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Estimating the Value of California Wine Grapes

Abstract

The California Grape Crush Report includes summaries of quantities produced and estimates of the average prices and value of wine grapes crushed in California, and serves as an authoritative source of information on production and returns per ton by variety of wine grapes. The data provided in the Crush Report are used to calculate the total value of winegrape production as reported in the annual Agricultural Statistics reports published by the United States Department of Agriculture and in major industry publications. We use the differences among crush districts in the shares of production crushed to growers' accounts to show that the current mechanism of calculating average statewide returns per ton understates the true total value of the crush by 4–16 percent. We show that a more accurate estimate of the total value and average price can be obtained if the prices of the wine grapes that are sold are used to infer the prices of wine grapes that are not sold before computing the weighted averages.

The California Grape Crush Report (or "Crush Report") is a useful compendium of data published annually by the California Department of Agriculture (CDFA) in cooperation with the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). The Crush Report includes summaries of quantities produced and estimates of the average prices and value of wine grapes crushed in California, by district and variety (for a total of 105 varieties across 17 crush districts) and for the state as a whole.[1] For example, the most recent Crush Report stated that the "2015 grape crush totaled 3,867,710 tons, down 7 percent from the 2014 crush of 4,144,534 tons" and the "… 2015 average price of all grape varieties was $671.31, down 10 percent from 2014" CDFA (2016, p. 1). Together these estimates imply a total crush value of $2.596 billion in 2015.

The Crush Report serves as an authoritative source of information. Its estimates of average prices per ton are used by the USDA/NASS to calculate the total value of winegrape production, as reported in the annual Agricultural Statistics reports (USDA/NASS 2016a) and California Agricultural Statistics reports (USDA/NASS 2016b) and in major industry publications (e.g., Wine Institute 2015). As we show below, these estimates may have understated the true total value of the crush by 4–16 percent in recent years, depending on the year. In addition, the estimates of average prices by variety and crush district in the Crush Report are used as data in economic studies of the California winegrape industry (see, for example, Alston, Anderson, and Sambucci 2015; Fuller and Alston 2012; Volpe et al. 2010; Goodhue et al. 2008), and some of these estimates might also contain errors.

The prices of wine grapes vary systematically across varieties and among regions where they are grown, and prices are observed directly only for those wine grapes that are sold; not for

[1] The latest available Crush Report to date (2015) provides detailed pricing for 105 white and red wine grape varieties as well as less significant varieties grouped under "other."

those used in winemaking by the grower (i.e., crushed to growers' accounts). The procedures used to compute the statewide averages have to account for these features appropriately. In this note we show how the current practice results in a distorted estimate of the average price and value of wine grapes, and how a small change in procedure would provide more accurate estimates. According to our estimates using this revised procedure, the value of wine grapes produced in California in 2015 was $2.6 billion, 4% higher than the official measure. In 2014, the published estimates understated the value of California wine grape production by 16%.

The mechanism for this understatement is straightforward. A greater proportion of higher-valued wine grapes are crushed to growers' accounts, and consequently the average value of all wine grapes is greater than the average value of wine grapes that are sold. The current procedure used by the CDFA is to apply the average value of wine grapes that are sold to the total volume, resulting in an underestimate of the total value. A more accurate estimate of the total value and average price can be obtained if the (observed) prices of the wine grapes that are sold are used to infer the (unobserved) prices of wine grapes that are not sold before computing the weighted averages.

The Challenge of Missing Data

The total quantity of wine grapes crushed (in tons), Q includes both grapes that are sold, Q^s and grapes that are not sold, Q^n (i.e., grapes that are "crushed to growers' accounts"): $Q = Q^s + Q^n$. Likewise, the total revenue or value of wine grapes crushed, R (in $), is equal to the sum of the value of wine grapes that are sold, R^s and the value of grapes that are not sold, R^n: $R = R^s + R^n$. The challenge is to measure the statewide annual average price per ton for all wine grapes, defined as $P = R/Q$ (in $/ton), when we do not directly observe R^n.

The 2015 Final Crush Report includes details of "Tons of grapes crushed by California processors from the 2015 crop by type, variety, and reporting district where grown, with comparisons" (in Table 2), "Tons of grapes purchased for wine, concentrate, juice, vinegar, and beverage brandy, by California processors from the 2015 crop by type, variety, and reporting district where grown, with comparisons" (in Table 4) and "Tons of grapes crushed to growers' accounts by California processors from the 2015 crop by type, variety, and reporting district where grown, with comparisons" (in Table 9). Table 2 refers to the total quantity crushed, whether sold or not, Table 4 refers to tons of grapes crushed that were sold from the 2015 crop, and Table 9 refers to the part of the total in Table 2 that was crushed to growers' accounts.

