The Multiplicity of Paths to Sustainability, Grand Challenges and Routine Changes: The Long Road for Bordeaux Winemakers

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ABSTRACT

We explore potential changes to the organizational routines of Bordeaux winemakers faced with the need to reduce their use of pesticides – one of the grand challenges for agriculture. A *routine dynamics* lens suggests that the goal of sustainability can be achieved through various paths. The uncertainties related to reducing the use of chemical pesticides to encourage ecological biodiversity have resulted in efforts by viticulturalists, winemakers, and policy makers to find local solutions. Our results reveal a three-layered process of patterning and creating new routines. Our empirical findings contribute to theoretical work on routine dynamics and *grand challenges*. We show that there are several potential solutions to environmental problems based on new patterns and demonstrate that reflection is a major structural enabler of changes. Our research explores the ontological multiplicity of routines in the journey to achieving sustainability and the role of policy making in this process.

Keywords: Routines Dynamics, Practices, Sustainability, Viticulture, Winemaking

JEL Codes: O33; R5; L21; L26.

1. 1. Introduction

Grand challenges such as reducing environmental degradation involve complex problems and multiple stakeholders and create uncertainty for organizations. Addressing the grand challenge of sustainability calls for a new problem-solving approach (Ferraro *et al*., 2015) and offers opportunities for organizations to become "active experimenters" (Ferraro *et al.*, 2015) in the reconfiguration of organizational practices (Wright, Nyberg, 2017).

Environmental degradation caused by French viticulture has become an urgent problem (Fried *et al.*, 2019; Wagner *et al.*, 2023). In 2019, vineyards accounted for only 3.7% of French farmland but 20% of the pesticides used in French agriculture. Vine cultivation is responsible

for the highest levels of pesticide use per hectare (Aka *et al.*, 2018). Policies such as the Ecophyto plan (2009/128/EC) are aimed at reducing pesticide use by 50% by 2025. Sustainable viticulture which minimizes environmental impact has become critical for all stakeholders (Mariani, Vostola, 2015) and winemakers[1] in Bordeaux are experimenting with new routines which involve reconfiguration of long-established practices to achieve the goal of sustainability (Adelsheim *et al.*, 2016; Van Leeuwen, Darriet, 2016).

The questions they need to address are: How can sustainable routines be defined and applied? What are the actions required to achieve sustainability?

The present paper explores how the challenges posed by sustainability of the Bordeaux wine industry create opportunities to reconfigure organizational routines. Specifically, we investigate the various ways that winemakers could adapt their practices, the mechanisms involved, and the role of policy in enabling this ecological transition.

A framework for research on organizational routines was proposed by Baldessarelli *et al.* (2022). Viewed through a routine dynamics' lens, organizational routines can be defined as "*repetitive recognizable patterns of interdependent action, carried out by multiple actors*" (Feldman, Pentland, 2003, p. 95). The routine dynamics literature suggests that the observed stability and change cannot be explained only by exogenous forces alone, but by inner dynamics (Feldman, 2016). This duality is defined by the expression "(n)ever changing world" (Cohen, 2007; Pentland *et al.*, 2011).

Sustainability can be achieved in various ways, but when it involves efforts to reduce the use of pesticides, the contradictions, limitations, and doubts about the chosen path are exacerbated. The actors may look for local solutions based on robust (sometimes improvised) actions and in the search for the "right path" may take a divergent path. What matters is "*how many pathways are possible*?" (Feldman *et al.*, 2021, p. 2). Thus, the notion of multiplicity is fundamental (Feldman *et al.*, 2021; Pentland *et al.*, 2020).

In this context, the research questions addressed in this paper are: How do sustainability goals create opportunities and challenges that question the actions and patterns and the multiplicity of paths? What are the mechanisms driving the changes implemented and what is the role of policy in these changes?

To study sustainability beyond its technological triggers (Saint-Gès, Belis-Bergouignan, 2009; Pinget *et al.*, 2015; Alonso Ugaglia, Peres, 2017), we need to scrutinize the organizational processes involved in actors' day-to-day management of problems and implementation of actions.

Our findings are based on a qualitative case study of Bordeaux winemakers. We collected data on 17 winemakers – some more inclined to continue employing conventional (*i.e.* unsustainable) routines, and some keen to experiment with more sustainable methods. We found empirical evidence for the existence of multiple pathways and a three-pronged process related to the creation of new ostensive and performative aspects of routines. The three parts of this process are: (a) environmental pressures, (b) structures, and (c) generative

1 Our choice of Bordeaux vineyards was based on the availability of specific data on grape growers' and winemakers' practices, the global reputation of Bordeaux wines, and the importance to France of wine production. In 2019, France produced 4.2 billion liters of wine (*i.e.* 17% of global production), making it the world's second-largest wine producing nation.

mechanisms. We investigate how the actors tackle these multiple aspects in a context of environmental degradation and uncertainty, and the role of policy makers in enabling the ecological transition (Ferraro *et al.*, 2015; George *et al.*, 2016).

This paper is structured as follows. Section 2 discusses the theoretical background. Section 3 describes the methodology and data collection process. Section 4 presents the data analysis and the results and discusses the findings. Section 5 summarizes the main contributions of our study and Section 6 concludes the paper.

2. 2. Theoretical background

Translating a Grand Challenge into Systematic Organizational Practices

Grand challenges such as reducing environmental degradation require organizations to adopt innovative approaches and reframe environmental issues as tangible problems that need effective solutions (Ferraro *et al.*, 2015). The idea of "business as usual" and short-term actions must be rejected (Wright, Nyberg, 2015, 2017). Tackling environmental degradation requires the reshaping of action patterns and establishment of new forms of organizing involving increased participation, reflection, and coordination, and new forms of governance (Ferraro *et al.*, 2015; George *et al.*, 2016; Howard-Grenville *et al.*, 2014).

