CATEGORY SIGNALING AND REPUTATION

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Abstract. We propose that category membership can operate as a collective market signal for quality when low-quality producers face higher costs of gaining membership. The strength of membership as a collective signal increases with the sharpness of the category boundary, or contrast. Our empirical study focuses on biodynamic and organic viticulture in Alsace.

1. Introduction

What do market categories communicate? Researchers have established that category memberships, via the labels attached to them, express signs of certain aesthetic or technical properties of products and producers. Studies of firm clusters, industrial segments, or cultural genres link conformity to category models with some form of appeal of the products and producers for an audience (Porac, Thomas, and Baden-Fuller, 1989; Zuckerman, 1999; Kennedy, 2005; Hsu, Hannan, and Koçak, 2009; Phillips and Kim, 2009; Ruef and Patterson, 2009; Kovács and Hannan, 2010; Negro, Hannan, and Rao, 2010a).

Category memberships also function as symbols, particularly as social identities (Tajfel and Turner, 1979). In this view, agents make investments in group membership for self-enhancement and develop orientations toward individual mobility from low to high status organizational groups, or seek social change to overturn a status order perceived as illegitimate (Rao, Davis, and Ward, 2000; Rao, Monin, and Durand, 2003).

In this study we propose a third role of category membership in markets: communicating collective market signals. According to theories of market signaling, some agents can signal their otherwise hard-to-observe quality and the audience can use the signal as a screening

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mechanism (Spence, 1973a, 1974). For an action to be a signal, the cost of producing the signal must decrease with increases in the agent's quality. Then a separating equilibrium can result where those who provide the signal have higher average quality.

Noise can affect the observability and interpretability of individual signals, particularly in markets with large numbers of producers and labels. We propose that *category* signals can, under specified conditions, identify otherwise-unobservable differences in quality in such settings and operate as *common signatures* in the interface between producers and the audience (Bacharach and Gambetta, 2001). This requires that (1) low-quality producers find it more costly to gain category membership and (2) the category has a sharp boundary, has high contrast in technical terms.

Signaling theories do not explicitly address why certain actions or claims come to be interpreted as signals. What matters is that the signal, however chosen, separates high- and low-quality producers in equilibrium. A focus on categories provides some analytic leverage on this issue. It seems likely that a history of high average level of quality of the producers whose performances are observed increases the likelihood that membership in the category gets taken as a signal of superior capability by the audience. In other words, category membership emerges as a signal similarly to how groups develop reputations (Tirole, 1996).

Our empirical study focuses on the use of two unconventional and categorically coded approaches to viticulture—organic and biodynamic, in the French region of Alsace. Following the codes for these categories requires higher capability and commitment (and higher costs of production) than conventional winemaking. Membership in either category therefore qualifies as a market signal of quality. In particular, many renowned wineries in the region follow the very unique ("bizarre" in the eyes of some) biodynamic approach, proposed by the Austrian polymath Rudolph Steiner in a series of lectures in 1924. His holistic view of farming, which builds on principles involving cosmic forces, is considered unique. His claim that "gnomes, undines, sylphs and fire spirits are actively involved in plant growth" (Steiner, 2003, 158) gives the flavor of this approach.

The biodynamic category arguably has higher contrast than organic winemaking for two reasons. First, its unique required practices (e.g., using cow horns and red-deer bladders to cure manure and yarrow blossoms in sprays for vineyards and compost) and the additional commitment these practices represent make biodynamicists stand out. Second, the organic

category has a fuzzy boundary due to the perceived overlap with another proto-category, "sustainable," whose adherents claim to be "nearly organic." This confusion lowers the contrast of the organic—but not the biodynamic—category. We surmise that membership in biodynamics sends a stronger market signal because of its high categorical contrast.

Our first hypothesis is that categories with higher contrast are more likely to emerge as signals of quality. This suggests a reputational basis for the biodynamic category but not the organic one as a collective signal. Our analysis of Alsatian wineries shows that higher-quality wineries have higher hazards of becoming biodynamic but not organic. The second hypothesis is that categories with higher contrast send stronger signals. We examine two market outcomes: critics' ratings and retail prices. We expect that wines will receive better ratings than organic wines when the evaluator can notice the producer's identity. Ratings by international critics tasting blind (who do not know the identity of the producer or its categorical affiliations) are more positive for wineries after they join either the biodynamic or organic category than before. A parallel analysis finds that ratings by prominent French critics who do know the producer's identity favor biodynamic over conventional wines but not so for organic wines. A final analysis of the American retail market similarly indicates price advantages for wineries using unconventional practices. Interestingly, these effects do not seem strong enough to also increase profitability.

We introduce a novel mechanism, collective signaling of quality, linked to category membership to appeal to critics and audiences. Our analysis adds to the existing literature on market categories described above. First, we bring attention to the position of a category in the market relative to other categories rather than examining the characteristics of a category in isolation. Audience members rely on certain market characteristics (technology, patterns of resource utilization, proximity, network ties, etc.) as seeds around which categorization might occur. Here, the idea of contrast suggests that the audience members will place particular emphasis on characteristics of members of categories with sharp boundaries.

We also suggest that signaling can emerge as an alternative means (other than displaying individual social identities) of conveying information about the characteristics of a group of producers. Signaling operates when the category boundary is less permeable, and so is distinguishable from the effects of mobility among categories. Producer quality is also stable, so signaling is distinguishable from the effects of social change. Our analysis of the role of

contrast finally suggests that a status ordering of categories is not required for categories to serve as signals of quality.

2. Theory

Market Signals. Producers and their offerings generally differ in quality. Information about quality tends to be asymmetric: a job applicant, a loan seeker, and a used-car seller tend to know more than the prospective employer, lender, and buyer. In general, both high-quality producers and audience members benefit from transmission of reliable information about quality. The benefits consist of material advantages such as higher prices. Other kinds of motivations also matter. For example, some producers simply take personal pride in the recognition of their offering as high quality.

Those possessing high quality face a problem: can they communicate their capability to the audience? This is where market signals come in. The signaling mechanism can address information asymmetry by yielding equilibria in which only high-quality producers find it worthwhile to invest in the signal. This requires that producing the signal is less costly for highly capable producers.[1] In Spence's job-market model, prospective employees can demonstrate their (potential) productivity by investing in education, which those of low potential find more costly (requiring more effort). Applications of market signaling consider investments made by individual agents: in economics, Spence (1973a,b, 1974); in biology, Zahavi (1975) and Grafen (1990); in political science, Jervis (1970), and in sociology Gambetta (2009). Connelly, Certo, Ireland, and Reutzel (2011) offer a comprehensive review of applications in management.[2]

The cost–quality relationship defines the key condition of the signaling mechanism, what Connelly et al. (2011) call signal *fit*. For a signal to be effective, it has to meet a second condition, *observability*—the audience must be able to detect and decode the signal. Many markets populated by a mix of high and low quality producers, for example such consumer goods as food and clothing, pose challenges to interpreting market signals. For instance, the presence of large numbers of producers makes the investments made by any one of them

[1] A signal does not need to but can be productive in the sense that adopting the signal improves performance. For a productive signal to operate effectively, the increase in productivity must be less than the cost of acquiring the signal (Spence, 1974).

[2] Our argument relates more directly to Spence's model than to others, particularly Podolny's 1993 status-signal model. Spence begins with quality differentials and derives signals; Podolny begins with the status signal and derives differences in quality.

more difficult to notice. Similarly, market labels can only provide summary information about a product or producer, making quality difficult to ascertain. Identifying quality also becomes complicated when names and labels of producers of different quality can resemble one another. Individual signals can lose their diagnostic power and the resulting equilibrium will be a pooling equilibrium (with mixes of high- and low-quality producers lumped together) rather than a separating one.

In some cases, *category* signals—collective signals associated with category membership—can still solve the problem of information asymmetry in the face of noise. The advantage of category signals comes partly from the fact that multiple producers can display the signal, which increases the visibility to the audience (Connelly et al., 2011). Political scientists make this argument about the efficiency of investing in industry associations for political action by individual firms; see, for example, Lohmann (1993). Because multiple producers use the same sign, collective signaling also enhances interpretability. The audience likely trusts conformity to a category more than idiosyncratic individual observables. For example, collective enforcement has more credibility than individual monitoring over one's own actions.[3] Social science accounts have long maintained that costly signs of group membership are correlated with intra-group cooperation and limited free-riding behavior.

