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Title
What Happened to the Potential for Weather Derivatives in Viticulture?

I want to submit an abstract for:
Conference Presentation

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Keywords
Weather contracts, derivatives, viticulture, hedging, willingness-to-pay, basis risk, blockchain, digital ledger technology

Research Question
The lack of adoption of weather derivatives for hedging weather variability within the viticulture industry, and in general, is examined through a quasi meta-analysis approach to the literature.

Methods
A quasi meta-analysis approach to the literature is employed to determine the overall impediments to the use of weather derivatives in hedging weather related risks in viticulture.

Results
Weather contracts in viticulture face several impediments: basis risk, index modelling, pricing and market structure. Lessons learned in lesser developed countries and block chain technology point to renewed promise.

Abstract
The evidence of global climate change has become increasingly evident and worrisome, and sceptics have largely fallen away as the predominance of empirical evidence continues to build. The recent release (November 2018) of the Fourth National Climate Assessment (NCA4) has added significant urgency to the need for action with respect to climate change. Although a rise in global temperature is a relatively simple measure and predicted impact, the effect of such a rise in terms of specific areas of the globe is much more difficult to predict. Although not without some debate (Alexander and Perkins, 2013; Huntingford et al., 2013), research suggests that increasing volatility of weather is one of the major impacts of climate change, particularly in the Northern hemisphere (Bothum, 2015: University of Washington, 2012: Purdue University, 2007; University of Colorado at Boulder, 2007; Warren et al., 2004). It has also been estimated that increased weather-related risks due to climate change could result in

economic losses as high as 19% of GDP in some countries and regions by 2030 (McKinsey & Company, 2009) .

The impact on viticulture of greater volatility and extremeness of weather has been evidenced in recent years in a number of regions (Mercer, 2018; Selsky, 2018).
Indeed the potential and real impact of climate change on the viticulture and wine industry has been the focus of a number of studies dating back to the early 90's. Ashenfelter and Storchmann (2016), van Leeuwen and Darriet (2016), Oczkowski (2016) and Shaw (2017) provide recent reviews and examples of the growing literature on the impact of climate change and weather on the viticulture and wine sector.

The number of weather variables that have a significant impact on viticulture are wide and varying and often idiosyncratic to particular viticulture zones. In broad terms they include the potential for spring frost or cool temperatures, excessive or low heat during the growing season along with precipitation effects, harvest season variables such as excess rainfall and finally, in some zones, the potential for extreme cold leading to winter injury of vines. All with the potential to increase in volatility and impact in the coming years.

Weather derivatives or contracts, more broadly known as parametric insurance, were first established in 1996 when the very first contract related to weather induced energy usage was constructed. The over-the-counter market grew somewhat and in 1999 standardized weather contracts were introduced on the Chicago Mercantile Exchange and continue to trade today. The impact of their introduction has even been postulated to have had an impact on the accuracy of weather data measurement (Purnanandam and Weagley, 2016).

However, despite a number of studies modelling potential viticulture applications (Turvey et al. 2006; Cyr and Kusy, 2007; Cyr et al. 2008, 2009, 2010, 2012, 2013; Zara, 2010; Yandell, 2012; Cortina and Sánchez, 2013; Paulson et al, 2013) the actual adoption of weather derivatives has been slow at best.

The apparent lack of extensive use of weather derivatives, despite their potential to mitigate weather induced financial risk, is not observed solely in viticulture. Indeed since their establishment, the growth of notional value of weather derivatives contracts for a wide variety of uses appears to have peaked in 2005/06 at 45 billon USD and subsequently declined to approximately 10 billion USD in 2010/11 (Weather Risk Management Association). There is no doubt that the 2008 financial crisis had a tendency, initially, to mitigate the interest in derivative securities in general (Capelle-Blancard, 2010). However, although the general use of derivatives has recovered and expanded greatly, the use of weather derivatives has done so rather slowly and only in limited sectors (energy, construction, event management) (Till, 2014). This despite weather being a “genuinely exogenous economic factor” (Roll, 1992), free of market manipulation by either party to a contract. The lack of substantial use on the part of agriculture is particularly perplexing given the significant impact that weather volatility has on commodity yields, quality and net revenues. Indeed in notional value, agriculture remains one of the lowest usages at only 12% of the market with a significant component of that usage related to the biofuel market (Roussis et al., 2017). This lack of use has been perplexing (Odening and Shen, 2014).

