginning of the post-period for the acres variables and 2008 marks the beginning for the tons crushed variables; $Pinot_j$ is a dummy variable equal to 1 if variety *j* is Pinot and 0 otherwise; δ_i is a vector of time-invariant, district-level fixed-effects, where $i = 1$–13; ε_{ijt} is an error term representing other unobserved factors that affect the supply response variables.

Since the distribution of our supply response outcome variables is close to log-normal, a log transformation is preferred to reduce skewness in the data. However, due to the prevalence of zero values, we approximate the log function by applying the inverse hyperbolic sine transformation (IHST), which is similar to the log transformation but retains zero values, as suggested in Burbidge, Magee, and Robb (1988) and Mackinnon and Magee (1990).[3]

In Specification (1), the DiD coefficient of interest is α_4, which indicates whether the supply response for Pinot was different in the post-period than for Merlot. The validity of the DiD estimation approach, or that the estimator α_4 is unbiased, is contingent on the identifying assumptions—the most critical of which is the parallel trends assumption that in the absence of the exogenous *Sideways* consumer demand shock, no other factors would have affected the difference in trends between Merlot and Pinot. In Figure 1, which aggregates supply response variable data for all included districts and normalizes it with 2004 as the base year, we see that Pinot and Merlot exhibited fairly constant differences in trends of the supply response variables in the pre-period.[4] There is no indication that the inherent characteristics of either variety could have caused one trend to change drastically relative to the other in the absence of the "*Sideways* effect" in the post-period, thus supporting the parallel trends assumption.

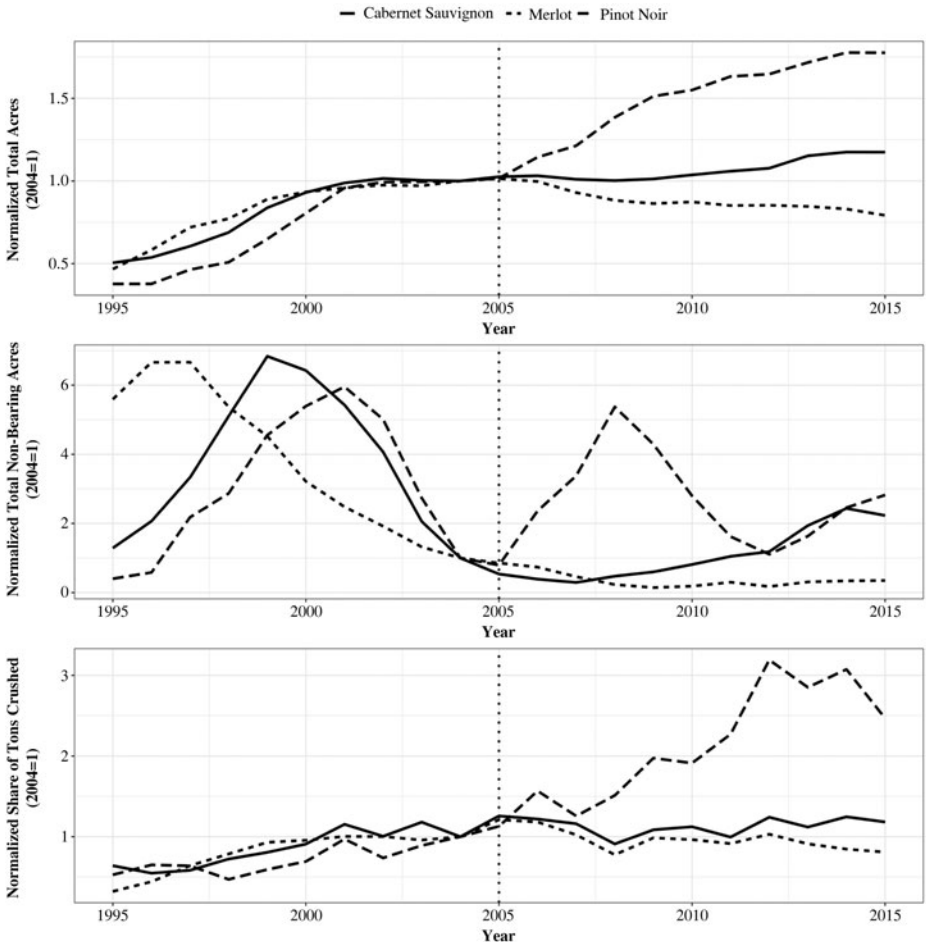
variety, the results of which can be found in Table A3 of the online Appendix, since it is widely grown and *Sideways* does not directly mention this varietal.