Category Contrast. Properties of categories likely shape how category signals operate. In our interpretation, the matter lies in the hands of the audience and any number of properties might matter in any particular situation. Some of these properties are accidental and not subject to prediction. We narrow our focus to one that has proven to have predictive value: the sharpness of the category boundary.

The line of theory we follow ties the sharpness of the boundary of a category to contrast. High contrast means that category membership is nearly crisp: producers tend to be fully in or out. For example, brewpubs have higher contrast than microbrewers in the beer industry due to storefront location and visibility of the production equipment on site. This makes them easily observable by the public (Carroll and Swaminathan, 2000). More generally,

[3]Take a more specific example, the signal of compliance to fair-labor standards in the apparel industry. Nike and Reebok invested in factory standards in Indonesia that were superior to the local legal requirements. They hired auditors of the working conditions in their plants, but the audits were not accessible to outsiders. The companies gained credibility once they joined a coalition of other manufacturers, activists, and labor groups, which organized the audits.

contrast is defined as the average grade of membership in the category of the producers to which the audience applies a category label.

High contrast increases the likelihood that audience members use similar interpretive schemas for a category (Hannan, Pólos, and Carroll, 2007). When such agreement obtains, audience members will generally find that the producers to which others have assigned the label will also have observable features that fit their understandings of the category. Under such conditions, conformity to category schemas by those bearing the category label becomes accepted as natural, as taken for granted.

We suggest that categories with high taken-for-grantedness can support strong category signals. Category members will have highly similar observable characteristics and audience members will apply the label in very similar ways. When one member applies the label to a producer, then others will also likely treat it as satisfying the category code (Hsu, Hannan, and Pólos, 2011). The core of our argument is that (1) high-contrast categories are more likely than low-contrast ones to become market signals and (2) if membership in a category does serve as a market signal of quality, then the strength of this signal increases with the category's contrast.

Category Reputation. Models of signaling explain how signals can operate to separate agents of different quality. But the knowledge of what sending and receiving a message means plays a critical role also (Gambetta, 2009). These are matters of interpretation not intentionality. Agents need not know that their actions transmit a signal for the signaling argument to hold. How do certain messages become collective signals of quality?

Models of collective reputation propose one answer (Tirole, 1996; Levin, 2009). These models too assume imperfect observability of current and past individual behavior and quality, which introduces noise in the screening process of products or workers by buyers or employers. In such situations, individual reputations have limited value. However, individual agents can also belong to collective entities, groups in which members share personal relationships or interests.

In the models of Tirole (1996) and Levin (2009) the current quality of a group is partially observable over the market interface. At any time, group quality is simply the average quality of its members. The group's past quality, which Tirole defined as the "track record" of past generations of members, is its collective reputation. Individual members affiliate

with a group based on the advantages linked to its collective reputation. A bad reputation creates incentives for members to cut corners, because high quality would not be rewarded. Conversely, a good reputation produces incentives for striving for quality. When membership and past track record of the group are known, collective reputation conveys information about the average current quality of individual members.

The assessment of individual quality in the presence of collective reputations builds on the group's history. The reputation developed by group members influences individual behavior and predicts future behavior reliably. Of course, groups can include opportunists. But since individual advantages depend on collective reputation, groups with good reputations sustain discipline and opportunists tend to behave honestly or be excluded.

In the context of market categories, these models suggest that categories with high contrast can sustain reputations for high quality more successfully. Audience members can more easily come to agreement about meaning in the high-contrast case, as we discussed above. Such agreement facilitates monitoring and sanctioning if disputes arise. Monitoring becomes easier because high contrast means fewer producers have partial memberships of middling value; there is less gray area. Sanctioning is easier because what one audience member finds troubling will also trouble others when the audience agrees about meaning. These are the seeds of strong signals.

As we describe below, membership in a high-contrast category visibly indicates a group of producers known for consistently attaching great importance to the value of input factors and for being attentive to the conditions in which products are made. Such past investments shape expectations of quality (Kreps and Spence, 1985). In this fashion, track records can affect the emergence of membership in a high-contrast category as a signal of quality.

In sum, our argument proposes that a category with higher contrast can attract producers with a good track record and, accordingly, develop a reputation for high quality. When it is more costly for producers of inferior quality to gain membership, a category with higher contrast can emerge as a collective market signal. Additionally, the sharp boundary of the category–its high contrast—increases the strength of this signal.

3. Biodynamic and Organic Winemaking in Alsace

We now explore the potential analytic value of the notion of category signaling by delving into the case of Alsatian winemaking. Biodynamic and organic practices have spread rapidly in the region. In 1980, only one winery in the region was biodynamic and one was organic. By 2010 roughly half of the 142 wineries in our data had joined one of these categories (30 biodynamic and 44 organic). We find this development interesting because adhering to biodynamics and organics increases production costs considerably. It was not clear that the market would pay a premium for these wines or indeed if they would have more than a fringe market.

The biodynamic and organic categories are sets of practices and have rules of conduct, codes. What are these codes? The codes for both categories proscribe the use of fertilizers and pesticides. However, the biodynamic code subsumes the organic and goes further. It proposes a unified approach to agriculture that relates the ecology of the earth to that of the entire cosmos. Biodynamics sets itself apart from other agricultural systems, including organic farming, by its association with the precepts of anthroposophy proposed by Rudolph Steiner in the 1920s. His teachings propose that the farm is a living organism. Biodynamic farming prescribes the use of certain practices including use of a set of preparations to promote healthy soil and plant growth (Steiner, 2003), described in Table 1.

While organic agriculture has become fairly mainstream, biodynamic production remains more esoteric. Its colorful and mystical practices mark a very strong turn from the scientific winemaking of the New World. Especially conspicuous is the use of several fermented "preparations" as field sprays and compost inoculants. These preparations consist of plant parts or extracts stored in animal tissues that have been buried in the soil. For instance, the iconic Preparation 500 is made by filling cow horns with manure from lactating cows fed with biodynamic grains, burying them in the vineyard on the autumn equinox, and digging them up on the spring equinox. Farmers then make very diluted liquids by combining about one teaspoon of the cured manure with about 40—60 liters of water and stirring for one hour in a pattern that "dynamizes" it. The preparation is then sprayed on the vines in the descending phase of the moon. (Reliance on astral and lunar calendars for timing actions in the vineyard and the cellar is a hallmark of this approach.) Adherents believe that these

preparations stimulate soil cycling, promote healthy plant growth and optimal compost development, and have myriad other beneficial effects.

Microbiologists and biochemists report mixed evidence about the impact of biodynamic and organic methods. A study comparing organic and biodynamic vineyard treatments found that both improve soil quality over conventional cultivation, but soil parameters or tissue nutrients of the two nonconventional approaches do not differ significantly (Reeve, Carpenter-Boggs, Reganold, Yorkland, McGourty, and McCloskey, 2005). More recently, a comparison of chemical profiles finds that the three methods do not directly influence the biochemical characteristics of grapes and wines (Tassoni, Tango, and Ferri, 2013). If viticultural science tells us that these methods produce similar or no improvements, we reasoned that the romantic, unique imagery of biodynamics and its apparatus of precepts could still serve as the basis for a very distinctive identity in the market.

Winemaking Practices and Quality. Issues of wine quality arise at least at two levels. First, there is what might be called *abstracted quality.* Here the issues are mainly technical, including: is the taste clean and intense; are the acids balanced; how much minerality is detected; are flavor and aroma complex; are there off smells, tastes, or reduction? The second level concerns *contextualized quality.* Here the issues are more socially embedded and involve typicality and authenticity. They include whether the wine faithfully expresses the region's identity and tradition, the winery's *terroir*[4], and the winemaker's style.

Quality depends on hundreds, perhaps thousands, of decisions that are not observable to outsiders. These include: how much care was taken in pruning and canopy management; how much was yield controlled; whether the harvest was timed appropriately; whether the grapes were properly sorted; how cold soaking was conducted; how fermentation, racking, and filtering progressed; whether anything (acids, sugar, oak chips or fluids, coloring agents, and so forth) was added to the product; whether the wine was ultra-filtered or put through reverse-osmosis.

