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INTRODUCTION

Mapping out the Triple Helix: how institutional coordination for competitiveness is achieved in the global wine industry

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As of 2010, the OECD countries spent over $968 billion annually on research and development (R&D), with China spending another $179 billion, Russia $32 billion and Taiwan $24 billion. Evidently, the world's policymakers have concluded that investment in R&D is a key to their future economic growth. As globalisation takes place, and developing countries increasingly show their ability to compete in labour-intensive manufactures, the race is on to develop new innovations that will create high skill, high productivity employment. President Obama's championing of electric cars, alternative energy research and other high technology ventures is mirrored in efforts around the global to win the innovation race. But how such efforts should be organised is very much open to debate. This paper reviews in depth perhaps the fastest growing perspective, namely the Triple Helix. In June 2013, a Google search for 'Triple Helix innovation' revealed 281,000 hits. A library search gave over 1300 citations in books and papers using the same terms. An international association, TripleHelix.org, organises an annual conference featuring thousands of participants from academia, government and business. All of this indicates that the Triple Helix has become one of, if not the, most widely used perspectives on innovation. However, there are some major shortcomings with the approach, in particular its applicability to policy situations.

Over the course of 2009–12, we developed case studies of the wine industry in Latin America, the Middle East, Central Asia, Australia, New Zealand, Canada and several US states by mapping out Triple Helix institutions and examining their interactions through secondary analysis of the literature; primary searches for industry and policy documents and websites; a global online survey of key actors; and, in most cases, in-depth interviews with the principals of key research, policy and industry bodies. Our exercise allows us to move towards more specific policy recommendations for improving innovation and competitiveness than Triple Helix theory has allowed up to this point. In creating a more precise and analytical mapping tool for Triple Helix interaction, we can develop the present heuristic approach of the Triple Helix into an approach that can examine what is actually happening in terms of inter-institutional coordination for innovation. With more precise maps of institutional interaction as it exists, we can understand more about what types of interactions are most effective in which situations. We are able to show the utility of this approach by revealing patterns across the wine case studies which suggest how the Triple Helix can be better understood, measured and applied to concrete situations. Above all, attention to strategy developed through consensus and policy leadership, and the development of specialised and locally-adapted hybrid organisations with both formal and informal overlapping personnel and funding, appear to be the keys to ensuring a successful Triple Helix innovation system.

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Understanding the rise of the Triple Helix Model

The Triple Helix Model is easily the most exciting new development in innovation studies in recent decades, as indicated by its growing popularity among academics and policymakers. It fills an important gap in innovation studies, one that holds important promise for our understanding of how to organise institutions for innovation for growth.

Innovation studies in terms of economic growth and development can be traced back to Joseph Schumpeter's work in the 1930s. Writing at the time of the Great Depression, Schumpeter's monumental work laid the foundation for innovation studies. While it is outside the scope of this paper to provide a full review, we can make a few observations that help to explain why the Triple Helix has taken off. Schumpeter's key contribution was to try to explain why business cycles occur, a problem that has confounded economists and fuelled Marxist predictions of the collapse of capitalism, a joust that appeared quite possibly correct at the time. Writing in *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process* in 1939, Schumpeter lays out the central premises behind 'creative destruction' as an explanation. In an indirect biological metaphor, Schumpeter suggests both industry and firm life cycles are related to economic business cycles. At the heart of these cycles is innovation in product or process, based on the incentive of capturing market share from well-established incumbents, who naturally tend to ossify over time as their position stabilises. Schumpeter thus popularises the now legendary notion of entrepreneurship, whereby an individual sees an opportunity through innovation to capture part of the markets, what is known in the literature as 'Mode 1 innovation'. Much of our economic lore and policy is based on this idea that an individual, such as Steve Jobs, can develop new products or processes that will shake up markets. Once innovation takes root, there is naturally going to be decline in the incumbent firms, thus leading to economic downturn that will reverse once the innovating firms grow and the innovation diffuses throughout the industry.

However, Schumpeter also suggests that there is 'Mode 2 innovation', whereby large incumbent firms alone have the wherewithal to engage in long-term research and development. Thus the ability of individuals to shake up the process is limited. This would parallel what we see in some large-scale industries where investments and payoffs are long term, such as pharmaceuticals. From a policy and institutional point of view, therefore, Schumpeter leaves us with a real conundrum. Should policy simply step back, providing an enabling environment, including macroeconomic and regulatory stability, ensuring market power is not abused, and providing indirect support, such as higher education and basic research funding, and allow Mode 1 entrepreneurs to lead the way to the new products and industries that will grow the economy? Or should policy help Mode 2 innovation through subsidies, targeted research and development expenditures, and the championing of leading firms? Rhetorically, Mode 1 policymaking has won out, but governments are always tempted to try and pick winners, revealing that Mode 2 is alive and well.