Grand challenges are characterized by complexity, uncertainty, and evaluative difficulty (Ferraro *et al.*, 2015). Achieving sustainability is complex because of the links to, and impacts on, multiple fields. How the actors perceive the connections among fields and their interactions is critical for the solution to such issues. Specifically, the perception of potential complexity affects the actors' decisions about a response to a particular problem and could lead to questions about the appropriateness of the proposed actions from a macro to a micro perspective (Feldman, Rafaeli, 2002). Complexity and radical uncertainty require reevaluation of current interactions and decision-making processes within a long-term context. Finally, evaluative difficulty implies the possibility of multiple ways to solve the problem.

To address a grand challenge, Ferraro *et al.* (2015, p. 370) adopt a pragmatist vision and implementation of robust action or: "*action that accomplishes short term objectives while preserving long term flexibility*". Since grand challenges emerge at the intersection of multiple technological, economic, social, and environmental issues and involve a diversity of actors, the construction of new patterns of action requires a reevaluation of the micro-level (Danner-Schröder, Geiger, 2016). Reevaluation of the patterns of actions within an organization allows observation of their effects at the macro level (Feldman, Orlikowski, 2011) and the links between the individual actors involved and the institutional context. This is in line with the structure *versus* agency debate (Dionysiou, Tsoukas, 2013; Howard-Greenville, Lodge, 2021; Lazaric, 2021, 2024).

To address grand challenges related to sustainability the involvement of public actors is essential. Ansell and Gash (2008) highlighted that collaborative governance involving the public, private, and civil society sectors is crucial for tackling complex issues. Mazzucato (2018) supports this view and suggests that measures to support mission-oriented research and innovation steers innovative activities toward sustainable developments. Stirling (2014) studied the policy power dynamics and showed the importance of democratic engagement and diverse perspectives in environmental decision-making. Similarly, Hoffman and Haigh (2011)

suggested that practices of positive deviance can lead to sustainable innovations within organizations and emphasized the significance of public actors for identifying and diffusing innovative practices.

The present study looks at the broad strategies while also conducting a granular examination of daily organizational practices, with a focus on both policy making and the routines shaping organizational life.

A new lens for observing changes to routines

Previous work on routines has focused on exogenous factors, such as shocks that trigger change or promote routine stability, and the possibility of dynamic capabilities to absorb these changes (Nelson, Winter, 1982; Parmigiani, Howard-Grenville, 2011; Biesenthal *et al.*, 2019; Baldessarelli *et al.*, 2022). Feldman and Pentland (2003) examined the endogenous processes that produce these dynamics, considering the ostensive (*i.e.* abstract understanding about how routines should be performed) and the performative (*i.e.* how routines are performed) aspects of routines. Their insights shifted the focus of research from Nelson and Winter's (1982) understanding of the effects of routines on organizations to the situated actions that comprise routines. In other words, routine dynamics research investigates how actions are performed by multiple actors at specific times and in specific places, and how recognizable, repetitive patterns of interdependent action emerge and change (Feldman *et al.*, 2016, 2021).

Having established the importance of a new lens to examine routines, we next examine their internal dynamics, exploring the way they balance stability and change within organizations.

Organizational routines and dynamics of change

Seeing "action" as an essential component of the micro-level dimension of routines allows scrutiny of the creation of routines from an agency perspective, as the outcome of the "*relationship between specific actions and patterns of action*" (Pentland *et al.*, 2012, p. 1485). It also allows reconsideration of the patterns of actions and their intertwining to form multiple connections (Feldman, Rafaeli, 2002). This theoretical approach enables a new understanding of routines as action patterns. According to this view, routines involve actors, actions, artifacts, and organizational contexts (Howard-Grenville, Rerup, 2017), and the four properties of being situated in a context, rooted in socio-materiality, relationality, and ontological multiplicity (Feldman *et al.*, 2016, 2021). Pentland (1995) compares routines to "grammars of action" where grammar defines a set of possibilities and variations for a specific language, and routines describes the set of possible actions to achieve a task: "*An organizational routine is not a single pattern but, rather a set of possible patterns*" (Pentland, Reuter, 1994, p. 491). The idea of multiplicity is important for understanding the different interpretations of actors and organizations of the same environment and is significant in the context of sustainability. "Ontological multiplicity" (D'Adderio, Pollock, 2020) refers to the fact that "*processes such as routines are not unified, singular 'objects' but are themselves multiplicities*" (Feldman *et al.*, 2021, p. 26). In this view, the ostensive aspect of routines is not a singular trait; rather it encompasses the subjective understandings of many participants since "*each participant's understanding of a routine depends on his (or her) role and point of view*" (Feldman, Pentland, 2003, p. 101). Thus, in the case of sustainability issues, there is no "one best solution" but rather many possible actions, many possible patterns, and many routines.

In this patterning and performing process, reflection and connections matter for the development of a shared understanding about "what to do in a particular instance" and "why some actions are appropriate" (Feldman, Rafaeli, 2002). Performing routines is a way of "*reflecting on what they [the actors] are doing and doing different things (or doing the same things differently) as a result of the reflection*" (Feldman, 2000, p. 625). This relational view explains the interdependence among the actors experimenting with actions.

Reflection is a critical element in the linking of action to patterns of actions and addresses the question of "*how do we do patterning*" (Feldman, 2016, p. 39). However, reflection must be mediated and organized, which highlights the role of "*reflective regulation*" in terms of "*attempts at managing the actions sequences of which routines are made*" (Feldman *et al.*, 2021, p. 4). This process of reflection can also be implemented through the design of artifacts that "*participate in the co-creation of knowledge and transformations of actions*" (D'Adderio, 2011, p. 211). Agency is at the heart of the reflection process and is the product of the agent's actions based on past patterns and future expectations, and that agent's ability to formulate a response to the "*emerging demands, dilemmas, and ambiguities of presently evolving situations*" (Emirbayer, Mische, 1998, p. 971). Agency and structures are co-shaped, providing the actors with a representation of what is expected of them and what is appropriate in certain contexts.

3. 3. Research setting

Our research setting is the prestigious Bordeaux winemaking region where changes in the emphasis of environmental issues have prompted a reconfiguration of some actors' routines. In what follows, we describe how actors in the Bordeaux wine region are struggling to address sustainability goals and implement robust actions to reduce environmental degradation. These issues and actions have created tensions and led in turn to consideration of traditional methods and opportunities to change existing routines.