Prices are more complicated. The 2015 Final Crush Report (CDFA 2016) includes details of the "Base price paid to growers for grapes crushed and delivered to California processors, from the 2015 crop, with Brix factors and purchased tonnage, by type, variety, reporting district where grown, and weighted average base price" (in Table 8). Each entry in this table refers to an individual "lot" of grapes sold for crush, organized by district, and variety within district, and then ranked by price from lowest to highest. Details are included on the base price, tonnage in the lot, and Brix adjustment factors. Lots may vary in size, quality or other characteristics that affect price. As these data reveal, even within a season, prices for the same variety in the same crush district can vary considerably. For example, in crush district 4 (Napa) the price of Cabernet Sauvignon ranged from a low of less than $1,000/ton for a total of 45.4 tons in five lots up to a high of more than $40,000/ton for a total of 20.5 tons in three lots. Comparable measures of unit value are not observed for grapes crushed to growers' accounts (i.e., not sold), and must be inferred.

"True" Measures of Statewide Average Prices and Total Value

In what follows we denote varieties by *v*, and districts by *d*. (We do not include an indicator for time, since all the computations refer to a particular vintage year.) For any variety, *v* (*v* = 1, . . ., *V*) from district *d* (*d* = 1, . . ., 17) of the total number of lots, *I*, a subset *S* (*S* < *I*) are sold, and the rest are crushed to growers' accounts. The total value ($) of the wine grapes sold for crush, R^s, is equal to:

$$R^s = \sum_{d=1}^{17} \sum_{v=1}^{V} \sum_{i=1}^{S<I} P_{vdi} Q_{vdi} \tag{1}$$

Alternatively, we can write:

$$R^s = \sum_{d=1}^{17} \sum_{v=1}^{V} P_{vd}^s Q_{vd}^s \,, \tag{2}$$

where P_{vd}^s is the average return ($/ton) for tons sold of variety *v* from district *d*—i.e., $P_{vd}^s = \sum_{i=1}^{S<I} P_{vdi}\left(Q_{vdi} / Q_{vd}\right)$, as observed in Table 6 of the Crush Report—and $Q_{vd} = \sum_{i=1}^{S<I} Q_{vdi}$ is the total quantity (tons) sold of variety *v* from district *d*, as observed in Table 4 of the crush reports.

Similarly, corresponding to equation (1), the total value of wine grapes crushed to growers' accounts (and not sold) is equal to:

$$R^n = \sum_{d=1}^{17} \sum_{v=1}^{V} \sum_{i=S+1}^{I} P_{vdi} Q_{vdi} \tag{1′}$$

and, corresponding to equation (2), we can simplify this expression to:

$$R^n = \sum_{d=1}^{17} \sum_{v=1}^{V} P_{vd}^n Q_{vd}^n \,, \tag{2′}$$

where P^n_{vd} is the average unit value of wine grapes of variety *v* from district *d* crushed to growers' accounts (i.e., not sold) and Q^n_{vd} is the corresponding quantity. We do not observe P^n_{vd} but Q^n_{vd} is provided in Table 9 in the Crush Report.

Combining (1′) an (2′), the total value of all wine grapes at crush is equal to:

$$R = \sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd}Q^s_{vd} + \sum_{d=1}^{17}\sum_{v=1}^{V} P^n_{vd}Q^n_{vd}. \tag{3}$$

Given that we have defined $P = R/Q$, where $Q = Q^s + Q^n$ is the sum of all quantities over varieties and districts, the statewide average return per ton of wine grapes is equal to:

$$\begin{aligned} P &= \sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd}\left(\frac{Q^s_{vd}}{Q}\right) + \sum_{d=1}^{17}\sum_{v=1}^{V} P^n_{vd}\left(\frac{Q^n_{vd}}{Q}\right), \\ &= \left(\frac{Q^s}{Q}\right)\sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd}\left(\frac{Q^s_{vd}}{Q^s}\right) + \left(1-\frac{Q^s}{Q}\right)\sum_{d=1}^{17}\sum_{v=1}^{V} P^n_{vd}\left(\frac{Q^n_{vd}}{Q^n}\right), \\ &= k^s\sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd}k^s_{vd} + \left(1-k^s\right)\sum_{d=1}^{17}\sum_{v=1}^{V} P^n_{vd}k^n_{vd}, \\ &= k^sP^s + \left(1-k^s\right)P^n, \end{aligned} \tag{4}$$