The producers know these facts; the audience does not. How a wine from a past vintage tastes can prove a useful guide for the audience to assess current quality. But, producers change practices all the time in response to changes in climatic conditions or technical

[4] *Terroir* is a somewhat mystical French notion that refers to the unique combination of geographical, pedological, and climatic characteristics of a certain land.

developments. Wine quality can only be assessed accurately in the act of consumption, and perhaps not completely (Nelson, 1970; Darby and Karni, 1973). This explains why critics have such importance as well as why information communicated through market signals has value for foretelling the quality of wines from new vintages.

Although quality depends on many actions and decisions that cannot be fully observed by outsiders, the members of the audience scan for signals (Gulati and Higgins, 2003). Wine critics are actively engaged in this role: they visit wineries and consultants, attend wine fairs and conferences, contact industry associations, and communicate with one another. Through these mechanisms, critics learn about producers and their category membership. Wine customers learn about wine in similar ways. However, they tend to have less knowledge than critics. For this reason, in wine like other mediated industries (film, music, art, stocks, etc.), the assessments provided by critics represent another source of information for the choices of final consumers.

4. Fieldwork

We conducted semi-structured interviews with *vignerons* from 23 wineries in 19 villages in Alsace in 2009 and 2010 from which the quotes in this section are drawn. The interviews allowed us to better understand the process of joining the biodynamic and/or organic categories. Because we knew less about them, we targeted more (14) biodynamic wineries. These interviews were extremely valuable in providing some insight into the core issues from the producers' perspective. They also help us understand the applicability of our theoretical argument to the empirical case.

Adopting Biodynamic and Organic Practices. We learned that the initial turn to biodynamic and organic production stemmed from a mix of intertwined reasons including making higher-quality wines that also better reflect the *terroir* and protecting the environment. Arguably, the experience of these dedicated producers provided a plausible connection between unconventional practices and quality.

Many winemakers observed that chemical herbicides and pesticides had killed organic life in the soil and had diminished wine quality. For instance, a winemaker in Turckheim focusing on the abstracted dimension said:

> "Chemical products and technology were a real miracle. They helped the growers a lot in reducing the amount of heavy-duty, physical work. It made it a lot easier, allowed the growers to do more vineyard stuff, so to be more productive, to lower the cost of a bottle of wine. Growers like my father were told 'this is new, it's modern, it works, it doesn't pollute, it's clean,' all the stuff you want to hear. It took years to realize that—Oh it was supposed to help me, but, in fact, I'm getting more and more diseases and more problems, and my soil has lost its fertility." (11/17/2009)

Many also suspected that the degradation of the vineyards had lowered the quality of the wine. For instance, a vintner in Beblenheim recalled:

> "I was thinking we were wrong—we should turn to a better agriculture. We were destroying what is the foundation of everything. I saw some vineyards, tasted some wines, and I thought what could help me get more harmonious wines, more complex wines? The wines we were producing before sold nicely, they had good reviews from Parker. But I found that I liked less and less what I was producing." (12/8/2010)

Others told us that they started to notice off-aromas in the wine, increasing heaviness, less minerality, and the loss of the ability of the wines to age properly.

The theme of contextualized quality also comes through strongly in our interviews, especially with biodynamic wineries. A vintner from Wintzenheim said: "... my objective is not to be biodynamic ... [but] to make the best wine from the place, from our soils, from our *terroir*. And the icing on the cake is that it's biodynamic ... because [this is] the more natural way to reach this goal." (11/20/2009) Another from Ammerschwihr agreed: "We have a great *terroir*... For us biodynamics ... really allows the *terroir* to express itself much better in the wine." (11/18/2009) And one from Epfig said:

> "*Terroir* is the key for great wines. There is no great wine without *terroir* ... that [biodynamics improves the expression of *terroir*] is why you move to biodynamics because you are convinced, because you have an environmental consciousness, but also you can come to biodynamics without any

environmental consciousness because biodynamics increases *terroir* in taste." (11/19/2009)

Costs of Category Membership. Organic and biodynamic practices impose higher costs than those they replaced. Adopting either method rules out the use of some labor-saving practices (e.g., the use of herbicides as a substitute for plowing). And, biodynamic production also imposes distinctive actions, such as spraying with the famous preparations and elaborate procedures of composting.[5]

In our fieldwork informants provided some information on this issue (unless noted otherwise all quotes come from the field interviews described above). One, from Wintzenheim, said: " [W]e earn less money than a conventional winery because we have 20% lower yields. We have 30% more handwork. In France, it costs a lot of money. So, for me to produce a bottle of wine, it costs at least 50% more. But we cannot charge 50% more." (11/20/2009) And a biodynamic winemaker from Turckheim told us:

> "It's not the organic and biodynamic estates that make the higher profits, because we have higher costs but the price of the bottle is not that much more expensive. An organic or biodynamic wine doesn't cost 40% or 50% more than a conventional wine at the same quality level, from the same area and in the same style. We are maybe less profitable ... I employ about seven more people per hectare than the average in the area ...for a bottle of wine my labor cost is several times higher." (11/17/2009)

One central issue for signaling is whether the cost of the signal is negatively associated with quality (Spence, 1973a; Connelly et al., 2011). We think that there are good reasons for thinking that this is the case here. Both organic and biodynamic category codes bring viticulture closer to the traditional craft of farming but impose discipline. Eschewing chemical pesticides requires great attention to the vineyard and skill in reacting to the appearance of pests. Wine-writer Kramer (2010, 117) argues the case for biodynamics in particular, which requires elaborate manual procedures and organizing by multiple natural cycles:

[5]Cole's fieldwork among Oregon wineries suggests that managing biodynamic vineyards costs 15% more than managing a sustainably farmed property and hiring a consultant can cost a thousand dollars per visit. Certification is a few hundred dollars, and applicants also pay a licensing fee of 0.5% on gross sales. Cole notes: "For the same price, organic certification sounds like a safer bet." (Cole, 2011, 58)

> "Biodynamic cultivation signals a willingness to pay extreme attention to vines and wines. Like driving a race car, if you take your eyes off the road—or in this case a highly vulnerable vineyard—an irremediable disaster can result. Ask any farmer: attentiveness is always a good thing . . . biodynamic processes are a form of discipline, some of which may actually work, while other practices may be more emotionally and psychologically sustaining to the practitioner than practical to the plant or wine."

Contrasts of Biodynamic and Organic Categories. Another central issue for signaling is the extent to which the audience can notice the signal (Connelly et al., 2011). Many consider the practices of biodynamic viticulture unique, which makes them highly salient. A winemaker from Wintzenheim, who joined biodynamics in 1996, said that many scoffed at these methods: "Early on, everyone was laughing at us. They were only waiting for us to have problems, to lose a harvest. But I knew what I was doing. I was sure. But these were hard times." (11/17/2009) Farming biodynamically is visible. Another winemaker said: "A neighbor. . . told me in Alsatian dialect, 'at your place, you really have grass for the rabbit.' I mean, for him it was dirty because you had plants, herbs, and flowers in the vineyard." (11/20/2009)

A leader in the biodynamic movement told us his reaction to a lecture by François Bouchet (who influenced many who converted to biodynamics): "I thought that's a fantastic thing. It's crazy, it sounds absolutely mad, but it was also quite fascinating and interesting." (11/17/2009) It is precisely the unusual quality of its practices that makes this category stand out, that gives it high contrast. Adhering to a category that demands use of peculiar practices and incurs ridicule, in addition to greater amounts of time investment, plausibly signals a commitment to quality.

Relatedly, the requirement of these practices means that organic production can represent one step along the way to becoming biodynamic. As a result, the movement of higher quality producers to biodynamic from organic will further lower the contrast of the organic category as biodynamic production becomes regarded as the end goal.

Second, a generic problem of organic foods is the lack of consistent interpretation of what is organic. Survey studies among European consumers suggest that non-conventional farming, particularly organic, is perceived as having benefits related to a series of values focused

around health, safety, and ethical soundness (Torjusen, Sangstad, Jensen, and Kjaernes, 2004). An international review that covers North America in addition to Europe draws similar conclusions (Yiridoe, Bonti-Ankomah, and Martin, 2005). However, the definition of organic recalls different labels including "green", "ecological", "environmental", "natural" and "sustainable" (Hutchins and Greenhalgh, 1995). This can lead consumers to choose products that do not in fact have the attributes implied by the label,and, as a consequence, it can lead to skepticism. In particular, in Alsace the contrast of "organic" is lowered by its perceived overlap with *lutte raisonnée* (loosely translated as the reasoned struggle), which might be called sustainable farming. This competing code specifies "minimal" use of herbicides and pesticides. In Alsatian winemaking, this alternative is promulgated by an association called Tyflo, which encourages: "...production of economically-viable high-quality grapes, giving priority to ecologically sound methods...in order to preserve the environment and human health" (Tyflo, 2011).