Bordeaux vineyards and possible paths to sustainability

Bordeaux vineyards have a reputation for producing world-renowned prestigious wines (Leszczyńska, 2020), often considered luxury goods. Like most farmers, Bordeaux winemakers are under pressure to change their routines and adopt more sustainable ways to grow grapes and make wine (Saint-Gès, Belis-Bergouignan, 2009; Sacchelli *et al.*, 2016; Fouillet *et al.*, 2022). In recent years, Bordeaux winemakers have experienced serious economic difficulties. Climate change has exposed the vines to frost, hail, and mildew damage, and tariff wars related to new international agreements and Brexit have had a negative effect on their wine exports. These economic conditions have resulted in price reductions and the resulting dwindling profitability is causing many winemakers to question their current winemaking patterns (Barroux, 2019). This situation can be perceived as an opportunity or a constraint, depending on the actor's patterns and schemata (Sacchelli *et al.*, 2016; Wright, Nyberg, 2017). Reducing environmental degradation and protecting the crops against the damage caused by climate change are specific and major problems for winemakers in Bordeaux (IPCC, 2020) and call for robust actions to address the increased uncertainty about climatic conditions in a context of global warming. Table 1 provides an overview of the Bordeaux winemaking process.

Table 1 - Bordeaux winemaking : An overview of economic and ecological choices

	2005	2010	2015	2020
No. of Winegrowers	10,239	8,244	7,900	7,845
Average surface area in Gironde (ha)	12.0	14.2	14.8	15.0
Price euros/ha of red Bordeaux	na	18,000	16,000	13,000
Organic cultivation (%)	4	6	10	18
Biodynamic cultivation (%)	na	na	0. 7	1.4

Source: Authors, na: non available data.

First, environmental degradation has been recognized by the scientific community (Oczkowski, 2016; Lapierre *et al.*, 2019) as an important aspect of wine production. Although fluctuating weather conditions affect a range of variables including annual crop yield, fruit quality, and wine characteristics, environmental degradation will have a permanent effect on the fundamental characteristics of the wine produced. The effects of global warming in Bordeaux have been paradoxical, and the absence of drought problems has delayed changes to current routines and the transition to more sustainable practices (Saint-Gès, Bélis-Bergouignan, 2009)[2], and has reinforced the status quo (Wright, Nyberg, 2017). Since 1980, the only visible effect of global warming on the vines in the Bordeaux region has been the 15-day earlier flowering which has led to riper grapes and an earlier harvest (Adelsheim *et al.*, 2016). However, the increased incidence of fires and high summer temperatures are calling for new viticulture patterns (Leturcq, 2022).

Second, intensive use of pesticides in viticulture has resulted in major contamination of the region's streams and ground water. French environmental evaluations highlight pesticide-based pollution of the natural environment (Saint-Gès, Bélis-Bergouignan, 2009) while French and European incentives such as the Ecophyto Plan 2[3] (European directive for the sustainable use of pesticides) are requiring grape growers to take robust action to reduce or discontinue use of chemical pesticides (Fouillet *et al.*, 2022). Winemakers are directedly exposed to pesticides during their application, and they are causing environmental degradation and conflicts with neighbors. Much of the pressure on winemakers to reduce their use of pesticides comes from those living near to a vineyard who suffer the negative repercussions of chemical phytosanitary winemaking methods, and from consumers who are starting to consider the ecological footprint of the wines they are buying (Lucas *et al.*, 2018). Business as usual is being eroded by the introduction of organic viticulture, biocontrol, and biodynamics. However, these changes are incremental and do not constitute a complete response to demands from consumers for environmentally friendly and organic wines (Barroux, 2019)[4]. For instance, between 2010 and 2019 the organic vineyard area in Bordeaux increased and now accounts for more than 1,100 ha. (approximately 18% of total Bordeaux vineyards). Organic wine is produced from grapes cultivated according to organic farming

2 In some years and in winemaking regions that formerly experienced high levels of rainfall and cool nighttime temperatures, environmental degradation has yet to pose a major threat (Van Leeuwen, Darriet, 2016).

3 https://solidarites-sante.gouv.fr/sante-et-environnement/les-plans-nationaux-sante-environnement/article/plan-ecophyto-2.

and winemaking principles which do not permit use of chemical fertilizers, pesticides, fungicides, or herbicides. More generally:

> "*organic farming emerged from social and ideological struggles against the development of productivist farming. Thus, the development of organic farming is not only characterised by different practices and values at the level of individual farmers and consumers, but also by specific institutions and organisations. [Consequently] conventional and organic farming constitute two different paradigms, framed by specific actors, institutions, knowledge and organisation systems*" (Schnebelin *et al.*, 2021, p. 601-602)

Biocontrol and pest control products based on biological entrants (bacteria, fungi, insects, etc.) are used in place of chemical inputs and biopesticides (Parmentier Cajaiba *et al.*, 2021). Increased use of biocontrol products is supported by the Ecophyto Plan which is aimed at achieving a switch from conventional phytosanitary products to biocontrol products even though some biocontrol products also have the potential to degrade the environment as demonstrated by the Asian ladybird invasions (Lapierre *et al.*, 2019). Ecophyto is a 'mission-oriented' policy action aimed at creating 'good substitutes' for chemical pesticides. However, biocontrol has been designed by policymakers far from the field and stakeholders' practices, not as a paradigm shift, but as a substitution policy without enough practical involvement to understand its complexity and the changes required: "*this weakens substitution as a policy option and makes stakeholders in the developments of public policies unlikely*" (Aulagnier, 2023, p. 37). Consequently, this substitution policy, without sufficient attention to a holistic approach to pesticide policy, leads to limited action and delays the necessary changes, thus preserving the *statu quo* and conventional routines.