[3] The inverse hyperbolic sine is typically defined as , and has grown in popularity as an alternative to ad hoc mechanisms used to enable the log transformation of a variable with zero values (Bellemare and Wichman, 2019).

[4] Note that Cabernet Sauvignon is also included in Figures 1 and 2 as a pseudo-control since it is widely grown and not directly mentioned by the *Sideways* film. Cabernet Sauvignon's nature as a pseudo-control is described in Section A.3 of the online Appendix.

Figure 1

Normalized Aggregate Values of Total Acres, Total Non-Bearing Acres, and Share of Tons Crushed by Variety across All Included Districts



An additional DiD assumption is that the "*Sideways* effect" was unrelated to the variety levels in the pre-period. That is, we assume that the decision of the film to portray Pinot in a positive light and criticize Merlot was independent of pre-existing levels of grower supply. As there is no known evidence of the influence of winemakers or winegrape growers on the content of the film, and the lead character's appreciation for Pinot and distaste of Merlot was likely a matter of personal preference, this assumption is likely satisfied, though cannot be fully confirmed. Lastly, the stable unit treatment value assumption is likely satisfied, as the composition of the winegrape districts is stable. This assumption also implies there were no spillover effects (the impacts on Pinot were not affected by the impacts on Merlot, and vice versa). This would be called into question if Merlot was largely directly replaced with Pinot; however, it is unlikely that this was a driving factor of the grower supply responses, as Pinot largely replaces other varieties besides Merlot or is added as new acreage altogether.[5]

This standard DiD specification restricts all the coefficients in Specification (1) to be the same for these two varieties. To relax this restriction, we estimate a simplified specification separately for Pinot and Merlot as follows:

$$log(Y_{it}) = \alpha_0 + \alpha_1 t + \alpha_2 Post_t + \delta_i + \varepsilon_{it}, \tag{2}$$

where α_2 indicates the average change in the supply response variable during the post-period.[6]

In order to account for potentially important differences between coastal and valley districts as described previously, we modify Specification (1) to form a triple difference model that again pools together Pinot and Merlot, yet not only allows for a different supply response between the two varieties but also distinguishes between the post-period effect in valley districts versus coastal districts:

$$\begin{aligned} log(Y_{ijt}) = \alpha_0 + \alpha_1 t + \alpha_2 Post_t + \alpha_3 Pinot_j + \alpha_4 Valley_i + \alpha_5[Post_t \times Pinot_j] \\ + \alpha_6[Post_t \times Valley_i] + \alpha_7[Pinot_j \times Valley_i] \\ + \alpha_8[Post_t \times Pinot_j \times Valley_i] + \delta_i + \varepsilon_{ijt}, \end{aligned} \tag{3}$$

where α_8 indicates the average difference in supply response in the post-period between Pinot and Merlot in valley districts compared to the difference in coastal districts. Next, we relax the restrictions in Specification (3) and estimate a simplified specification separately for Pinot and Merlot as follows:

$$log(Y_{it}) = \alpha_0 + \alpha_1 t + \alpha_2 Post_t + \alpha_3 Valley_i + \alpha_4[Post_t \times Valley_i] + \delta_i + \varepsilon_{it}, \tag{4}$$

[5] Figure A1 of the online Appendix shows the average change in total acres in the three years before and after the release of *Sideways* by variety and district. A negative change (shown on the left) reflects a decision by the growers to not replace that variety, while a positive change (shown on the right) could reflect an immediate increase. While a few districts certainly exhibit a large increase in Pinot alongside a large decrease in Merlot, such as district 3, the increase in Pinot is not always coupled with a decrease in Merlot. For some districts, an immediate increase in both varieties exists simultaneously, suggesting that the effects of *Sideways* on Pinot and Merlot are not always a direct result of the effect on the other. The fact that Pinot is not only added as a one-for-one replacement of Merlot suggests that this aspect of the stable unit treatment value assumption holds in this case.

[6] To test the sensitivity of our time window of 1999–2012 relative to longer and shorter windows, we estimate Specifications (1) and (2) for the share of tons crushed for Pinot Noir, for all possible combinations of time frames between the years 1990 and 2019, the results of which are included in the online Appendix (Tables A1 and A2). We find that there is no change in the significance level for Specification (1) based on the time window and that the significance level for Specification (2) is not sensitive to the specific 1999–2012 window.

where α_4 tests whether the post-period supply response for a given variety is different in valley districts as compared to coastal districts.