Theories of market signaling suggest that low-quality producers have an incentive to imitate market signals (Spence, 2002). *Lutte raisonnée* appears to us to imitate the signals of higher quality in the market. However, this imitation blurs the boundary and lowers the contrast of the "organic" signal. The organic producers face a problem: the practitioners of *lutte raisonnée* claim to be "nearly organic." Their presence on the scene, as well as the attempts by their industry association to legitimate their nearly-organic character, blurs the boundary of the organic category but, due to its sharper boundary, not the biodynamic one. Indeed "organic" and "sustainable" are often used interchangeably (Ministère de l'Agriculture, 2011; European Commission, 2012).

The claim to be nearly organic incites strong reactions towards *lutte raisonnée.* For instance, the director of a large organic winery in Riquewihr said: "I've never met somebody who's not at least *raisonnée.* Because if you are not, you are really a dirty bastard!" (11/19/2009) A biodyamicist from Epfig also objected: "*Lutte raisonnée*—it's a big lie. It's an invention from the classic agriculture to give a smoke screen about the real practice and to produce some confusion with real organic practice." (11/19/2009) Another from Pfaffenheim, said: "We should call it *pollution raisonnée.* The solution was to say we do *lutte raisonnée*—they are organic but we are *raisonnée,* it's almost like organic farming. That's not true! It has nothing to do with organic farming." (12/9/2010)

The arguments detailed above about category contrast lead us to expect that membership in the biodynamic category sends a stronger signal of quality than membership in the organic category in the Alsatian context. The next section explains how we seek evidence of signaling in critical ratings of quality and retail prices, and that differences in the critics' tasting methods allow us to isolate the role of the signal from confounding influences. We expect that biodynamic wines will receive better ratings than organic wines when the evaluator knows the producer's identity. We conduct empirical analyses to see whether this is the case. To be clear, we observed the main patterns in the average ratings by category before building models. The pattern suggested to us that a signaling interpretation might be warranted. This means that we cannot perform an independent test of the implications of the argument. At best, our empirical work speaks to the plausibility of the argument.

5. Statistical Analysis

In addition to the qualitative data from in-person interviews described in the previous section, our quantitative data come from three archival sources and a telephone survey.

The first archival source is Robert Parker's *Wine Buyer's Guide* (Parker, 1988–2008). Parker is widely regarded as the world's most influential wine expert (Hadj Ali, Lecocq, and Visser, 2008). The guide compiles scores for wineries on a five-star scale, where five stars indicate the highest rating, producers that "make the greatest wine of their viticultural region, and they are remarkably consistent and reliable even in mediocre and poor vintages" (Parker, 1993, 8). We constructed a time series of ratings from the seven editions of the guide.[6] Because of its focus on wineries of high quality, we use this source to understand generalized winery quality. Our main ratings analyses focus on the next two archival sources.

The second archival source is the U.S. publication *Wine Spectator*, arguably the most influential wine guide internationally. Its online database contains tasting notes for Alsatian wines from the issues of February 1987 through August 2010. WS conducts blind tasting: its tasters and editors do not know who made the wine or how much it costs when they assign

[6]We record the number of stars assigned to wineries for the vintages covered by the guides as follows: First edition (1988): 1981, 1982, 1983; Second edition (1990): 1984, 1985, 1986; Third edition (1993): 1988, 1989, 1990; Fourth edition (1995): 1991, 1992, 1993; Fifth edition (1999): 1994, 1995, 1996; Sixth edition (2002): 1998, 1999, 2000; Seventh edition (2008): 2003, 2004, 2005. Values for four intervening years (1987, 1997, 2001, and 2002) were linearly interpolated from the years immediately preceding and following. At the time of writing, Parker had not yet published an eighth edition; accordingly, we carried forward the ratings from the 2008 edition. The number of wineries rated grows unevenly over time from 38 in 1988 to 60 in 2008, reaching a maximum of 66 in the 1999 edition.

a score, but they do know some of the context including the vintage, appellation, and grape variety. Each editor generally covers the same wine regions from year to year, allowing lead tasters to develop expertise in a region. Other tasters might participate in blind tastings to help confirm impressions. However, the lead taster always has the final say.

The third source is *Le Guide de Vins de France*, curated by Gault et Millau, a sister publication to the well-known review of restaurants in France. Starting in 1984, GM published special bulletins with general notes on leading wineries and price information for a few selected wines, but no comprehensive ratings. These earlier editions provide us with winery-level information, particularly price levels and the number of bottles produced. From the 2003 edition, the guide provides comprehensive wine ratings. We coded label-level information in this and subsequent yearly editions through 2010. The GM guide has considerable influence in France. Wineries often highlight the ratings received from the guide in the "pressrooms" on their websites.

Beginning with the 2007 edition, GM tells about the viticultural practices of interest. However, we lacked such data for earlier periods. Accordingly, we conducted a telephone survey in 2010 with informants from all the wineries with wine ratings in either guides, a total of 155 wineries. We asked about viticultural practice, particularly biodynamics and organics. We obtained such data for 142 of the 155 wineries. Our informants also indicated when they began bottling, which we use to determine the time at risk of conversion. We used these data to code memberships in the two non-conventional categories. We code the distinction between organic and biodynamic production as mutually exclusive: "organic" means "organic-but-not-biodynamic" throughout. Because of the inherent ambiguity in adherence to sustainable, or *lutte raisonnée*, practices (with several producers claiming adherence and no strict method to ascertain these claims), we do not try to distinguish membership in the "sustainable" camp. These producers are part of the "conventional" category in all analyses.

When we analyze the hazards of becoming biodynamic or organic as a function of a winery's quality, we use three indicators of quality. The first measures the quality of resource endowments by the number of *grand cru*, the highest quality classification for a vineyard, in the wineries portfolio. The other measures are experts' assessments of the overall quality of a winery's products. One is Parker's overall ratings of wineries, described above. But, Parker can review wines using blind or open tastings, and these ratings likely reflect some

combination of quality and status (see footnote 14). As an alternative, we use the average of WS's blind ratings of a winery's products by vintage.

When we seek to understand how critics and consumer audiences respond to category signals, we follow previous studies and characterize such response in terms of ratings assigned by specialized critics and of prices in retail markets (Shrum, 1991; Hsu et al., 2009).

We first examine ratings based on WS's blind tastings, where category signals remain hidden. Members of the unconventional categories can receive similar evaluations to conventional producers if the intrinsic quality of the product does not change, or better evaluations in these tastings only to the extent that they put more discipline into their work, i.e., the investment in the signal is productive. One category will receive higher ratings than another only if its practices improve on the other's.

We also examine ratings from GM's non-blind tastings. Here, the taster knows the identity of the producer but not the wine's price. When the evaluator knows producers' identities, the category schemas enter directly in evaluations. One such schema is what wine journalist Kramer (2010, 39) calls site deference: "less about where great wines come from and more how they are from." Knowledge of the context of production can shape perceptions of a wine as different. This is where biodynamics stands out more sharply due to the high contrast owing to the philosophical framework, the unique practices. The potential confusion of the boundary of organic methods created by the claims of the "sustainable" producers also plays a part in making the identity of biodynamics more distinctive. Arguably, the blind tastings incorporate the abstracted quality dimension we described above. The non-blind tastings can also feature the contextualized dimension more explicitly.

The GM guide presumes that its audience cares about the categories we are studying. It categorizes wineries as conventional, organic, or biodynamic. Given our emphasis on the distinctiveness of biodynamics, we find it interesting that it chose to symbolize organic wine with a generic leaf and biodynamic wine with a more distinctive crescent moon.

We treat the difference in tasting method as providing a unique opportunity to distinguish more clearly the effects of category memberships. Inference depends on the counter-factual assumption that blind tastings by GM would provide the same patterns of association as recorded from the blind WS ratings. In general, we cannot verify that this is the case; and our conclusions are therefore conditional on this assumption. However, we conducted

additional analyses to validate our analytic strategy by using a smaller sample of ratings data of blind and open tastings drawn from another archival source. These and other tests of the robustness of the ratings results are described in the next section.