In the search for non-chemical means to combat pests, biodynamic actions such as zero plowing techniques are being adopted by certain viticulturalists and winemakers who are considered rebels by some. Indeed, biodynamic methods involve a radical reconfiguration of current routines and not incremental changes (Barroux, 2019). Note that: "*organic and biodynamic techniques are strictly linked but with an important difference: organic viticulture is regulated by an official set of rules [...] while biodynamic regulation is still founded on a 'voluntary' basis, without any public intervention*" (Castellini *et al.*, 2017, p. 9). The biodynamic movement was founded in 1924 by Rudolf Steiner whose holistic vision was:

> "*founded on the anthroposophy theory, which states that the human being is in the middle between the earth and cosmos rhythms, bridging a gap between spiritual and material world. Soil, man, plants and all the natural and cosmic elements take part in a holistic view typical of biodynamic agriculture. Growers embrace this philosophical approach and it guides them in daily agricultural practices. Considering this vision of agriculture and the role of biodynamic farmer in the universe, it is clear why biodynamic discipline sometimes appears more as a belief than as a cultivation technique.*" (Castellini *et al.*, 2017, p. 9)

Viticulture and winemaking: many options and paths

France and other countries employ a range of different viticulture and winemaking routines that combine conventional and novel methods. Some winemakers are continuing to use chemicals to combat diseases and insects; others are introducing sustainable techniques to

4 Organic wine is made exclusively from organic grapes produced in line with the June 24 1991 European regulation which bans the use in organic viticulture of any substance derived from chemical synthesis and requires engagement in a long (at least three years) and effortful learning process.

respond to market demand and new regulations. Wine can be produced in many ways and opinions about the best method are similarly variable and numerous. Sustainable production involves diverse patterns, actions, and interdependencies among biocontrol, organic cultivation, and biodynamic processes. The winemaker will decide whether to experiment with new routines or find new ways to address sustainability concerns based on individual convictions, personal experience, and work processes.

4. 3. Methodology

We conducted an inductive qualitative case study (Feldman, 2000; Gehman *et al.*, 2018) of the viticulture and winemaking practices of 17 prestigious wine producers in Bordeaux, France. We followed Ann Langley (Langley, Royer, 2006; Gehman *et al.*, 2018) and chose from the "toolbox" of qualitative methodologies described in the large body of work on routine dynamics. To identify the underlying structures and mechanisms that (do not) enable routines to be changed and reconfigured, we structured our data using the principles of grounded theory (Gioia *et al.*, 2013).

Our meticulous methodological approach reflects the complexity of our case study. Our strategic selection of informants from the Bordeaux viticulture sector was aimed at capturing a diverse range of perspectives on sustainable *versus* conventional practices. These classifications allow analysis of the influence of public innovation policies on routine change. By situating our case within the broader discourse on innovation and societal challenges, we provide a nuanced understanding of the sector's response to policy interventions.

Data collection

Data collection occurred between December 2018 and April 2019. We interviewed actors involved in sustainable and conventional winemaking practices. Interviews lasted between 60 and 120 minutes (see Table 2) and were recorded with the permission of interviewees, anonymized and transcribed (160 pages of transcript). Informants were asked to describe their job, their background, and the viticulture and wine production activities in their vineyard. Our investigation covers the entire winemaking process with a specific focus on:

- Viticulture, the agricultural activity of cultivating a particular grape variety which involves preparing the soil (weeding, tilling, fertilizing), cultivating the vines, and harvesting the grapes.
- Winemaking which includes pressing and fermenting the grapes and storing and aging the wine in barrels.

Table 2 - Data collection

Approach	Code	Informant's role	Vineyard size (ha)	Date of certification/ Stage of certification process
Sustainable	BIO1	Manager	na	na
	BIO2	Manager	15	Organic farming conversion 3rd

				year
	BIO3	Technical Director/Owner	93	2018
	BIO4	Technical Director	30	2010 Biodynamic
	BIO5	Head of Administration and Commerce	9.5	Organic farming conversion 3rd year
	BIO6	Chief Operating Officer	6	1999
	BIO7	Manager and Owner	32	2009
	BIO8	Manager	80	2010 Biodynamic
	BIO9	Manager	9.5	Organic farming conversion 3rd year
	BIO10	Chief Operating Officer	42	2014
Conventional	PBIO1	Manager and Owner	6	na
	PBIO2	Manager	30.5	
	PBIO3	Manager	25	
	PBIO4	Owner	26	
	PBIO5	Chief Operating Officer	23	
	PBIO6	Technical Coordinator/Hygiene Pilot and R&D Director	30	
	PBIO7	Technical Director	78	

Our informants discussed their concerns regarding environmental degradation and potential actions to deal with it, such as radical changes and adoption of new patterns, modifications to conventional actions, or incremental changes to achieve sustainability alongside maintenance of conventional practices. Since actors operating under the same conditions and faced with the same problems, interpreted sustainability issues differently, our methodological approach enabled us to study the tradeoffs associated with addressing sustainability at the level of routines (actions and patterns).

Our data collection period coincided with a period of economic crisis and environmental degradation, and challenges to the winemakers' ostensive and performative routines which required them to justify their choices and beliefs. Data collection was facilitated by the third author's agronomist training which allowed her to engage in discussions on oenological techniques and winemaking with local stakeholders.

Data analysis

Data coding involved three steps (Glaser, Strauss, 1967; Gioia *et al.*, 2013). In the first step, open coding was applied to understand the types of sustainability-related actions taken by the winemakers. This allowed identification of (a) possible "paths" to sustainable, (b) the characteristics of the winemaking environment, and (c) possible causal explanations for changes. Our first-order codes consisted of "labels" based on words, sentences, and qualifications in the data. The second step involved systematic comparison and discussion of

the first-order codes and their grouping into abstract categories using second-order codes grounded as far as possible in the data (Gioia *et al.*, 2013). In the third step, we aggregated the second-order codes into more abstract third-order categories which provided an initial understanding of the phenomena being studied. Figure 1 depicts the data structure.

Figure 1 - Data structure

5. 4. Results

Multiplicity of the paths to sustainability

The empirical data revealed five different paths which we labeled: (i) business as usual, (ii) business should evolve, (iii) organic in doubt, (iv) organic committed, and (v) rebel.