where, for wine grapes of variety *v*, of the statewide quantity sold, k^s_{vd} is the proportion coming from crush district *d* and, of the statewide quantity crushed to growers accounts, k^n_{vd} is the proportion coming from crush district *d*. Aggregating across all varieties and crush districts, k^s is the proportion of all wine grapes that are sold and $1-k^s$ is the proportion crushed to growers accounts, and not sold.

The average return per ton for all wine grapes (across all varieties and districts and whether sold or not) is therefore a weighted average of (a) the average return across all varieties and districts for wine grapes that <u>are sold</u> (the first part of each line of equation (4), denoted by

superscript "*s*") and (b) the average return across all varieties and districts for wine grapes that are crushed to growers' accounts, and not sold (the second part of each line of equation (4), denoted by superscript "*n*"). The corresponding estimate of the statewide total value of production is $R = P \times Q$.

Estimates of Statewide Average Prices and Values in the Crush Report

In the Crush Report, the average return per ton of wine grapes sold is used as a measure of the average return for all wine grapes:

$$\hat{P} = P^s = \sum_{d=1}^{17} \sum_{v=1}^{V} P_{vd}^s k_{vd}^s. \tag{5}$$

The corresponding estimate of the statewide total value of production is $\hat{R} = \hat{P} \times Q$.

The difference between the "true" average return per ton and the return per ton calculated in the crush reports is equal to:

$$P - \hat{P} = P - P^s = \left(1 - k^s\right)\left(P^n - P^s\right). \tag{6}$$

The error in the estimate of the statewide average price is equal to the product of (a) the proportion of the crush that is crushed to growers' accounts and hence for which prices are unobserved (i.e., $1 - k^s$), and (b) the difference between the average price per ton for grapes crushed to growers' accounts (i.e., P^n), which is not observed, and the observed average price per ton for grapes sold to others (i.e., P^s). If there is little no difference between the average value per ton of grapes that are sold and grapes that are crushed to growers' accounts, or if the fraction crushed to growers' accounts is very small, then the discrepancy will be negligible.

Whilst we do not observe value per ton of grapes that are crushed to growers' accounts, we do observe the proportion of the crush that is sold for each variety and crush district. The

general pattern is that the districts with higher-priced grapes (e.g., districts 3 and 4 in the North Coast region) also have greater shares of grapes crushed to growers' accounts. Consequently, the statewide average value of grapes crushed to growers' accounts (i.e., P^n) will be greater than average price per ton for grapes sold to others (i.e., P^s), and hence the true average return per ton, P will be larger than the return per ton in the Crush Report, $\hat{P} = P^s$. Estimates of the total value of the crush using this downward-biased estimate of the average value per ton will be biased down accordingly.

Alternative Estimates of Statewide Average Prices and Values

An alternative method, which we describe next, may provide more accurate estimates of the true average value per ton and total value of the California grape crush. For this calculation, we apply the average value per ton for grapes that are crushed to growers' accounts as an estimate of the average value per ton for grapes of the same variety in the same district that are sold to others—i.e., assuming $P^n_{vd} = P^s_{vd}$ for all varieties, v and districts, d. Making this substitution in equation (4) yields:

$$\tilde{P} = k^s \sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd} k^s_{vd} + (1-k^s)\sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd} k^n_{vd}$$

$$(4') \qquad = \sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd}\left[k^s k^s_{vd} + (1-k^s)k^n_{vd}\right]$$

$$= \sum_{d=1}^{17}\sum_{v=1}^{V} P^s_{vd}\left[k^s_{vd} + (1-k^s)\left(k^n_{vd} - k^s_{vd}\right)\right].$$

In this case, the error in the estimate of the true average return per ton is:

$$(7) \qquad P - \tilde{P} = (1-k^s)\sum_{d=1}^{17}\sum_{v=1}^{V}\left(P^n_{vd} - P^s_{vd}\right)k^n_{vd}.$$

Here, the discrepancy depends on the difference between the average value of grapes crushed to growers' accounts and average price per ton for grapes sold to others, but now at the level of varieties within districts rather than at the level of the statewide overall average. If grapes of the same variety within any crush district have similar unit values per ton, regardless of whether they are sold or crushed to growers' accounts, this difference will be small or close to zero. However, if districts exist where this difference is large, and these districts account for a large share of tonnage crushed to growers' accounts for the state, the discrepancy could be large.