We also examine retail prices in the American market using WS data. Categorical signals can affect prices in two ways, directly via audiences' interpretations of the categories and indirectly via critical evaluations. Consumers have less domain knowledge than specialized critics. In the wine world, thousands of labels compete in the marketplace. Because clear and simple information has great value for consumers, signaling ought to operate in their market as well.

6. Results

Quality and Category Membership. How does quality affect the choice to adopt biodynamic or organic practices? We address this question by estimating the effect of a variety of measures of winery quality on the hazard of joining the two categories during the period ranging from 1981, the first year of available winery scores from Parker, through 2010.[7]

We use lagged values of the three measures of each winery's quality discussed in the previous section: number of *grand crus*, Parker's ratings, and WS ratings.[8] We control for the size of the operation, measured as the number of bottles produced (in thousands) using data from the GM and WS and the telephone survey, and calendar year (set to zero in 1981), which controls for time effects including trends in the wine market. We include a left-censoring dummy equal to one for wineries in operation in 1981. The model analyzing the hazard of joining the biodynamic category includes a control for whether the winery had already become organic (six had done so); no winery moved the other way.

The strong and consistent finding is that the hazard of adopting biodynamics increases with winery quality (Table 2, columns 1–3). The effect of quality on the biodynamic hazard is positive and statistically significant for all three measures. In contrast, the effects of

[7]Only one winery started using biodynamic methods before the start of the study period (in 1969) and one started using organic methods before the start of the study period (in 1970). We excluded both from the analysis of changes in categorical membership. Our informants suggested to us that these early conversions were somewhat unusual. The very first biodynamicist in the region was said to have converted because he had been poisoned by pesticides. One vintner in Pfaffenheim recalled "he was blind for a week. He couldn't see anything and so he said to himself, 'I will no longer work with such products'." (12/09/2010)

[8]In additional analyses, we included shared frailties in the same model specifications to correct for unobserved winery characteristics. The patterns we found are similar to those reported, while the frailty parameters did not reach statistical significance. For ease of interpretation we present estimates without such corrections.

winery quality on the hazard of joining the organic category are negative but not statistically significant (Table 2, columns 4–6). So on average the biodynamic wineries had high quality when they joined, but this was not the case for the organic category.

These estimates show that the rate of joining the biodynamic category increases with the average levels of pre-membership quality. Producer quality thus can provide a reputational basis for the biodynamic category signal, in the sense that high quality before joining the category can be associated to the schema for biodynamics. The members of the audience can infer that producers that will join the category will also have high quality if they can signal their membership. The difference in prior quality made membership in the biodynamic category more likely to become a category signal than membership in the organic category, issues of contrast aside. This makes it imperative that we control for track records of quality in analyzing the effects of category membership on ratings and prices.

In unreported analyses we examined whether joining biodynamics becomes more prevalent as the practice proliferates. In hazard models with interaction terms between the three quality measures and the time trend, we do not find the effects of winery quality to vary significantly over time. We think these results reinforce our interpretation of the reputational basis for efficient category signaling. In markets where both high and low quality producers operate, if high quality producers join a category early on, the information conveyed by the track record of numerous high quality producers is consistent, and the signalers will succeed at having their quality signaled (Connelly et al., 2011).

Effects on Critical Evaluations: Levels. We analyze the ratings assigned to wines by GM and WS for the vintages from 1981 through 2008 (the most recent vintage covered by the publications at the time of writing). The analysis includes ratings of all dry white wines and excludes sparkling wines and red wines because they differ substantially in production processes and only a small fraction of the high-quality producers make them. The dataset generated from the two publications comprises 4,715 ratings from GM and 3,775 ratings from WS. The dependent variable is the critical rating of a wine on a 100-point scale.[9]

[9]WS used a 100-point scale throughout. GM used a 100-point scale until 2007, then switched to a 20-point scale. For comparability we converted the latter to the 100-point scale. The median score is 87 for both GM and WS, and the fraction in the upper range is similar: the top ten percent of wines receive a score of 90 or higher in GM and 91 or higher in WS. The publications differ somewhat in the lower range distribution: the value of the first decile in the GM ratings is 73 and 80 in WS.

The controls include dichotomous variables that identify wines made from old vines, *vieilles vignes* (VV), and *vendange tardive* (VT) or *selection grains nobles* (SGN) wines, two types of late-harvest wine. We include the lagged star rating in Robert Parker's guide to measure a winery's vintage-to-vintage variation in quality and status. Alternatively, we include lagged scores in WS and GM ratings to control for variation at the level of the specific wine. All specifications also include a linear time trend and fixed effects for vintages, as well as for the grape varieties from which Alsatian white wines can be made, and for each of the 51 *grand crus,* the sites judged by the French authorities as producing exceptional wines. Finally, we include the predicted hazards of becoming biodynamic and organic obtained from the hazard analysis to address endogeneity concerns for the time-varying propensity to commit to unconventional methods. Thus we control for various forms of heterogeneity among wines ands wineries.

We take advantage of the difference in the method of evaluation used by the two sources to address two questions. First, are the categories productive? That is, do category members receive different evaluations on average from those who practice conventional winemaking when the evaluator does not know either the identity of the producer or its categorical membership? Second, do the results of non-blind tastings and blind tasting diverge as our argument suggests, such that the returns in ratings are substantially higher for biodynamics than for organics in non-blind tastings as compared with blind tastings?

We explore the productivity question by analyzing the (blind) WS ratings. In both analyses we control for persistent differences stemming from endowments and winemakers' skills in analyzing ratings by examining only *within-winery* variation over vintages. That is, we use fixed-effects at the winery level. This lets us examine the effects of changes in practices; we compare a producer's ratings after joining biodynamics or organics to its ratings before.

We see in the estimates of column 1 in Table 3 that WS ratings rise significantly after a winery becomes *either* biodynamic or organic. In these analyses, we can separate whether signal observability has separate effects from signal credibility (communicating a signal honestly) (Connelly et al., 2011). Formal certification can serve as a measure of credibility. As one would expect, formal certification in either category does not matter in the blind evaluations (column 2 in Table 3). We cannot reject the null hypothesis that the effects of

the two category memberships are equal ($X^2 = 0.13$, p = 0.72 with 1 df). Adopting the practices consistent with either category is productive—improves quality, but apparently not differently so.

Overall, this pattern conforms to the notion that membership in both categories can potentially serve as a categorical signal of quality. Moreover, these estimates suggest that critics and consumers do *not* have a "real" basis for preferring biodynamic over organic wine, at least according to the aesthetics of the WS tasters. Below we discuss supplementary tests conducted on blind tastings of another French publication, which shows that critics may not have a basis for preferring non-conventional wines in general.

We turn now to our second hypothesis: does category membership convey a signal of quality? We explore this question by comparing effects of the category memberships on the (open) GM ratings and the blind WS ratings. That is, we compare the effects of categorical memberships in columns 1 and 3 (and 2 and 4) in Table 3. We see that the effect of biodynamic production is again positive and significant; indeed the magnitude of this effect is nearly double that estimated from the WS blind tastings.[10] Moreover, the effect of organic production is much smaller. Indeed, the organic effect is negative for the GM ratings. We see in column 4 that certified membership in biodynamics seems to amplify the positive effect for this category for the GM ratings. This pattern agrees with our expectations based on considerations of category signaling and contrast.

Our argument does not predict that the organic effect would be significantly negative in non-blind tastings. The effect is not stable in the subsequent analyses. In the Discussion section we speculate about what this might mean.

Effects on Critical Evaluations: Dynamics. It is natural to wonder whether the effect of converting to either set of practices remains stable over time. We address this issue by estimating dynamic models for ratings. We do so by including lagged ratings as covariates, which converts the specifications we have used to this point to growth models—see Tuma and Hannan (1984, Part III). (The lagged rating is not available for a wine's first entry into the data, and so the number of cases and of wineries drop.)

[10] In additional analyses not reported for brevity, we found no evidence that membership in the biodynamic category has a stronger effect for lower quality members, as would be the case if there were a simple status spillover mechanism at work.

Here we face another choice on what variation to analyze. If we continue with fixed-effects for wineries, we will learn how ratings change after conversion as compared with before. But the audience is not static. So it seems more interesting to compare patterns of changes in ratings between those who change memberships with those who do not. This means analyzing both within- and between-winery variation. We do so using the method of generalized estimating equations which report average differences adjusted for values of covariates (including lagged dependent variables).[11]

Biodynamic membership has a significant positive effect on the change in WS ratings, but organic membership does not (Table 4, column 1). This suggests the presence of general and continuing gains in quality from biodynamics linked to vineyard and cellar management.