Figure 2 suggests that there is largely not a difference in trend between coastal and valley districts until the post-period. While we cannot isolate any factor other than a *Sideways* effect that could have caused the change in trends in the post-period, the standard DiD limitations apply since we cannot conclusively confirm the parallel trends assumption. Furthermore, we cannot rule out the presence of spillover effects besides the spatial effects evident in differential supply responses in land-constrained coastal locations and less-constrained valley locations, which are captured in Specifications (3) and (4).

To facilitate interpretation of the results of these estimations, we compute proportional grower supply responses, which we refer to as a semi-elasticity since it is the percent change in supply variables with respect to the discrete *Sideways* shock in the post-period. We compute these semi-elasticities using the regression estimates of the coefficients of interest in our four specifications and report them in brackets in Tables 2–5. Following the method outlined in Bellemare and Wichman (2019) for calculating semi-elasticities for arcsinh-linear specifications with dummy independent variables, we define the grower supply semi-elasticity as the estimated percentage change in the supply response variable associated with a discrete change in the $Post_i$ dummy variable from zero to one.[7]

Finally, we estimate a flexible semiparametric regression separately for Pinot and Merlot to visualize post-period changes in supply response variables using the following specification:

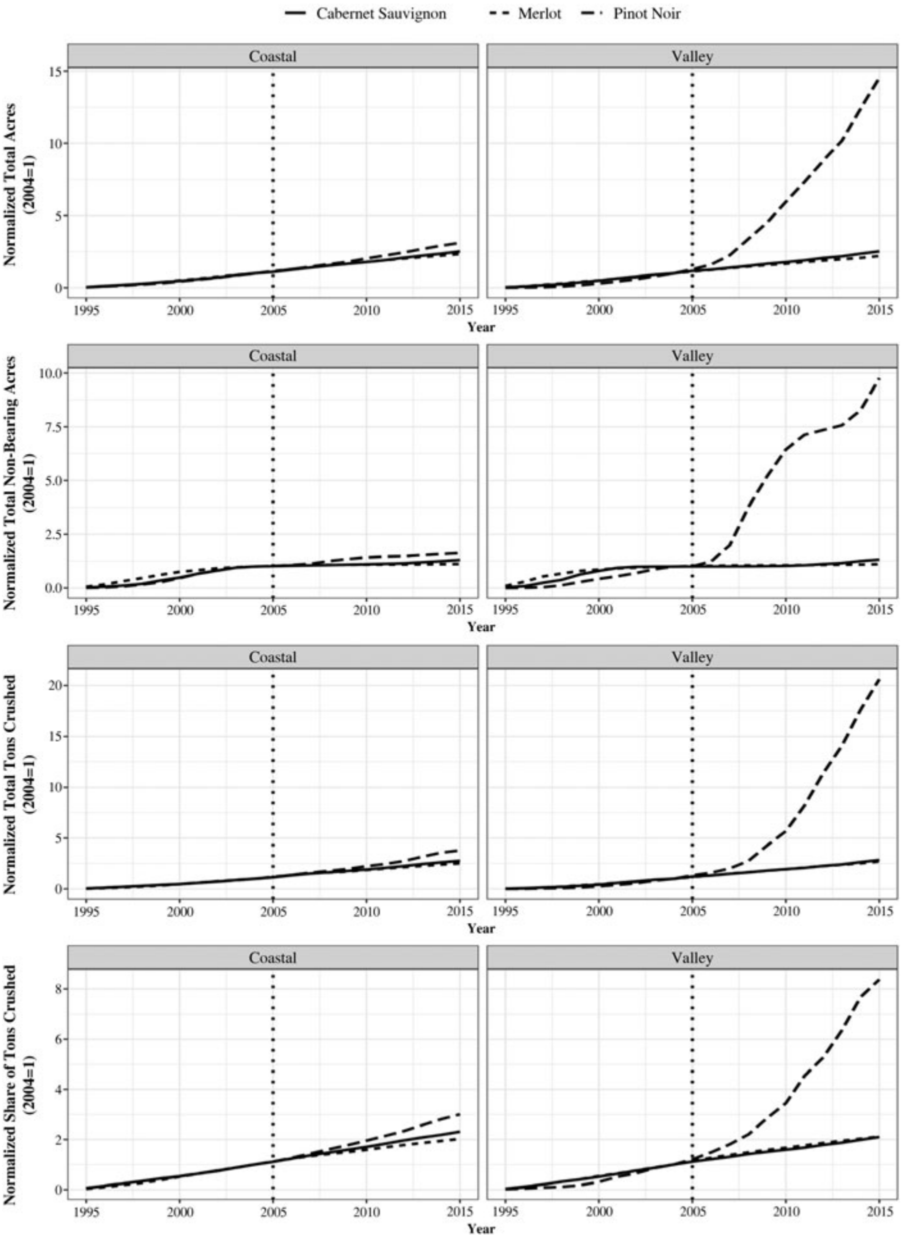
$$\log(Y_{it}) = \alpha_0 + f(t) + \delta_i + \varepsilon_{it}, \tag{5}$$