Which method of estimating the statewide average value per ton is more accurate? Consider the difference between equations (7) and (5):

$$\left(P-\hat{P}\right)-\left(P-\tilde{P}\right)=(1-k^s)\left(P^n-P^s\right)-(1-k^s)\sum_{d=1}^{17}\sum_{v=1}^{V}\left(P_{vd}^n-P_{vd}^s\right)k_{vd}^n$$

(8)
$$=(1-k^s)\left[\left(P^n-P^s\right)-\sum_{d=1}^{17}\sum_{v=1}^{V}\left(P_{vd}^n-P_{vd}^s\right)k_{vd}^n\right]$$

$$=(1-k^s)\sum_{d=1}^{17}\sum_{v=1}^{V}P_{vd}^s\left(k_{vd}^n-k_{vd}^s\right).$$

The term in square brackets in the second line of equation (8) can be seen as a difference between two terms. The first term is the difference between the statewide average prices of wine grapes that are sold and those that are crushed to growers' accounts, a difference between two means; the second term is the weighted average of the differences between variety-cum-district average prices of wine grapes that are sold and those that are crushed to growers' accounts, the mean of differences. Intuitively, the latter is likely to be smaller.

The third line of equation (8) can be seen as a weighted average (within the summation) of observed variety-cum-district-specific prices. The weight for each price (for a given variety in a given crush district) is equal to the difference between (a) the crush district's share of the

statewide quantity of that variety crushed to growers' accounts, and (b) the crush district's share of the statewide quantity of that variety sold to others. As discussed above, a greater proportion of tonnage is crushed to growers' accounts in crush districts with higher variety-specific prices, so the expression in equation (8) is likely to take a positive sign, which means $\tilde{P}$ provides a better approximation of true statewide average return per ton, *P* than the estimate in the Crush Report, $\hat{P}$.

Numerical Illustration

Table 1 includes estimates of district-level and statewide average prices for wine grapes in 2014 calculated using observed district-specific average prices for wine grapes that were sold applied to (a) just the quantities sold (i.e., $\hat{P}$ from equation (5)) in column (2) as in the Crush Report, and (b) the total quantities crushed (i.e., $\tilde{P}$ from equation (7)) in column (3), our suggested alternative measure. The implied district-level and statewide total value of wine grapes crushed are also reported in that table, in columns (4) and (5). Within crush districts, the differences in the estimated prices between columns (2) and (3) are generally modest. However, when we aggregate up to regions, and the state as a whole, the aggregation bias becomes greater. The statewide average value of wine grapes calculated using $\hat{P}$ (as in the Crush Report) is $759/ton, while the value per ton calculated using $\tilde{P}$ is $881/ton. Applying these average unit values to the total volume of wine grapes produced, the implied estimates of the total value of production in 2014 differ by about $0.5 billion in 2014, 14% of the larger estimate (16% of the smaller estimate).

[Table 1: *Alternative Estimates of Average Wine Grape Values, 2014 Data*]

Table 2 provides information on the differences in production patterns among crush districts that account for these discrepancies. While providing district-level detail, we have organized the data by production regions, defined such that each district fits entirely into one region. Production regions differ in terms of their terrain, climate, soil types, mixture of varieties grown, and quality of grapes and wines produced. The unit of analysis relevant for our purposes is a crush district, but crush districts within each major region have similar characteristics, and it is helpful to look at data for particular crush districts in the context of the regions to which they belong.

[Table 2: *Characteristics of Grape Growing Regions in California*]

In general, the share of production crushed to growers' accounts is greater for Napa-Sonoma and the Central Coast, where average prices per ton are generally higher, and lower for the Northern and Southern Central Valley regions, where average prices per ton are much lower, but the volume of production is large. In column (3) Table 2 includes two measures of production for each district *d*: total tons crushed, denoted by Q_d and tons sold, denoted by Q_d^s. The ratio, k_d^s is the district-specific measure of the share of production that is sold rather than crushed to growers' accounts. Among regions these shares differ appreciably, from 95% in the Southern central valley to less than 60% in crush district 4 (Napa). The crush districts also differ in terms of their relative importance as producers. The last two columns show the district-specific shares of total tons crushed and of the total quantity that is sold rather than crushed to growers' accounts. Among regions these shares differ appreciably, too—the Central Valley regions account for over 70% of the total volume and 78% of the volume sold.