Business-as-usual was preferred by those winemakers not keen to abandon conventional routines (see Wright, Nyberg, 2017) who believed there was no need to modernize and favored the inherited routines: "*I am not in the race to be the most modern, the most innovative, where I forget to take my time. In my wine chateau, everything is very conventional*" (PBIO1).

The *business should evolve* category includes winemakers who respected tradition but believed that viticulture and wine production should be more sustainable. They had already taken steps towards reducing their use of chemicals, but any greater adoption of sustainable practices was dependent on the results of their current efforts. They required strong evidence of the robustness of new methods before switching to sustainable routines: "*We are doing*

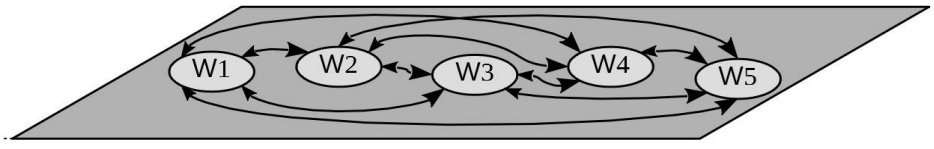
everything we can do to reduce the environmental impact of our process. We prohibit the use of products presented as CMR [carcinogenic, mutagenic, or reprotoxic] or as endocrine disruptors. So suddenly, we have fewer and fewer options. So, if we can use biocontrol products that have proven to be efficient, we are using them" (PBIO3).

The *organic in doubt* path includes winemakers who had adopted sustainable routines but were not completely convinced. For instance, some had noticed a decrease in wine sales: "*In the conventional wine market, the merchants have filled their stocks, but the problem is that currently this wine is not selling anymore. So, the price of wine is decreasing, given the low sales volume*" (BIO1). Their ecological concerns were real, but the negative outcomes associated with sustainable methods left them unconvinced. The marketing of the wine was evidently not being effective in communicating the added value of sustainable agricultural practices.

The *organic committed* path includes winemakers who had converted completely to sustainable routines and saw this path as irreversible. They had long-term agendas for developing and evolving sustainable winemaking methods. These "pioneers" were convinced that organic farming was the way forward, and actively sought ways to guarantee the autonomy of their routines*:* "*Initially, our understanding of copper usage was limited. We were able to go organic the day we met the right person who helped us better understand how copper works*" (BIO3).

The *rebel* path includes winemakers who had adopted biodynamic routines. Biodynamic methods are even more effective for achieving the goal of sustainability. The rebel winemakers were concerned about soil quality and soil life and were making efforts to balance exchanges and inputs between the soil and plants. They had reverted to old actions such as minimum tillage and composting and had abandoned techniques such as plowing. Their commitment to sustainability went beyond the final product and was part of a logic of total and continuous improvement: "*The idea is that the organism that we have chosen to breed, to cultivate, must have a functioning metabolism throughout its growth cycle*" (BIO5). Figure 2 depicts the five winemaker groups and the possible paths to sustainable routines.

Figure 2 - Winemaker possible paths toward sustainability



These five paths are positioned along an action spectrum from maintenance of conventional routines to transition to sustainable routines. The winemakers were aware that organic wine production could be achieved in different ways. Some were very sensitive to the expense

involved in adopting sustainable practices, others were unconvinced. Those wine producers that had embraced sustainability had explored several different paths. However, a multiplicity of paths does not preclude a return to conventional methods. In some cases, the winemaker had changed directly from conventional to biodynamic methods (W1⟍W5); in other cases, the winemaker had abandoned sustainability and reverted to conventional methods (W3⏐W1). Others had advanced gradually along a sustainability continuum (W1⟍W2⟍W3⟍W4) adjusting their actions and patterns over time as their understanding about how to achieve sustainability increased. This process of developing protocols is complex, uncertain, and requires some reflexivity to allow selection of actions appropriate for local conditions.

Our data reveal the existence of a multiplicity of actions and patterns of actions among Bordeaux winemakers related to the achievement of sustainability. The long learning path offers options but introduces doubts about the reconfiguration of organizational routines depending on the actors' agency and willingness to address or ignore environmental issues. Reflection enables perception of the different depth and scope of the problems involved in the transition to sustainability and varies significantly depending on the chosen path and conviction about the correctness of the path followed.

Sustainability pressures

All winemakers in Bordeaux operate under similar conditions; despite being exposed to the same climate and economic environments, they have adopted different routines. They are strongly committed to ostensive and performative routines and are concerned about environmental degradation with many keen to implement sustainable actions:

> "*There is a desire to perpetuate our vineyard, the vineyard that we are going to pass on. It is also a desire to take this step and announce a sustainable development policy both for luxury brands and in the vineyard*" (BIO3).

However, respect for nature can be difficult, especially if nature is not compliant. The climate is humid, and one interviewee told us that: "*organic viticulture practices are not viable, especially in the climatic conditions of our region*" (PBIO2).

In our empirical setting, the market and demand have both evolved. Social influence also has an effect: "*Others around us say that now they don't have much choice, that we all have to move to sustainable practices … directly to the north, we have a property that is converting to organic*" (BIO3). Although those who were persisting with conventional routines acknowledge being affected by these developments, they wanted time for reflection. So, if all winemakers in Bordeaux operate in a similar environment, each interprets the opportunities and constraints imposed by these local conditions in different ways to justify their patterns of action. Their justifications for continuing to use conventional methods or adopting sustainable practices are grounded in structural explanations.

Structural explanations

Our data allow us to distinguish two structural explanations: visions about performance of routines, and structural reflections.

Visions about performance of routines can facilitate or hamper adoption of sustainable routines and are associated with the ostensive aspects of routines. Winemakers have three visions related to their practices. First, a technological vision focused on adopting innovations

to reduce environmental degradation. Decision-makers understand that innovation is necessary for progress. Second, a business vision centered on wine sales and reflecting the winemaker's identity. Third, an emotional vision, winemaking businesses are often inherited, meaning the winemaker's approach involves both emotion and action: "*Winemaking is an art that must arouse emotions*" (BIO5).