where *t,* the linear time variable representing the years 1999–2012, enters the regression non-parametrically. The graphical depiction of the non-parametric element, $f(t)$, allows us to represent potential time lags and nonlinearities in the supply response following the 2004 release of *Sideways* in a more flexible manner compared to our parametric models. Instead of estimating the average response over the eight-year post-period, these semi-parametric regressions show the year-on-year changes and more flexibly capture the dynamics of the supply response represented in the coefficients of the parametric models. While Specification (5) parametrically nets out district fixed effects, it does not differentiate between valley and coastal districts.

[7] While not a full elasticity, as we are determining the grower supply responsiveness to the *Sideways* exogenous consumer demand shock, rather than to changes in price levels, Bellemare and Wichman (2019) define a semi-elasticity for the arcsinh-linear specification as the percentage change in the dependent variable in response to a discrete change in the dummy variable.

Figure 2

A Comparison of Normalized Supply Response Variables before the Release of the *Sideways* Film Compared with Levels in the Post-Period, by Variety for Coastal Districts and for Valley Districts



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V. Results

Table 2 reports the estimates of Regressions (1) through (4) for total acres as the supply response outcome variable. We see in Column (1) of Table 2 that the standard DiD coefficient is statistically significant and 1.13, which corresponds to an overall post-period grower supply semi-elasticity of 2.01: the change in total acres from the pre-period to the post-period for Pinot compared to Merlot is approximately 201% higher. The 3DiD results in Column (4) clarify that this acreage supply response is greater in valley districts. The separate regressions shown in Columns (2)–(3) and (5)–(6) largely confirm this pattern of results: while there is no significant post-period effect found for Pinot and Merlot in the DiD specifications in Columns (2) and (3), by differentiating between coastal and valley districts the 3DiD results in Columns (5) and (6) show a strong positive post-period acreage expansion for Pinot and a reduction in total acres dedicated to Merlot in the valley. Interestingly, the results in Columns (5) and (6) suggest the expansion in valley districts of Pinot acreage in the post-period is significantly greater than that of the coast. That is, there is a reduction in Pinot acres on the coast that is more than offset by the expansion in valley districts and, similarly, a small expansion of Merlot acres on the coast that is more than offset by a reduction in the valley. The results for Cabernet Sauvignon, which we included as a pseudo-control in Table A3 of the online Appendix, suggest a small reduction in acreage (–16.5%) in the valley.[8]

When we use non-bearing acres as our supply response variable, the results are largely consistent with the total acreage results. As shown in Table 3, we find a strong expansion of non-bearing acres in favor of Pinot relative to Merlot that predominantly occurs in vineyards located in the valley. Consistent with the planting timing, we see a much larger (positive) effect in the post-period for Pinot relative to the (negative) effect in Merlot in Column (1) of Table 3 relative to Table 2. The non-bearing acres grower supply semi-elasticity is 803%. However, it is important to note that this does not imply that Merlot was directly replaced by Pinot, especially in the two years immediately following the release of *Sideways*, as vine nurseries likely would not yet have had sufficient Pinot vines readily available for growers. In the separate regressions by variety, we see that the expansionary response in non-bearing acres for Pinot in the valley is much stronger than the contractionary response for Merlot (indeed, we see no statistically significant reduction in non-bearing acres for Merlot). We can think of this as evidence of an increase in replanted or additional acreage of Pinot in the valley region, as compared to Table 2, which shows evidence of an increase in total Pinot acreage in the valley. We do, however, find a strong reduction in non-bearing acres for Cabernet Sauvignon in the post-period, which provides further evidence that this may serve as an imperfect control or is driven by other factors that are beyond our DiD empirical approach.