The average district-level prices per ton do not differ significantly between the two methods of calculation: as shown in detail in Table 1, the difference is at most 6 percent, and it is

between 0 and 3 percent for crush districts where most of the volume is produced. However, when the average weighted return is calculated for the state, the difference between the two methods of calculation becomes quite large. Given the information in Table 1 and Table 2, and informed by equations (5)–(8), it is easy to see why. Weighting the average return per ton by tons sold under-represents the districts in the coastal valleys where larger shares of production are crushed to growers' accounts—in particular districts 3, 4, 7, and 8, in the Napa-Sonoma and Central Coast regions. These districts produce comparatively high-priced wine grapes. Conversely, disproportionate weight is given to prices from districts where nearly all wine grapes are sold, in particular those included in the Southern and Northern Central Valley regions that produce a very large volume of lower-priced grapes.

The estimated average value per ton of wine grapes crushed for each district is calculated using the same method and therefore is susceptible to the same type of error. However, for each variety the share of the total tons crushed within a district is usually similar to the share of the purchased tons within the same district (i.e., the share of production crushed to growers' accounts is similar across varieties within a district). And, in Table 1, column (3), we see small district-level differences between the two estimates of average prices.

Therefore, the difference between the two methods of calculating state-level prices is mainly attributable to the difference in district-level shares of total state production compared with the district-level shares of state production that is sold (comparing columns (5) and (6) of Table 2). In equation (5), to compute the statewide average price, $\hat{P}$ for the Crush Report, the district-level price per ton for wine grapes is weighted by the district-specific share of tons sold statewide, which is generally smaller than the share of tons produced for districts with higher-priced grapes. Returns per ton in districts with lower-valued grapes are given disproportionately

greater weight in calculating the average statewide price per ton for wine grapes, since the district-specific share of tons sold statewide tends to be closer to the share of production in these districts.

Conclusion

The difference between the two methods of calculating average weighted returns per ton of California wine grapes at crush stems directly from differences among crush districts in the shares of production crushed to growers' accounts. Generally, regions producing higher-priced grapes have a larger share of grapes crushed to growers' accounts and a smaller share sold compared with regions producing lower-priced grapes. The share of production crushed to growers' accounts ranges from only 5–20% of volume in the Central Valley regions but represents 35–40% of the volume crushed in the premium Coastal Valley regions. Regions also vary in how much they contribute to total state production. The Napa-Sonoma and Central Coast regions together account for 25% of the state's total crush, but only 19% of the quantity sold. Conversely, the Central Valley regions account for 71% of the total crush and 78% of the quantity sold. The remaining crush districts grouped under "Other" account for 5% of total crush and 4% of the quantity sold.

The composition of the crush differs from year to year, and, consequently, so does the discrepancy between the alternative methods of estimating the district, regional, and statewide average prices. Table 3 shows the difference between the estimated average statewide return per ton calculated using the two methods described above for each year during the period 2004–2015, except 2009. The average difference in price is about 6% of the lower value, except for 2014, when the difference was 16%. While the difference in estimated price was especially large

for 2014, the average difference of 6% over the past ten years still understates the value of wine grape production by about $150 million per year compared with our preferred method.

[Table 3: *Statewide Average Price and Total Value of Wine Grape Production, 2004–2015*]

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Table 1: *Alternative Estimates of Average Wine Grape Values, 2014 Data*