For GM ratings (column 2 in Table 4), the effect of biodynamic membership on change is again positive and significant; but the effect of organic membership on change is negative and not significant. Moreover, formal certification as biodynamic amplifies the effect of category membership.

These estimates imply that quality ratings of biodynamic and organic wines continue to diverge and that the difference becomes greater with the continued use of the two sets of practices. Moreover, some of this pattern appears to arise from category signals, because the positive effect of use of biodynamics on change in ratings is much larger in open tastings (GM) than in blind ones (WS). In other words, the strength of the category signal increases over time. This seems plausible because the confusion effect of the sustainable category has likely intensified as the size of its membership has grown.[12] In line with this result, in the hazard analysis we also do not find changes over time in the rate of joining biodynamics for high quality producers.

So the categorical signals differ substantially, as predicted. The critics usually know the categorical memberships, so the signals work even when the winery does not seek and receive formal certification. There is some evidence that getting such certification amplifies the signal for critics.

Additional Tests on Ratings. One can wonder if our findings hide specific differences between the rating sources or their rating systems. One way in which we could support

[11]This method provides high-quality estimates of average effects that do not depend on the distribution of the unobservables (Zeger, Liang, and Albert, 1988).

[12]Tyflo began in 1997 with 20 members; the membership had grown to 71 in 2012 (Tyflo, 2011).

our argument more convincingly would be to find a single source that rates wines blindly and non-blindly. Typically, critics rely on a single methodology to rate wines, which makes such a concern challenging to address using archival data. However, we did locate another influential French wine critic, the *Revue du Vin de France*, which adopts a mixed tasting method. The *Revue* publishes an annual guide with ratings obtained from open tastings, but it also conducts special tastings and publishes a monthly magazine and a second guide of lower priced-wines with ratings from blind tastings. Using their online archive, we identified 385 white wines from Alsace that were tasted twice, once openly and once blindly.

In Table 5 we report estimates of the ratings—measured on a 20-point scale—of the wines from the *Revue* data. As in Table 3 the model specifications include the main covariates of biodynamic and organic category membership and controls for wines made from old vines, late harvests or selected grapes, Parker's winery rating, a linear time trend, and the predicted hazards of becoming biodynamic and organic. The limited sample size does not allow us to add the fixed effects for vintages, varietal and designated growth places simultaneously. We include them stepwise. Column 1 reports estimates from the the blind ratings, column 2 the non-blind ratings, and column 3, the non-blind ratings where we add the blind rating as an additional regressor. In this way, the effect of the signal ought to be isolated from the intrinsic features of the product (Negro and Leung, 2013). Columns 1–5 include an additional dichotomous control for whether the wine comes from *grand cru* sites. Columns 4–6 add the fixed effects for vintage, varietal, and vineyard.

In column 1, where the signal is hidden by blind tasting, neither organic nor biodynamic status has significant effects on the rating. The difference in the effects for the two categories is also not statistically significant ($F = 0.40$, $p = 0.40$). In model 2, where the tasting is open and the signal discernible, wines of biodynamic wineries receive 1.4 higher ratings than conventional wines. The effect is statistically significant and holds in the next specifications, in which we include the blind rating of the same wine as an additional regressor (column 3), and when we add fixed effects for vintage (column 4), varietal (column 5), and vineyard (column 6).

These supplementary analyses confirm the pattern of results we first presented above. Wines made by producers in the biodynamic category receive higher ratings than conventional wines in open tastings, while wines made by organic producers do not. The fact that

the wines made with unconventional methods do not have higher ratings in blind tastings might be surprising. As one reviewer suggested, each critic might have a different taste. The productivity of the signal, however, is not essential to the signaling argument (see, Spence (1974, 21)). More importantly, the effects of the biodynamic category signal are consistently positive.[13]

Effects on Retail Prices. How does category membership affect the general audience and the market? We gain some insight on this question by analyzing retail prices when the wines first appeared on the American market. Unlike the critics, the consumer audience likely does not know about actual practices but can easily learn about certification from widely posted lists of membership, from wine labels, and from guides such as GM, Hachette, and others. So we expect that certification will matter to American consumers. Including this analysis on retail prices allows us to understand the effect of biodynamic and organic practices in the supply and demand dynamics of the consumer market.

WS collects price information from retailers and producers. We adjusted nominal prices for inflation dividing them by the consumer price index (1982 = 1). The distribution is skewed to the right so we use the natural log transformation as the dependent variable. The modeling strategy follows closely that used to analyze critical ratings. One difference is that we add a control for critical scores obtained from WS to account for the impact of quality

[13]One reviewer also wondered if the observed effects might be driven by cultural differences between American and French critics, for example the Americans like organics, and the French like biodynamics and/or dislike organics because the Americans like it. We collected additional ratings on Alsatian white wines from two sources, the *Hachette* guide in France, and the *Wine Advocate* in the US. *Hachette* uses blind ratings. On the *Wine Advocate*'s website (http://www.erobertparker.com/info/legend.asp), founder Robert Parker states: "When possible all of my tastings are done in peer-group, single-blind conditions." Although this claim has been questioned, Parker explicitly describes two exceptions to tasting blind: "all specific appellation tastings where at least 25 of the best estates will not submit samples for group tastings," and "all wines under $25." While the first condition is difficult to control for using the review data, the second is more tractable, and we coded the ratings for wines priced less $25. In analyses unreported for brevity we modeled the wine ratings of the *Hachette* and *Wine Advocate* data. *Hachette* uses a 1-to-4 star rating system, and *Wine Advocate* a 100-point scale to rate wines.The specifications followed those in Table 3 of the paper. One exception is the exclusion in the *Wine Advocate* sample of the late harvest dummy—late harvest wines are normally more expensive, and the publication did not review any wines below the $25 price point. For *Hachette*, the estimates show that the biodynamic and organic categories do not have significant effects on the ratings. The difference of the effects is also not statistically significant ($F = 0.34$, $p = 0.56$). For *Wine Advocate*, the ratings are higher than those of conventional wines for biodynamic wineries but not so for organic ones. The difference between the two coefficients of the two nonconventional categories is statistically significant ($F = 6.01$, $p = 0.01$). These findings confirm the pattern of the main analyses as well as the supplementary tests of Table 5. Although the *Wine Advocate* data are somewhat less representative than the other samples, national differences between French and US critics do not seem to confound the effects of category signaling.

of the focal wine on prices. Due to missing prices for some wines, the final dataset covers 3,545 wines from 96 wineries.

Biodynamic and organic wines garner higher prices than conventional wines, net of the effect of WS ratings (column 1 in Table 6). The effects of the two memberships are nearly equal. Formal certification also affects prices significantly, positively for biodynamic and negatively for organic wines in the American market (see also Delmas and Grant (2011)). This pair of results also supports our interpretation of the situation. The stronger signal comes from membership in the category with higher contrast. The price regressions control for Parker's winery ratings and the WS rating of each wine. The estimates indicate that the status accorded to a winery by Parker significantly increases prices in the U.S. market, as does quality measured in blind ratings. Again, the category effects hold net of these factors.

The estimated effect of biodynamic membership (Table 6, column 1) implies that the expected retail prices of biodynamic wines rise 8% after conversion. Taking account of the indirect effect on prices through the effect on ratings, the combined effect implies an increase of roughly 11%. The anecdotal evidence we collected suggests that conformity to the biodynamic codes increases a winery's operational costs by at least 20%. The increase in prices barely goes to repay the associated higher costs of producing the categorical signal. Consistent with what our informants said, biodynamic practice likely reduces profits at least in the short run.[14] We suggested that winemakers value long-term gains in productivity, sustainability, and/or emotional benefits that are not reflected in current prices.

7. Discussion and Conclusion

Many highly regarded Alsatian winemakers broke ranks with the highly technicized modern approach to winemaking and adopted the seemingly irrational practices of biodynamics without receiving a negative reaction in the market. Our effort to explain the pattern led us to think of category memberships operating as market signals. This conceptualization requires attention both to costs of membership and to category boundaries. Theories of market signals emphasize that signals provide information about quality (in equilibrium) when the costs of producing the signal fall with the producer's quality. When the signal

[14] In markets like these where competing producers sell differentiated products, (1) changes in prices that are proportionate to changes in costs and (2) stationary demand curves, i.e., firms are moving along the same downward sloping demand curve and not switching curves, result in decreasing profits (Dixit and Stiglitz, 1977). Because the elasticity of demand exceeds one, revenues as well as profits are lower.

comes from membership in a social category, the strength of the signal increases with the contrast of the category.