[8] On this basis, it is unclear whether this serves as a clean control. We cannot distinguish whether this is due to the pronounced changes in Pinot and Merlot over several years after 2005 indirectly affecting Cabernet Sauvignon acreage or to other factors unrelated to the release of *Sideways*.

Table 2

Results for Annual Total Acres for the Period 1999–2012 with 2005+ as "Post"

	DiD			*3DiD*		
	Pooled Pinot Merlot	*Pinot*	*Merlot*	*Pooled Pinot Merlot*	*Pinot*	*Merlot*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Year	0.0585**	0.133***	–0.0160***	0.0585***	0.133***	–0.0160***
	(0.0295)	(0.0215)	(0.00579)	(0.0221)	(0.0183)	(0.00549)
Post	–0.478*	0.133	0.0437	–0.369	–0.531***	0.153***
	(0.270)	(0.175)	(0.0472)	(0.246)	(0.170)	(0.0511)
		[0.125]	[0.044]		[–0.420]	[0.164]
Pinot	–2.479***			–0.472**		
	(0.186)			(0.205)		
Post*Pinot	1.133***			0.359		
	(0.246)			(0.271)		
	[2.011]			[0.381]		
Valley				1.063***	–2.005***	0.403***
				(0.291)	(0.211)	(0.0634)
Post*Valley				–0.203	1.233***	–0.203***
				(0.261)	(0.153)	(0.0459)
					[2.392]	[–0.184]
Pinot*Valley				–3.728***		
				(0.279)		
Post*Pinot*Valley				1.436***		
				(0.369)		
				[2.927]		
Observations	364	182	182	364	182	182
R^2	0.725	0.949	0.981	0.847	0.963	0.983

Standard errors in parentheses. Semi-elasticities in brackets. District fixed effects are included, but not reported.

$^*p < .10$, $^{**}\ p < .05$, $^{***}\ p < .01$

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Table 3

Results for Annual Non-Bearing Acres for the Period 1999–2012 with 2005+ as "Post"

	DiD			*3DiD*		
	Pooled Pinot Merlot (1)	*Pinot* (2)	*Merlot* (3)	*Pooled Pinot Merlot* (4)	*Pinot* (5)	*Merlot* (6)
Year	–0.194***	0.0120	–0.400***	–0.194***	0.0120	–0.400***
	(0.0424)	(0.0572)	(0.0461)	(0.0398)	(0.0557)	(0.0463)
Post	–0.894**	–0.0733	0.549	–0.902**	–0.890*	0.540
	(0.388)	(0.466)	(0.376)	(0.443)	(0.518)	(0.430)
		[–0.166]	[0.613]		[–0.641]	[0.564]
Pinot	–1.312***			0.273		
	(0.267)			(0.369)		
Post*Pinot	2.262***			1.454***		
	(0.353)			(0.488)		
	[8.025]			[2.801]		
Valley				0.740	–1.713***	0.250
				(0.524)	(0.643)	(0.534)
Post*Valley				0.0161	1.517***	0.0161
				(0.470)	(0.465)	(0.387)
					[3.091]	[–0.057]
Pinot*Valley				–2.944***		
				(0.503)		
Post*Pinot*Valley				1.501**		
				(0.665)		
				[2.596]		
Observations	364	182	182	364	182	182
R^2	0.609	0.706	0.733	0.659	0.724	0.733

Standard errors in parentheses. Semi-elasticities in brackets. District fixed effects are included, but not reported.
* $p < .10$, ** $p < .05$, *** $p < .01$

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We now shift to production outcomes, beginning with total tons crushed as the supply response variable in Table 4. As a reminder, to account for the production lags involved, we designate 2008 as the “Post” year. Here the evidence follows directly the pattern we observed with acreage responses noted previously. In Column (1), we see a dramatic increase in tons crushed in favor of Pinot after 2008, with an overall grower supply semi-elasticity of 538%. Such a large expansion in Pinot production follows from newly planted acres reaching production maturity but could also be due to other adjustments. Since we are unable to parse out these different adjustment dimensions, we interpret these production responses as the net effect of adjustments made through both adjustments in the harvest method and changes in acreage. Table 4 also shows clearly that the Pinot production response is concentrated entirely in the valley districts: while tons crushed in coastal districts declined for all three varietals (including Cabernet Sauvignon in Table A3 of the online Appendix) in the post-period, the expansionary response shown in Columns (5) and (6) in valley vineyards relative to the coast for Pinot is larger than that of Merlot (767% compared to 14.8%). The fact that Column (2) indicates that Merlot crush is down by 29.6%, but the decrease was not greater in the valley, could suggest that the reduction of Merlot acreage or share of production harvested occurred across both the coast and the valley.