Structural reflections, refer to ways of thinking about evolving practices. Our data reveal that winemakers engage in reflection at three levels: critical, anticipatory, and collaborative. Critical reflection drives change by testing, analyzing, and reconfiguring actions: "*I don't like sexual confusion [in viticulture] because dropping hormones like that in nature, whatever the sellers of the products say, I'm not sure that we really know what the consequences are*" (BIO3). Anticipatory reflection involves deliberating whether to continue sustainable practices. Whether transitioning to sustainable farming or continuing conventional practices, winemakers were pessimistic about the future of viticulture: "*It is certain that the latest restrictions on the use of copper increase the difficulties related to changing to organic viticulture and will slow the process*" (PBIO7). Finally, collective reflection involves exchanging ideas with other winemakers and solving problems: "*I think we should discuss change. The profession, I mean technicians as well as managers, financiers, etc., should indeed be aware of the advantages that this can bring*" (BIO5).

Reconfiguration mechanisms

In addition to structural explanations, our data revealed three mechanisms that enable reconfiguration of routines: *learning, flexibility* and *engagement with public actors.*

Our informants highlighted the importance of learning in their efforts to reconfigure their viticultural and winemaking practices: "*I need to learn a little bit more about biodynamics. Above all, it is a lot of experimenting to learn things, while remaining very open, and then you shouldn't try to do the same everywhere*" (BIO4). Those who had implemented sustainable routines recognized that learning was a long and complex process: "*Biocontrol practices are only effective in combination with other techniques, but they are not effective in themselves. To be effective you have to learn to use them*" (PBIO3). Although our informants agreed about the importance of learning when reconfiguring routines, not all viewed change as positive and some preferred to continue with conventional routines (use of chemicals) and considered learning to be a constraint.

Winemakers learn new ways to practice sustainable routines by adopting a hands-on approach to problem solving, and by experimenting with and collaborating on R&D projects. Potential sustainability patterns are underpinned by the individual winemaker's philosophy. Owners of wine estates tend to identify closely with their vineyards. Their roots are in vine cultivation, and the appropriate actions and patterns that fit their local microclimate are based on their individual experience. A hands-on approach to problem solving enables learning about the most effective actions to achieve sustainability: "*It is by knowing your site and it is in choosing, from a range of possible techniques … that are adapted to your structures in order to progress with alternatives to phytosanitary products*" (BIO2).

Winemakers collaborate with research institutes and public universities to diversify their knowledge about appropriate actions and diverse approaches to winemaking. Collaboration with universities and research institutes enables collective reflection and faster problem solving. These interactions reveal new paths which inform their performative actions and

expand their knowledge. They trust the outcomes of collaborations and are likely to adopt some of the findings:

> "*We are working on a research program with the French Institute of Vine and Wine Sciences. This kind of collaboration is very important for our sustainable approach*" (BIO1).

Flexibility allows for the development of a wide range of actions and patterns. Sustainability certifications include organic grape growing, organic viticulture, organic wine and biodynamic wine, the latter being organic wine produced with respect for plants, animals and people. Winemakers have the flexibility to set their own sustainability goals and adjust their actions and patterns accordingly. Some have made significant adjustments to their soil management practices to be more sustainable. One winemaker, who was originally 'committed to organic' but has gone a step further to implement biodynamic practices and can be considered a 'rebel', told us that information about the impact of tillage on the timing of product application has led to changes in his farming practices:

> "*You will need to replace all the synthetic products previously used with contact products. But if you continue working your soils the same way, you won't be able to enter your vineyard after rain to apply the contact products in time before the soil dries out in 3 or 4 days'. So, we decided to stop working the soil in the same way. We opted for controlled natural grassing*" (BIO4).

Some sustainable certifications are restrictive in terms of disease prevention. For example, using copper to treat vine blight is not allowed whereas in conventional farming there is a wide range of chemical inputs that can be used to prevent or cure blight. There is flexibility in relation to the fermentation process:

> "*We do not use Saccharomyces yeasts. To us, that does not make sense. Rather, as we do not do cold pre-fermentation in winemaking, we choose to use yeast cocktails that come from our vineyards. We put them in the tank very early … for me it's part of the biocontrol, but it's not Saccharomyces yeasts*" (BIO3).

However, the flexibility inherent in organic techniques is not recognized as presenting opportunities for change. Conventional winemakers argue that although organic or biodynamic farming reduces the environmental burden caused by their activities, they are not willing to engage in the long and arduous process required to achieve organic or biodynamic certification for their processes and products. They prefer to rely on technological innovations to achieve sustainability, and some are using drones to monitor their vines to reduce the number of chemical treatments:

> "*We also use a drone. We pass a machine called the Green-Seeker through our vines and we carry out pruning weight estimates manually. This allows us to create vigor maps of our vines. According to these maps of vigor, we will be able to determine if our vineyards are deficient or not, which will allow us to define the fertilizer inputs*" (PBIO7).

Learning and flexibility enable reconfiguration of viticulture practices and promote engagement with public actors and pursuit of sustainability certifications. This highlights the transformative potential of conventional wisdom combined with innovation and collaboration in the path to sustainable winemaking. Indeed, the paths to sustainability chosen by winemakers are shaped by a range of factors including engagement with public actors.

The cornerstone of sustainable viticulture in Bordeaux is the partnerships between vineyards and academic institutions. These interactions are crucial for refining vineyard practices and exploring sustainable methodologies. A notable example is the interactions with the French Institute of Vine and Wine Sciences:

> "*This program concerns Saccharomyces cerevisiae, the characterization of Saccharomyces cerevisiae strains, their diversity, their impact, etc. It gives us R&D tools, which we do not have*" (BIO1).

Second, achieving sustainability requires environmental management systems and certifications. By obtaining ISO 14001 certification, vineyards demonstrate a structural commitment to reducing their environmental impact and achieving continuous improvement.