We think that the conditions for category signaling hold in Alsatian winemaking. Biodynamic and organic methods are costly, but more costly (and risky) for less capable wineries. However, the biodynamic category has higher contrast than the organic one due both to its many strange practices and lack of overlap with the "nearly organic" *lutte raisonnée*. So biodynamics, because of its crisper boundary, sends a stronger positive signal of quality than organic production.

Because critics and consumers see high-quality producers move to biodynamic production in the first place, the subsequent higher quality of biodynamic producers can operate as a "self-confirming belief": incoming data in a feedback loop confirm the quality signal (Spence, 1973a). However, the difference in reactions to organic wines in blind and open tastings seems striking, especially given that the GM guide (the source of the open ratings) professes a commitment to supporting "natural wines." This difference in blind and non-blind reviews for these two costly categories is interesting precisely because it suggests that the signaling power of the high-contrast biodynamic category matters more to reviewers than that of its organic counterpart.

In some analyses of blind tastings we find a negative effect of organic membership. Why? A first explanation for the divergence in the effects of organic viticulture on estimates of quality in blind and non-blind tastings points to a category-reputation effect. But this would not have an obvious basis from our research. The hazard of adopting biodynamics was significantly higher for higher-quality wineries, and we did not find that the hazard of adopting simple organic production was significantly lower for the higher quality wineries. The effects of winery quality are negative but small and insignificant. If the pattern of findings about membership and critical ratings reflects only a reputation effect, then we would expect to find that the wineries that went organic were substantially lower in initial quality, which we do not.

Another explanation for the negative effect of organic methods involves a negative valuation in wine markets (see, for example, Asimov (2012)). In fact, organics tends to be regarded with favor in the wine world. Consumer research shows that organic food is perceived as healthy and safe (Torjusen et al., 2004; Yiridoe et al., 2005). An online survey

indicates that the majority of American respondents who had tasted organic wines had a positive opinion of their quality (Delmas and Grant, 2011). The French government and the European Commission also explicitly favor the use of organic practices and define them as "good for nature and good for consumers" (European Commission, 2010). The Gault et Millau publication, from which we culled our data, champions wines that are as close to natural as possible, and put organic in this group of "real" wines (in 2010 the editors published a guide focused on organic wineries). Finally, the effects we report are largely cleansed of fixed winery characteristics.

Nonetheless, organic winemaking, which emerged before biodynamics, might have gained an initial poor standing in the French market. Several organic and biodynamic winemakers told us that they did not indicate their category membership on labels and did not want their wines to be sold in wineshops that specialized in organic wines, because they judged that some of the wines on offer in those shops were of low quality. The winemakers worried about spillover effects of reputation.

What does this mean for the interpretation of the greater positive effect of biodynamic production in non-blind tastings as compared to blind tastings? Is this evidence of a simple category-reputation effect that does not depend on market signaling (the costs of membership being inverse to quality)? If organic and biodynamic viticulture are roughly non-productive or equally productive (as we see in the static analysis of WS ratings), the initial differences in category reputations would tend to weaken over time. But our estimates of the dynamic specification tell that the gap judged from blind tastings is growing over time. Taking account of lagged ratings, biodynamic wines—but not organic wines—improve significantly in quality over vintages. This suggests that the strength of the market signal of biodynamic wines relative to organic ones is not fading, it is increasing. We view this pattern as one that suggests that market signaling at the category level has been at work.

A third explanation also depends on perception of organic viticulture but involves confidence beliefs. Agents typically make choices by focusing on the strength of the available evidence (Griffin and Tversky, 1992). Membership in the biodynamic category sends a strong signal, one consistent only with a hypothesis of high quality. The signal has high diagnosticity. Membership in the organic category as a signal lacks such strength because it is compatible with multiple hypotheses, including low quality. Pragmatically, critics aim to

make judgments they will not regret. Then, the low diagnosticity of this category membership can generate under-confidence in the evaluation of offerings.

The surprising devaluation of organic wines by GM does not find a parallel in prices on the U.S. retail market. Consumers can, of course, learn which wines are organic and biodynamic (some list their category certifications on labels, others indicate their practices on their webpages, and the American wine press has extensive coverage of the move toward "natural" wines). And importers and distributors can take these views into account in setting retail prices. If organic wines have a poor reputation globally, then prices on the American market ought to reflect this. But they do not.

A final account involves aesthetic perception, rather than valence or beliefs. Our research design capitalizes on the difference in method of evaluation of different critics. In the main analyses, one tastes blindly and the other knows the identity of the producer at the time of tasting. We attribute differences in patterns of association from the two critical sources as reflecting only the difference in method. In other words, we rely on the counterfactual that the two sets of critics would produce the same pattern of association if they both used blind tastings. We cannot evaluate the plausibility of this counterfactual using these samples, and only replications can tell whether the process we identify empirically is robust.

In supplementary analyses we attempted to conduct such replication. Data from the *Revue du Vin de France* let us compare blind and non-blind ratings from the same source, and establish two findings. In blind tastings organic and biodynamic wines receive ratings like those of conventional wines; in non-blind tastings, we find higher ratings for biodynamics similar to the GM data, while the penalty for organic wines disappears. These results reinforce the signaling interpretation, but also underscore that the critics might diverge in their evaluations.

The effect of signaling can interact with taste. Although different members of the audience can interpret a category signal with high contrast as a mark of quality, taste preferences can generate variation in actual appeal. A critic like *Revue* might be less sensitive to the schema of site deference, an important component of the biodynamic identity. This would imply some advantage for biodynamic wines while other categories like organic could not attract enough attention. A critic like GM might put more weight on the schema, and biodynamic wines would receive significantly higher ratings, while organic wines would be viewed as

their poor copies and, as such, unappealing. This interpretation fits with the overall pattern of results in our analyses, and future studies can study more closely if category effects, individual attributes, and the market context explain variation in audience responses to signals or category membership in general. In both cases, we restate, the high contrast signal is strong enough to be noticed.

Processes involving concepts and categories have received much recent attention in several branches of sociology and organizational studies. In studies of markets, research now conceptualizes the dynamics of the interface of producers and audiences in these terms (Zuckerman, 1999). Work on institutional fields, organizational forms, product classification systems, and social movements have been enriched by attention to categorical dynamics (for reviews, see DiMaggio (1997); Benford and Snow (2000); Hannan (2010); Negro, Koçak, and Hsu (2010b)). This line of work shows that category boundaries are construed and controlled by the perceptions of audience members and that category-based processes have significant impact on market outcomes.

Our study on category signaling establishes three general connections to this literature. First, the signals conveyed by category membership help overcome information asymmetries that challenge the audience in screening producers of different quality. Second, membership in categories with sharper boundaries produces a more effective indicator of quality in the presence of multiple signals. That is, holding constant prior quality, a high-contrast category has a higher probability of emerging as a market signal. Apparently unproductive actions indicating category membership do not affect the quality of a producer's output. But, they can shape perceptions of the producers' identities that signal quality, according to our interpretation. Third-party certification agencies and critics, who often meet with producers one-on-one, can monitor active participation and valid membership in this distinctive category. Thus, the category membership itself can provide a monitoring mechanism for the quality signal. Third, the histories of category members link signals to quality when the audience observes actions not readily understood as requiring high capability.

Some treatments of signaling generally stress intentionality: producers want to signal their quality and take actions accordingly. Like the theory's original account, which argues that signals operate "by design or accident" (Spence, 1974, 1) we do not make such strong

reliance on intentions. What matters is that audience members come to associate quality with a practice that is hard to imitate for low-quality producers.

The examination of multiple dimensions of producer identities, individual and collective, seems a fruitful avenue for future research. Another area to explore concerns the link between the structure of market categories and trust beliefs in the audience. Our findings suggest that category memberships can signal quality when other observables cannot. Categories with sharp boundaries perhaps play a role in judging trustworthiness, even when the features that make a category distinctive are impractical and hard to decipher and when exchanges are not based on personal relationships between producers and audience members. We hope that our study provides ground for new work on these questions.

TABLE 1. Codes of biodynamic and organic farming.