Next, we turn to the district-level share of tons crushed to provide a different angle on the production response to the “*Sideways* effect” in Table 5. This supply response variable is different than tons crushed in one subtle but important way: since this share is constructed at the district level, it represents the relative importance of a given variety in a district. As such, there is no mechanical relationship between the absolute level of tons crushed of, say, Pinot and its relative share at the district level. With this distinction in mind, the results in Table 5 suggest that the relative importance of Pinot production increased and that of Merlot decreased post-release of the film. In contrast to the earlier results, however, we do not see that this relative expansion of Pinot is concentrated in valley districts. Instead, it is coastal districts that see statistically the clearest increase in the relative importance of Pinot and a (larger) decrease in the relative importance of Merlot in the post-period. This is not necessarily inconsistent with all the earlier results but does suggest that the valley districts were expanding production of many different wine-grape varieties during the post-period in addition to Pinot. The fact that coastal districts witnessed an increase in the relative share of Pinot and a decrease in the relative share of Merlot is nonetheless consistent with a *Sideways* supply response.

Finally, in Figure 3, we present the non-parametric estimates from our semi-parametric specification in Equation (5). Overall, these figures show the positive post-period trend for Pinot (left panels) in contrast to the largely negative post-period trend for Merlot (right). The top two rows show the acreage response and—as expected—illustrate a more rapid reaction to the film release than do the production outcomes that appear in the bottom two rows. Specifically, total acres increase (decrease) most sharply for Pinot (Merlot) in the three years after the film release

Table 4
Results for Annual Tons Crushed for the Period 1999–2012 with 2008+ as "Post"

	DiD			*3DiD*		
	Pooled Pinot Merlot (1)	*Pinot* (2)	*Merlot* (3)	*Pooled Pinot Merlot* (4)	*Pinot* (5)	*Merlot* (6)
Year	0.106***	0.182***	0.0314***	0.106***	0.182***	0.0314***
	(0.0278)	(0.0378)	(0.00828)	(0.0226)	(0.0333)	(0.00822)
Post	–0.874***	0.488	–0.349***	–0.950***	–0.701**	–0.425***
	(0.268)	(0.318)	(0.0697)	(0.270)	(0.326)	(0.0807)
		[0.548]	[–0.296]		[–0.530]	[–0.348]
Pinot	–2.495***			–0.864***		
	(0.155)			(0.185)		
Post*Pinot	1.887***			0.774**		
	(0.260)			(0.310)		
	[5.384]			[1.068]		
Valley				0.681**	–1.856***	0.188*
				(0.296)	(0.395)	(0.0977)
Post*Valley				0.141	2.208***	0.141*
				(0.299)	(0.311)	(0.0770)
					[7.670]	[0.148]
Pinot*Valley				–3.029***		
				(0.253)		
Post*Pinot*Valley				2.067***		
				(0.423)		
				[6.226]		
Observations	364	182	182	364	182	182
R^2	0.710	0.797	0.966	0.811	0.844	0.967

Standard errors in parentheses. Semi-elasticities in brackets. District fixed effects are included, but not reported.

*$p < .10$, ** $p < .05$, *** $p < .01$

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Table 5

Results for the Annual Share of Tons Crushed for the Period 1999–2012 with 2008+ as "Post"

	DiD			*3DiD*		
	Pooled Pinot Merlot	*Pinot*	*Merlot*	*Pooled Pinot Merlot*	*Pinot*	*Merlot*
	(1)	*(2)*	*(3)*	*(5)*	*(6)*	*(7)*
Year	0.00132**	0.00328***	–0.000640	0.00132**	0.00328***	–0.000640
	(0.000656)	(0.000634)	(0.000694)	(0.000653)	(0.000635)	(0.000684)
Post	–0.0372***	0.0138**	–0.0235***	–0.0456***	0.0118*	–0.0319***
	(0.00632)	(0.00534)	(0.00584)	(0.00782)	(0.00623)	(0.00671)
		[1]	[–0.023]		[0.012]	[–0.031]
Pinot	–0.0764***			–0.0732***		
	(0.00366)			(0.00536)		
Post*Pinot	0.0647***			0.0710***		
	(0.00613)			(0.00898)		
	[0.067]			[0.074]		
Valley				–0.0381***	–0.0552***	–0.0267***
				(0.00858)	(0.00755)	(0.00812)
Post*Valley				0.0156*	0.00388	0.0156**
				(0.00865)	(0.00595)	(0.00640)
					[0.004]	[0.016]
Pinot*Valley				–0.00580		
				(0.00731)		
Post*Pinot*Valley				–0.0117		
				(0.0122)		
				[–0.012]		
Observations	364	182	182	364	182	182
R^2	0.754	0.869	0.810	0.759	0.869	0.816

Standard errors in parentheses. Semi-elasticities in brackets. District fixed effects are included, but not reported.