> "*EMS [Environmental Management System] is a management tool for the company and the community that allows it to organize itself in a way to reduce and control its environmental impacts. It commits the company or the community to long-term environmental improvement by enabling it to continually perfect itself. The following ISO standards describe the EMS: ISO 14001 [ISO 96-1] and ISO 14004 [ISO 96-2] define the specifications and guidelines for the use and implementation of the EMS. ISO 14010 [ISO 96-3], ISO 14011 [ISO 96-4], and ISO 14012 [ISO 96-5] define the principles and procedures of environmental auditing, as well as the qualification criteria for environmental auditors*" (PBIO2).

Third, the integration of cutting-edge technologies such as drones and NDVI mapping shows how Bordeaux's viticulture is evolving. These tools offer precise insights into vine health and environmental conditions, enabling targeted and efficient interventions:

> "*Our problem is when it's going to rain, we need to go through the vineyards and treat them before the rain. And, if it has rained 50 mm before, and the soils are impassable, we can't enter the vineyard to treat it. So, in modern terms, potentially an individual treatment by drone could be a solution*" (BIO7).

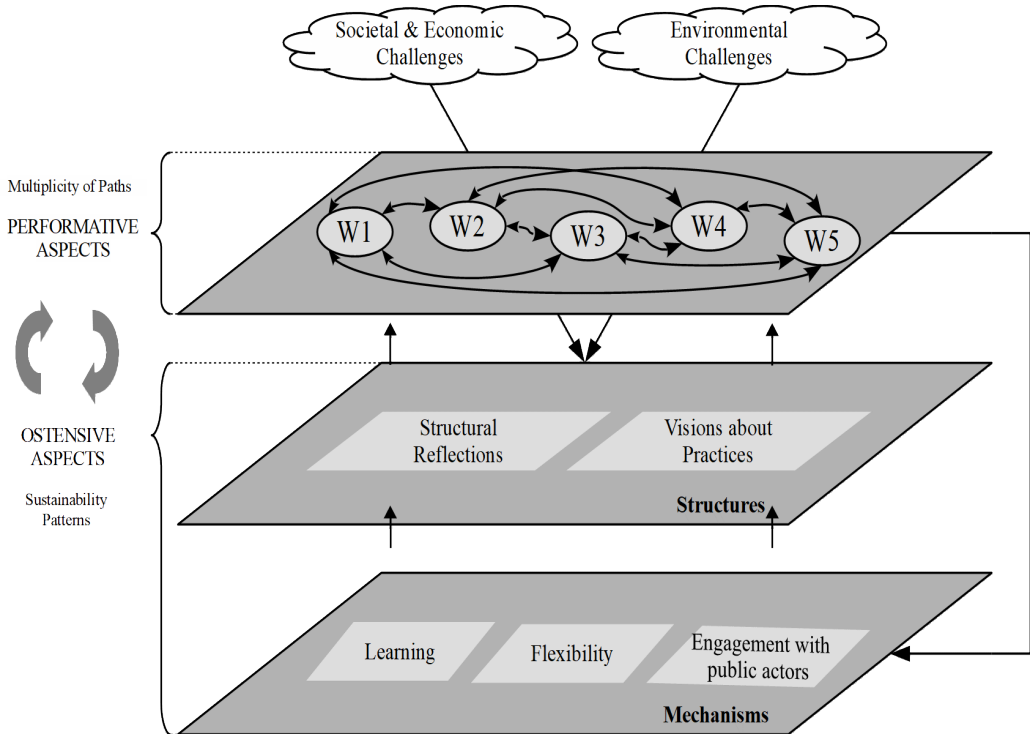
This varied landscape of transitions toward sustainable practices offers a granular view of how public policies and digital tools can facilitate or impede progress in this sector.

To sum up, the journey towards sustainability in viticulture exemplified by the actions of Bordeaux winemakers, is mediated by learning, flexibility, and engagement with public innovation policies and digital technologies. These elements in combination provide pathways that allow the winemakers to adapt their practices to the challenges posed by sustainability. Over recent decades, wine quality in various regions has been influenced by extreme climatic conditions including high temperatures and much reduced rainfall. These environmental shifts are highlighting the need for more sustainable routines. The empirical findings from our study highlight that achieving the goal of sustainability requires both individual commitments to learning and adaptability and a supportive policy framework combined with new technologies. A multifaceted approach is essential for continued production of high-quality wines in the Bordeaux region in a context governed by the imperatives of environmental conservation and climate resilience.

6. 5. Discussion

Figure 3 (below) summarizes our results and depicts our three-layered analysis.

Figure 3 - Three layers of analysis regarding the evolution of routines



First, we identified the paths followed by winemakers according to their different responses to grand environmental, societal, and economic challenges. These paths represent a continuum, and an open-ended process of changes made by winemakers to their viticulture and winemaking routines. Movement along this continuum is bidirectional and nonlinear (*i.e.* winemakers can move back and forth along the continuum and can skip steps). Our analysis of the environmental context in which routines evolve identified two types of challenges – environmental, and societal/economic - which are complementary, and which facilitate or constrain Bordeaux winemakers' efforts to change their practices. The winemakers interpreted these challenges in different ways and justified their actions accordingly. Some winemakers saw these challenges as opportunities to address sustainability concerns and engage in a process of reflection and a reconfiguration of their current routines. Some consider sustainability an additional hurdle and prefer to persist with their conventional routines as far as possible. The journey towards achieving the goal of sustainability involves multiple paths and opportunities to build and perform patterns that justify their actions. Our study highlights the contribution of individual agencies and subjective perception of environmental degradation and their translation into actions and patterns of actions.

Second, we analyzed the structural conditions that facilitate or hinder the transition to sustainable routines. These structures represent the ostensive aspects of viticultural and winemaking routines at an abstract level. Our results show that winemakers subject to the same structural conditions make different choices about experimenting with more sustainable routines or persisting with conventional routines. Every winemaker interprets these structures differently resulting in multiple actions and patterns. At the same time, the ostensive aspects

of routines are questioned as part of the performative actions to justify either changes to these routines or stability.