The purpose of this paper is to provide a quasi meta-analysis of the literature on weather derivatives and to explain the factors that have resulted in the lack of their significant adoption in general, and what might specifically relate in terms of viticulture.

The use of weather derivatives has been of great interest in terms of humanitarian applications regarding agriculture with the World Bank first exploring such opportunities in 2000. Since then there have been over 150 donor-supported weather index insurance pilots, spanning perhaps 50 countries including India, Kenya, Malawi, and Mexico with few maturing into sustainable, large-scale programs (World Bank, 2016). Within this context, numerous studies have examined the issue of rational demand for weather derivatives and have explored the role that basis risk, hedging efficiency, willingness-to-pay and risk aversion plays (Cole et al., 2013; Carter et al., 2014; Clarke, 2016, Jin et al., 2016, Sibikio et al., 2018, Doms et al., 2018 among many others) and even differences in demand due to gender (Akter et al., 2016). These studies have potential implications for understanding the lack of use in viticulture and are reviewed in this context.

The market structure for weather derivatives is also an area examined. Although organized exchanges such as those on the Chicago Mercantile Exchange exist in terms of some applications, particularly temperature and

snowfall, the limitations of standardization of such contracts results in the over-the-counter market being the most viable avenue for agriculture. This can contribute to a noted lack of knowledge or awareness by many potential users (Bank and Wiesner, 2014). The paper reviews the history regarding the market structure and viability of over-the-counter weather contracts, current suppliers (MSI GuaranteedWeather among others) along with the history of some industry pioneers such as Weatherbill Inc.

The study also explores the potential for blockchain or digital ledger technology and smart contracts to facilitate the market development for weather derivatives and other insurance-linked securities. Applications of the technology, specifically related to agriculture are now starting to appear (Mackintosh and Mancini, 2018). In 2016 the global property & casualty insurance group Sompo Japan Nipponkoa Holdings Inc., partnered with a Japanese fintech startup named Soramitsu to create blockchain based smart contracts for catastrophe and weather derivatives (Artemis, 2016a). Arbolweather is a startup firm also focused on blockchain solutions for weather contracts that is scheduled to begin operations in 2019. (www.Arbolweather.com). Indeed the technology has the potential to greatly increase the efficiency and reduce operational costs of issuers by as great as 30% in the reinsurance market, critical to the availability of smaller, idiosyncratic weather contracts relevant to viticulture. However some industry analysts predict that this will not have a significant impact for at least five years (Fitch Ratings, 2018).

The expanded use of satellite weather data as the basis for weather contracts is another area of development which has the potential to provide for more localized weather related contracts and the reduction of geographic basis risk, as well as an expansion of the weather related perils upon which contracts could be written. Recently MSi GuaranteedWeather (wholly owned by the Japanese insurance group Mitsui Sumitomo) has entered into a partnership with NASA to employ satellite data for this purpose (Artemis, 2016b)

The paper concludes with the implications for agricultural government agencies and how agricultural support policies may be required to promote the use of weather derivatives in viticulture risk management. Indeed, the need for aggregation across an industrial sector and the potential role for government and non-government agencies is found to be a fruitful area of consideration (World Bank, 2016). The experience of the Canadian provincial crown corporation Agricorp Inc. with respect to weather contracts based on rainfall is detailed. Such governmental support may become increasingly important with the growing impact of climate change and the desire for a sustainable industry.

Detailed references not included as would exceed 2000 word count. Available upon request.