*$p < .10$, ** $p < .05$, *** $p < .01$

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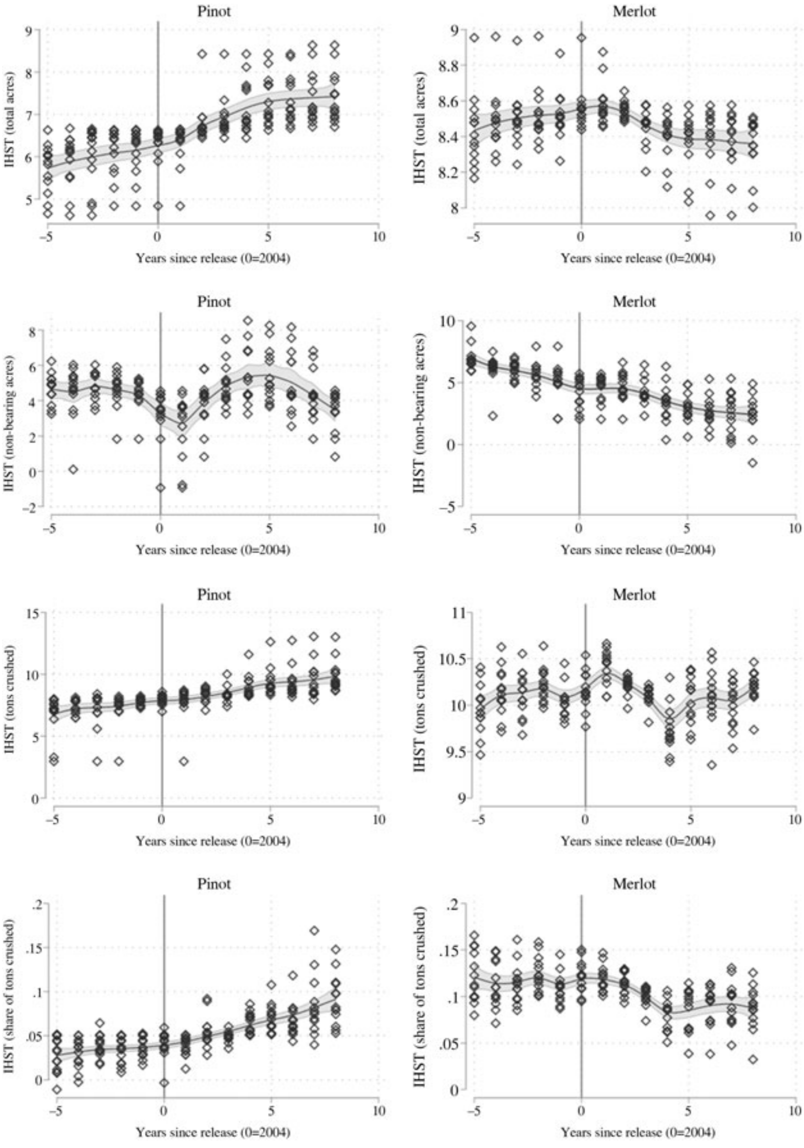
Figure 3

Non-Parametric Component, *f*(*t*), of the Semiparametric Regressions for the Supply Response Variables (in IHST Form) with year=0 Distinguishing before and after the 2004 Release of the *Sideways* Film



and then stabilize. Non-bearing acres of Pinot increase in the five years post-release and then return to prior levels, but note that these acres represent a flow of new acres into the stock of total acres and, therefore, indicate a long-term increase in acreage.

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Tons crushed and share of tons crushed show a slower reaction time for Pinot, as expected: three years post-release, we begin to see a modest increase in these production outcomes on average for Pinot, the increase in post-release tons crushed likely driven largely by a supply response of vineyards in the valley. Merlot, however, does see an immediate decrease in the production outcomes, which is intuitive as the share of Merlot production harvested could be immediately reduced, or growers could decide to hold off on replanting or choose not to replant, Merlot acreage resulting in a quicker possible decrease in tons crushed than the increase possible from adding new acreage of Pinot.