Region	Crush District d	Average Return		Value	
		$\hat{P}_d$	$\tilde{P}_d$	$\hat{P}_d \times (Q_d^s + Q_d^n)$	$\tilde{P}_d \times (Q_d^s + Q_d^n)$
		$ per ton		*$000'*	
Napa-Sonoma	3	2,319	2,343	592.8	599.0
(NS)	4	4,077	4,071	715.9	714.8
	Total	**2,968**	**3,046**	**1,280.0**	**1,313.8**
Central Coast	7	1,240	1,238	394.9	394.4
(CC)	8	1,524	1,534	324.7	326.8
	Total	**1,358**	**1,357**	**721.9**	**721.2**
Southern Central Valley	14	315	313	99.5	99.0
(SV)	13	313	314	384.8	386.2
	Total	**313**	**314**	**484.3**	**485.2**
Northern Central Valley	9	513	530	28.4	29.3
(NV)	11	607	608	409.2	410.1
	12	451	439	152.0	148.0
	17	584	577	82.2	81.2
	Total	**563**	**554**	**679.7**	**668.5**
Other California	10	1,236	1,259	24.9	25.4
(OC)	15	839	804	0.3	0.3
	16	1,474	1,450	7.1	7.0
	1	1,493	1,581	92.5	98.0
	2	1,519	1,532	58.7	59.2
	5	839	870	19.5	20.2
	6	1,114	1,125	31.4	31.7
	Total	**1,309**	**1,363**	**232.3**	**241.8**
California (CA)		**759**	**881**	**2,953.2**	**3,430.5**

Notes: Prices calculated using values for total tons and tons sold from Table 2. District-level prices were calculated using data from CDFA crush reports, district-level detail by variety.

Table 2: *Characteristics of Grape Growing Regions in California, 2014.*

(1) Region	(2) Crush District	(3) Tons Crushed		(4) Tons sold as a share of tons crushed	(5) District quantity as a share of state total	(6)
		Total	Sold		Total Tons	Tons Sold
	d	Q_d	Q_d^s	k_d^s	Q_d/Q	Q_d^s/Q^s
Napa-Sonoma	3	255,635	166,808	0.65	0.07	0.05
(NS)	4	175,607	97,680	0.56	0.05	0.03
	Total	**431,243**	**264,488**	**0.61**	**0.11**	**0.08**
Central Coast	7	318,491	199,596	0.63	0.08	0.06
(CC)	8	213,087	141,873	0.67	0.05	0.04
	Total	**531,578**	**341,468**	**0.64**	**0.14**	**0.11**
Southern Central Valley	14	315,791	301,014	0.95	0.08	0.09
(SV)	13	1,229,482	1,173,186	0.95	0.32	0.36
	Total	**1,545,273**	**1,474,199**	**0.95**	**0.40**	**0.46**
Northern Central Valley	9	55,331	35,776	0.65	0.01	0.01
(NV)	11	674,177	618,999	0.92	0.17	0.19
	12	337,026	250,311	0.74	0.09	0.08
	17	140,717	122,636	0.87	0.04	0.04
	Total	**1,207,250**	**1,027,722**	**0.85**	**0.31**	**0.32**
Other California	10	20,184	13,959	0.69	0.01	0.00
(OC)	15	342	121	0.35	0.00	0.00
	16	4,846	2,246	0.46	0.00	0.00
	1	61,960	42,232	0.68	0.02	0.01
	2	38,673	27,406	0.71	0.01	0.01
	5	23,273	19,647	0.84	0.01	0.01
	6	28,175	18,521	0.66	0.01	0.01
	Total	**177,453**	**124,132**	**0.70**	**0.05**	**0.04**
California (CA)		**3,892,796**	**3,232,009**	**0.83**	**1.00**	**1.00**

Sources: Alston, Andersen and Sambucci (2015), own calculations.

Table 3: *Statewide Average Price and Total Value of Wine Grape Production, 2004–2015*

Year	Statewide Average Unit Value			Total Value of Production		
	$\hat{P}$	$\tilde{P}$	Percentage Difference	$\hat{P} \times Q$	$\tilde{P} \times Q$	Difference
		$/ton	*%*		*$ million*	
2004	571.36	601.82	5.33	1,585	1,670	85
2005	582.93	621.17	6.56	2,189	2,333	144
2006	583.09	628.98	7.87	1,829	1,973	144
2007	564.84	604.03	6.94	1,834	1,962	127
2008	601.07	640.12	6.50	1,840	1,960	120
2009	612.03	611.3	-0.12	2,266	2,264	-3
2010	573.68	607.39	5.88	2,059	2,180	121
2011	636.68	665.88	4.59	2,131	2,229	98
2012	772.56	807.98	4.58	3,104	3,247	142
2013	753.13	790.02	4.90	3,197	3,354	157
2014	759.01	881.1	16.09	3,223	3,741	518
2015	678.83	707.62	4.24	2,515	2,621	107

Source: Calculated by the authors from the CDFA California Crush Reports, 2004–2015.