Exploration in the Design of an Optimal Weather Hedging Variable for Viticulture

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Abstract

A number of significant annual weather variables are known to be critical to the quantity and quality of vineyard harvest. In rain-fed viticulture regions for example, most quality wines are produced in areas where the annual precipitation is below 700 to 800 mm (Jackson and Shuster, 1987; Galet, 1993). Indeed, barring any moisture stress to the vine, a warm, dry growing season is generally associated with good quality and high prices (Haeger and Storchman, 2006). Ashenfelter et al. (1995) for example, finds that great vintages for Bordeaux wines correspond to the years in which the previous winter has been wet, the growing season is warm and August and September are dry. Figure 1 (adopted from Cyr et al., 2008a) indicates the typical weather related risks associated with grape growing in the northern hemisphere. These include: severe winter temperatures leading to vine injury; frost and/or heavy rainfall in spring; cool wet conditions or conversely excessive heat during the growing season; heavy rainfall in the harvest season and/or early frost in the fall. Indeed excessive rain during the harvest season and the subsequent dilution of grapes can lead to lower brix levels and consequently a reduction in the price per ton obtained by as much as 60% for some varietals (Cyr et al, 2008b).

Figure 1: Weather Related Risk Factors

Excessive Cold –Winter Damage	-Frost -Heavy Rain	-Excessive Heat Or Cool Rainy Conditions	-Heavy Rain -Early Frost
November – March	April-May	June - August	Sept - Oct

Of course not all viticulture regions around the world experience the same degree of risk with respect to the various weather factors listed in Figure 1. The risk of vine damage due to severe winter conditions is a more serious risk factor for grape growers located in the northern

US, Canada or Northern Europe as opposed to other regions. Conversely excessive heat during the growing season has been a significant risk factor in recent years in France, California and Australia. Different grape varieties may also be more sensitive to some weather conditions than others. Early to mid-season varieties with thin-skinned and/or tight bunches such as Pinot Noir, Chardonnay and Riesling, for example, are especially susceptible to bunch rot following a period of heavy rains, especially during the harvest season (Cyr et al., 2008b).

In recent years the growth of financial contracts in the over-the-counter market to hedge specific weather related risks has gained much attention and use in a number of sectors of the economy. All that is required is a nearby weather station where temperature or precipitation variables can be measured objectively and a financial intermediary willing to write the appropriately designed contract. Although the potential benefits to the economy from the use of weather contracts is estimated to be great (Weatherbill Inc., 2008), their adoption in sectors such as agriculture, appears to still be lagging. A recent survey carried out on behalf of the Chicago Mercantile Exchange (Chicago Mercantile Exchange Group, 2009) indicates that among agricultural sector respondents in particular, 94% were somewhat to extremely concerned with regards to weather risk however only 25% have attempted to even quantify the financial risks due to daily weather volatility; the lowest among the sectors surveyed. In addition, only 8% indicated any attempt to hedge weather. Climate change research also suggests that the volatility of weather is increasing and will continue to do so, particularly in the Northern hemisphere (Purdue University, 2007; University of Colorado at Boulder, 2007; Warren et al., 2004). Indeed 60% of agricultural respondents to the CME survey indicated they were concerned about increased variability of weather due to climate change.

Despite the existence of a number of studies examining the benefits of weather derivatives in viticulture (Cyr et al., 2008a, 2008b, 2008c, 2009), as in other agricultural sectors, their use has not been widely adopted (Gedeon, 2008). Several issues could account for this including a lack of awareness. In addition however, there is a paucity of studies clearly delineating the economic impact of weather risk factors in viticulture. Estimation of this impact is a critical requirement for the design and choice of weather contract specifications on the part of a producer. As well, although previous studies have examined the design and use of weather contracts to hedge isolated weather risk factors, it is often that case that the interrelationship between annual weather variables can have a significant impact on harvest quantity and quality. The aggregation of a risk factor, in a spatial sense, has proven to be beneficial in hedging through the reduction of basis risk (Woodward and Garcia, 2008) and hence the aggregation across varying risk factors deserves exploration.

In the current study we provide a practical exploration of the potential design of a combined annual weather risk variable that could be used by wine grape producers as the basis for an overall weather contract to hedge the viticulture endeavour. Using relevant weather data from 1964 to 2009 for the Niagara region of Ontario, Canada, we examine the statistical properties of several critical annual weather risk variables, simultaneously, and their impact on harvest quantity and quality for the region. Specifically we examine the combined impact of: cumulative winter injury temperatures for the period of November through March; spring frost temperatures for April; cumulative heat index measures for May through August; and cumulative harvest period rainfall for September and October, on annual regional harvest quantity and quality variables. We then combine the critical risk factors into an optimal cumulative measure, and examine its stochastic process over time. We then consider the pricing of an aggregate weather contact based upon the cumulative measure or index.

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