Third, we analyzed *learning, flexibility, and engagement* with public actors and their role on sustainability practices adoption.

7. 6. Contributions

On routines dynamics

Our empirical findings contribute to theoretical research on routine dynamics and the grand challenges related to sustainability. We fill a gap in routine dynamics literature (Turner, Cacciatori, 2016) by identifying three types of reflection: anticipatory, collective, and critical. We provide empirical evidence on how reflexive processes shape the ostensive level of routines, and how patterning reveals an ontological multiplicity. Reflection interacts with visions about actions and refers to subjective agency in the business, emotional, and technological realms. Our findings highlight that in the absence of a structured vision, reflection on routines and ideas about possible paths become difficult; this suggests the need for more research into how reflection shapes routines. The connections between routines are crucial for understanding their multiplicity and deciding about new actions (Pentland, 1995; Feldman *et al.*, 2021).

Our study also indicates new ways to conceptualize the ostensive aspects of routines. We suggest that actors may make tentative changes to current practices. Feldman and Pentland (2003, p. 110) argue that "*individuals or groups with power to identify particular performances as 'routine' have the power to turn exceptions into rules and, thus, to enact the organization in ways they think appropriate*". In our empirical setting, we show that the power to build or reshape the ostensive aspects of routines reflects the struggle to retain certain ideals and ontological visions about natural resources while implementing robust actions to change some dimensions. Actors' values and commitment are tested during their day-to-day actions and their management of new problems. If adherence to their values and commitment becomes too difficult, they may change course. We demonstrate that learning and flexibility are path-dependent mechanisms which push the actors in one or another direction and expand or restrict the space for possible new paths. These findings contribute to research on the importance of learning through the reconfiguration of routines (Aldrich, Yang, 2014; Dowell, Muthulingam, 2016; Rerup, Feldman, 2011). However, in contrast to Rerup and Feldman (2011), we find that rather than being incremental and involving only some elements of routines, the process of reshaping the ostensive aspects of routines is more radical.

On Grand Challenges

Our work contributes to studies of grand challenges and sustainability by exploring how actors address these issues through the rethinking of routines. We add to the routine dynamics debate (Ferraro *et al.*, 2015; George *et al*., 2016) by showing how the actors' struggle to address environmental challenges. We show that the different interpretations of these challenges justify the changes implemented by the actors or maintenance of "business as usual". Actors are more active experimenters than is sometimes suggested (Wright, Nyberg, 2017), and are keen to adopt new techniques, and engage in problem-solving and local

actions. Their involvement in different types of reflection suggests new patterns and new values which shape their ostensive understandings of routines. In most cases, this is a long and uncertain process punctuated by unexpected problems. Extensive involvement and emotional engagement are required to establish new viticultural and winemaking routines. Our results highlight the importance of providing justification for the ostensive level of routines and the strong involvement of actors in the re-creation of routines. The reconfiguration of routines from within is difficult at both the individual and collective levels and values play a critical role in the construction of a new grammar of actions. Creativity is crucial for exploring new routines, and as Pentland *et al.* (2020) point out: "*There may be many ways to arrive at a particular situation and many ways to proceed*".

Public innovation policies to address grand challenges

The need for changes to public innovation policies to address grand challenges requires consideration of both sustainability and environmental degradation issues. The interaction between organizational routines and public innovation policy highlights how systemic change may be enabled or constrained. Public innovation policies and specifically measures aimed at grand challenges such as climate change, biodiversity loss, and sustainable development provide a foundational framework for organizations to operate in and reconfigure their routines.

Policy transformations require both resources and technology and absolute commitment from policymakers. Our empirical findings suggest that anticipatory, collective, and critical reflection are structural components that have a significant influence on the emergence of new patterns of sustainable practices. These reflective processes are essential to allow organizations to navigate the complexities introduced by evolving public policy and enable critical assessment of current practices, envisioning of alternative futures, and adaptation of routines to be in line with both organizational goals and societal expectations. The importance of a structured vision and collective reflection for reconfiguring organizational routines resonates with Ansell and Gash's (2008) collaborative governance framework. By providing empirical evidence of how these processes facilitate the emergence of new sustainable practices, our research underscores the significance of collaborative mechanisms both *across sectors* and *within organizations* which extends the idea of collaborative governance to internal organizational dynamics. Public policy is crucial for achieving sustainability goals and can be supported by local private advisors. Given the growing importance of these private consultants, who provide different advisory structures and promote their own visions and subjectivities for the greening of agriculture, the role of public policy is therefore crucial for guiding and implementing change (Bechtet, 2023; Clément *et al.*, 2023; Laurent *et al.*, 2021).

Our findings on ontological multiplicity point to the multiple paths that organizations can take in responding to grand challenges. Public innovation policies that recognize and support this multiplicity by providing flexible frameworks and encouraging a variety of approaches will enhance the ability of organizations to innovate and adapt. Policy changes should be targeted at specific outcomes and should also empower organizations to experiment with and develop a range of solutions tailored to their individual contexts and problems. The 33% reduction in pesticide use by French wine growers over 10 years is evidence of the move towards sustainability (Fouillet *et al.*, 2022)[5].

5 The period of observation was 2009 to 2019 (Fouillet *et al.*, 2022).

8. 7. Conclusion

Our study shows that Bordeaux winemakers are under pressure to change routines and explore diverse vine cultivation and wine-making methods that reduce environmental degradation. Our interview data provides evidence of the multiple and divergent understandings among winemakers which are leading to different viticulture actions and patterns. We identified five paths: a) business as usual, (b) business should evolve, (c) organic in doubt, (d) organic committed, and (e) rebels. While these paths are aimed at addressing the grand challenges involved in sustainability not all lead to sustainable outcomes. The business-as-usual path is likely to perpetuate practices not conducive to long-term sustainability. Our empirical analysis examined the structures (*i.e.* structural reflection and visions about robust actions) and mechanisms (*i.e.* learning, flexibility and engagement with public actors) activated by these different paths. However, we need a better understanding of how patterns are established and in what contexts and under what conditions actors create new grammars of action related to solving complex and uncertain problems.

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