Biodynamic & Organic
Excludes chemical fertilizers
Excludes growth regulators
Excludes GMOs
Avoid risk of pesticide drifts from neighboring farms
Long-term plan for maintaining soil fertility
Monitoring suitable cleaning measures
Biodynamic only
Philosophical motivation
Observation of lunar and other cosmic rhythms for crop cultivation
Create biodiversity in the field
Moderate or no use of SO2
Manual harvesting
Manual selection
Preparations:
500 Cow manure buried in cow horns in the soil over winter
501 Ground quartz buried in cow horns in the soil over summer
502 Yarrow flowers buried sheathed in a stag's bladder
503 German chamomile flowers sheathed in a cow intestine
504 Stinging nettles buried in the soil in summer
505 Oak bark buried sheathed in the skull of a farm animal
506 Dandelion flowers buried sheathed in a cow mesentery
507 Valerian flower juice sprayed over or inserted in the compost
508 Common horsetail made either as a fresh tea or fermented liquid manure applied to the vines or to the soil

TABLE 2. Winery quality and the hazards of becoming biodynamic and organic (ML estimates of constant hazard models)

	Effect on the hazard of becoming:					
	Biodynamic			Organic		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	−7.27*	−8.20*	−23.6*	−8.58*	−8.53*	−3.76
	(0.870)	(0.790)	(7.61)	(0.773)	(0.773)	(5.52)
Number of *grand crus*	0.612*			−0.105		
	(0.124)			(0.231)		
Parker winery rating		0.318*			−0.065	
		(0.105)			(0.104)	
Mean WS rating			0.205*			−0.074
			(0.078)			(0.062)
Bottles produced	−0.002*	−0.002*	−0.002*	−0.0001	−0.0001	−0.0004
	(0.001)	(0.001)	(0.001)	(0.0002)	(0.0002)	(0.0004)
Left censoring	0.422	0.705	0.025	−0.481	−0.487	0.028
	(0.392)	(0.396)	(0.615)	(0.342)	(0.344)	(0.592)
Year trend	0.063*	0.086*	0.079	0.133*	0.133*	0.175*
	(0.023)	(0.020)	(0.052)	(0.021)	(0.021)	(0.061)
Already organic	2.74*	2.53*	2.13*			
	(0.389)	(0.400)	(0.618)			
Log pseudolikelihood	−37.1	−41.6	−4.00	−59.8	−59.8	−7.9
Number of observations	3790	3790	592	3813	3813	632
Number of producers	142	142	82	142	142	83

Notes: $^*p < .05$; standard errors adjusted for clustering on winery in parentheses.

TABLE 3. Effects of category membership on ratings from blind tastings by Wine Spectator and non-blind tasting by Gault et Millau (OLS estimates of winery-fixed-effect regressions)

	Wine Spectator		*Gault et Millau*	
Variable	Model 1	Model 2	Model 3	Model 4
Constant	87.0*	87.0*	91.1*	90.9*
	(2.35)	(2.35)	(6.05)	(6.04)
Biodynamic producer	0.706*	0.732*	1.30*	1.30*
	(0.232)	(0.249)	(0.444)	(0.444)
Organic producer	0.860*	1.148*	−2.18*	−2.06*
	(0.410)	(0.449)	(0.420)	(0.423)
Biodynamic certification		−0.123		1.83*
		(0.308)		(0.594)
Organic certification		−1.38		−0.654
		(0.826)		(0.762)
Parker winery rating	−0.018	−0.019	−0.171	−0.170
	(0.080)	(0.080)	(0.103)	(0.103)
Old vines (VV)	0.243	0.239	0.131	0.135
	(0.353)	(0.353)	(0.324)	(0.323)
Late harvest (VT or SGN)	2.40*	2.39*	0.667*	0.658*
	(0.211)	(0.211)	(0.226)	(0.225)
Year trend	0.011	0.18	−0.538*	0.541*
	(0.089)	(0.089)	(0.223)	(0.233)
R^2 within	0.279	0.280	0.437	0.439
Number of observations	3775	3775	4715	4715

Notes: $^*p < .05$; standard errors (adjusted for clustering on winery) are in parentheses. The specifications include predicted hazards of becoming biodynamic and organic, and fixed-effects for varietal, *grand cru,* and vintage.

TABLE 4. Effects of category membership on changes in critical ratings (GEE estimates)

Variable	*Wine Spectator* Model 1	*Gault et Millau* Model 2
Constant	86.2*	85.9*
	(10.7)	(39.3)
Biodynamic producer	0.848*	1.79*
	(0.210)	(0.530)
Organic producer	0.297	−1.13
	(0.443)	(0.586)
Biodynamic certification	0.028	1.85*
	(0.265)	(0.827)
Organic certification	−1.39	0.297
	(0.744)	(1.20)
Wine WS rating	0.136*	
	(0.014)	
Wine GM rating		0.269*
		(0.020)
Old vines (VV)	0.370	0.126
	(0.393)	(0.449)
Late harvest (VT or SGN)	2.57*	0.203
	(0.202)	(0.355)
Year trend	0.427	−1.22
	(0.405)	(1.51)
Wald X^2	1592	2182
Number of observations	2413	2557
Number of producers	71	113

Notes: $^*p < .05$; robust standard errors are in parentheses. The specifications include the same fixed effects and covariates as in Table 3.

TABLE 5. Effects of category membership on ratings from blind and non-blind tastings by *Revue du Vin de France* (OLS estimates of winery-fixed-effect regressions)

	Blind		*Non-Blind*			
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	16.6*	14.2*	11.1*	19.2*	10.6*	10.5*
	(0.663)	(0.551)	(0.949)	(2.45)	(1.37)	(0.981)
Blind rating			0.189*	0.155*	0.197*	0.246*
			(0.047)	(0.048)	(0.047)	(0.049)
Biodynamic producer	0.240	1.40*	1.35*	1.27*	1.32*	1.36*
	(0.714)	(0.594)	(0.579)	(0.582)	(0.561)	(0.588)
Organic producer	0.519	0.436	0.534	0.581	0.819	0.636
	(0.620)	(0.515)	(0.503)	(0.499)	(0.493)	(0.515)
Parker winery rating	−0.156	−0.007	0.0231	0.009	−0.023	−0.054
	(0.107)	(0.089)	(0.087)	(0.088)	(0.086)	(0.090)
Grand Cru site	0.789*	1.44*	1.29*	1.38*	1.16*	
	(0.219)	(0.182)	(0.182)	(0.186)	(0.193)	
Old vines (VV)	1.54	0.553	0.277	0.377	0.715	−0.100
	(0.513)	(0.474)	(0.422)	(0.409)	(0.429)	(0.460)
Late harvest (VT or SGN)	−0.483	0.568	0.644	0.696	0.708	0.431
	(0.570)	(0.427)	(0.463)	(0.453)	(0.450)	(0.474)
Year trend	−0.034	0.034	0.041	−0.253*	0.051*	0.028
	(0.028)	(0.023)	(0.023)	(0.103)	(0.022)	(0.023)
Vintage dummies	No	No	No	Yes	No	No
Varietal dummies	No	No	No	No	Yes	No
Grand cru dummies	No	No	No	No	No	Yes
R^2 within	0.091	0.227	0.267	0.365	0.343	0.416
Number of observations	385	385	385	385	385	385

Notes: $^*p < .05$; standard errors (adjusted for clustering on winery) are in parentheses. The specifications include predicted hazards of becoming biodynamic and organic.

TABLE 6. Effects of category membership on (log) retail prices (GEE estimates)

Variable	Model 1	Model 2
Constant	0.922	0.600
	(0.678)	(0.694)
Biodynamic producer	0.082*	0.067*
	(0.013)	(0.014)
Organic producer	0.074*	0.127*
	(0.024)	(0.026)
Biodynamic certification		0.051*
		(0.018)
Organic certification		−0.216*
		(0.045)
WS rating of focal wine	0.025*	0.025*
	(0.001)	(0.001)
Parker winery rating	0.041*	0.040*
	(0.005)	(0.05)
Old vines (VV)	0.136*	0.137*
	(0.020)	(0.021)
Late harvest (VT or SGN)	0.673*	0.671*
	(0.012)	(0.012)
Year trend	−0.030	−0.017
	(0.026)	(0.026)
Wald X^2	15904	15480
Number of observations	3545	3545
Number of producers	96	96

Notes: $^*p < .05$; robust standard errors are in parentheses. The specifications include the same fixed effects and covariates as in Table 3.

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