We conducted two robustness tests based on the Great Recession and California geography. First, we estimate these specifications, including dummy variables for the Great Recession years 2008 and 2009. We find that the main results are robust to this inclusion. We further explored literature surrounding the effects of the Great Recession on the wine and wine grape market; Jordan, Newton, and Gilinsky (2014) find that during the Great Recession, larger wineries fared better compared to small wineries and that the sales of lower-priced wines increased while high-priced wines suffered. This is likely due to the economies of scale of large wineries and a larger existing consumer base. On the contrary, the popularity of direct-to-consumer sales in the form of tasting rooms and wine club memberships emerged during this time (Veseth, 2020). Thus, based on the lack of a net negative effect for the wine and wine grape market as a whole, we decided not to include Great Recession dummy variables.

Second, since the film took place on the Central Coast, one would suspect that there would be a greater response there than from the North Coast or the Central Valley. Furthermore, there was concern that the coastal region included dissimilar districts that would skew the results, relative to considering impacts, in the Central Coast and the North Coast separately. Following wine region delineation set by Volpe et al. (2010a), we modified Specification (4) to use a coastal dummy rather than a valley dummy and then compared the results to a version that used separate North Coast (districts 1, 3, and 4) and Central Coast (districts 6, 7, and 8) dummies. The expectation was that growers in the North Coast would be less inclined to shift production toward Pinot when the region is more characteristically known for other winegrape varieties, relative to the Central Coast region that was the topic of the *Sideways* film. We find that total acres of Pinot decreased in both coastal regions in the post-period, whereas Merlot and Cabernet Sauvignon had slight increases. In terms of non-bearing acres, there is a significant negative result for Pinot in the North Coast, while results for Central Coast, Merlot and Cabernet Sauvignon are insignificant. Furthermore, we find a significant decrease of tons crushed of Pinot in the post-period in both the Central Coast and North Coast that correspond with the results from the decrease in total acreage for Pinot. The share of tons crushed for Pinot in the post period is slightly negative and only significant at the 1% level in the North Coast. The supporting regression results for this robustness check have been included in the online Appendix (Tables A6–A9). While these results may seem concerning, since the film was staged on the Central Coast, and one would expect a positive response in that region for Pinot, they are nevertheless consistent with the 3DiD results comparing coast and valley, where we find negative supply responses in the coast that are more than offset with positive responses in the valley for Pinot.

VI. Conclusions

In this analysis, we use a DiD econometric method to estimate the effect of the film *Sideway*s on Merlot and Pinot acreage and grapes crushed in California and find strong support for the hypothesis. The results suggest that growers expanded acreage of Pinot and decreased acreage of Merlot in the years following the release of the film. This estimated supply response is not symmetric or uniform: we find stronger positive effects on Pinot in the Central Valley than negative effects on Merlot.

We recognize that there may well have been other factors unrelated to the film that influenced these production trends. However, we applied a number of standard tests and checks, and the main results remain robust. With this important caveat in mind, it is best to frame our results more conservatively: our production estimates for Pinot and Merlot are consistent with the presence of a *Sideways* supply response, but demand factors other than the film may have also contributed to these estimated responses. That these supply responses are at least partially attributable to the film is reasonable given the price effects attributed to the film in Cuellar, Karnowsky, and Acosta (2009): vineyard managers and winemakers may or may not have watched the film, but they watch prices and respond accordingly.

We conclude by revisiting one lingering puzzle from these results. Why was there a negative supply response in the coastal regions for Pinot? One explanation is that coastal districts tend to produce high-priced wine, whereas valley districts produce low-priced wine, suggesting that there was an increase in demand for lower-priced Pinot. Yet, Cuellar, Karnowsky, and Acosta (2009) find that case volume increased for Pinot at all price points with the largest increases in high price points. We suspect that blending may have played an important role in this pattern of results. A number of large, vertically-integrated wineries manage winegrape production in both valley and coastal vineyards and strategically blend the resulting wine under higher-priced coastal labels. Such a blending strategy could help to explain the distinctly different valley-coast supply response we attribute to the *Sideways* effect. The rise of this strategy and its implications for the wine market deserves greater attention in future research.

Supplementary Material

To view supplementary material for this article, please visit https://doi.org/10.1017/jwe.2021.26.

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