Innovation as a method of creating new industries is ready medication in economic downturns. We can see the increasing importance of innovation policy as the dominant position of the United States in the world economy began to fade after World War II, particularly from the 1970s. As the standard of living rose dramatically with technological breakthroughs from the previous 100 years, ranging from electricity to health care, the hope is always for a similar breakthrough to current

problems, including energy, climate change and poverty reduction. However, with a downturn, innovation is also seen as a way to improve relative gains. The development of endogenous growth theory in economics originating in the 1960s has only increased the relative gains aspects of innovation. Robert Solow's groundwork in 1957 laid out the idea that the classical notions of economic growth, based on the utilisation of the key natural factors of land, labour and capital, were inadequate. He introduced another factor, which he called 'alpha', to represent technological change. Since then, productivity has become a key focus for economists who study growth. The endogenous growth school, including Paul Romer (1994), built upon these ideas in the 1980s in order to try to explain the differences in economic development across different parts of the world, a vexing problem since we recognise that knowledge flows fairly easily across borders. Endogenous growth theories suggest that there is a path dependency to the development of new technologies. Once a firm or set of firms in a country develops them, they have a head start on the next wave. Proximity to other firms and developing skilled human capital will also increase knowledge flow and development. Moreover, once a firm or industry is well-established, it can use monopolistic rents to fuel more innovation (*à la* Mode 2). While endogenous growth theory offers many insights, it also leaves policymakers with the question of how to spark the initial innovation that will give their firms a head start, and the more vexing question of how to catch up once you are behind.

The vilification of government intervention in the economy, including in innovation, underlies much of the political conflict in the US over the past three decades. The market paradigm of competition by private companies leading to breakthroughs (Mode 1) is undermined by the historical record in several areas. For example, the monopoly status of AT&T in telecommunications pushed it to fund long-term research in Bell Laboratories, which was the genesis of a number of breakthroughs in telecommunications and IT, including cellular phone technologies. The infamous failure of Xerox to take advantage of innovations from its PARC laboratory, such as the icon-based computer interface behind Windows and the mouse, also demonstrates that a pure incentive approach cannot explain the trajectory of innovation. Moreover, the US government has had a direct hand in developing a number of breakthrough technologies, from GPS to the internet to the emerging genetic approaches to medicine (Tassey, 2007, pp.247–50). The historical record shows, therefore, a potential well beyond the infrastructure or broker provision suggested by the market paradigm.

Experience with well-publicised industrial policy projects gone awry, especially in the context of the failure of the Planning Model in the Eastern bloc and parts of the developing world, such as Chile's attempt to build an auto industry, led to scepticism that competitive industries could be created by governments. This brings us back to the problem of linkages, expressed by Albert Hirschman (1958) as backwards linkages and forwards linkages. We could extend this analogy to consider the importance also of horizontal linkages (Hira, 2007). As Robertson and Jacobson (2011, p.5) state:

> These facts point to a major shortcoming in the implicit theorizing favoured by analysts and policy makers who advocate special support for high-tech sectors and effectively disregard the performance of the rest of the economy. Modern market economies do not grow linearly on a sector-by-sector basis, nor is growth simply the result of increased inputs such as larger investments in R&D. Instead, economies operate on the

> principle of a 'circular flow' in which organizations are both consumers and producers that convert inputs (produced by themselves or bought in the market) into outputs that are then sold to others … the point remains that the functioning of a sector is in general heavily dependent on the performance of the economy, broadly or narrowly defined, in which it is embedded.

The national innovation systems (NIS) approach, which became popular in the early 1990s, sought to develop a more holistic, economy-wide view of innovation. Lundvall traces the concept indirectly to Friedrich List, who wrote in the 1840s about national systems of production, and more directly to Christopher Freeman, who wrote a paper in 1982 using the term national system of innovation (Lundvall, 2010, p.319). The NIS approach sees institutions playing a key role to promote learning in the economy, which will then lead to economic growth through innovation (Johnson, 1992). An economy is not based on pure, isolated, transactions; these are mixed in with ongoing relationships involving trust, loyalty and power (Lundvall, 2010, p.328). A key idea is that as the economy moves towards knowledge-based value, a more systematic approach, as opposed to relying on individual entrepreneurs or breakthroughs *à la* Edison and the light bulb, is needed. A system is needed to develop cross-sectoral knowledge that individuals alone are unlikely to create (Mokyr, 2002, p.19). Richard Nelson is one of the leading proponents of this movement. Nelson helped to introduce the idea that innovation requires cooperation among research, policy and production spheres (1996). In some ways, he therefore allows us to move beyond the Mode 1 *vs.* Mode 2 debate by acknowledging that both are important. Basic research can help to support innovation, but ultimately businesses need to apply that knowledge to actual market situations for industries to be created or developed. Therefore, government is no longer a leviathan of planning or direction, but more of a leader of the innovation process, providing collective and public goods for industries. The NIS approach was adopted widely, including the early case of Finland, where it helped to guide telecommunications giant Nokia in the 1990s (Hira *et al.,* 2012). The NIS approach gave rise to parallel theoretical efforts, such as the regional innovations systems and sectoral innovation systems approaches.

The Triple Helix approach, while similar, makes an important distinction, in that it does not posit a national system approach with a clear goal, inputs or outputs, in mind (Clark, 2011, p.109). The Triple Helix dates back to a 1995 paper by Etzkowitz and Leydesdorff. As Etzkowitz later put it, 'Government is expected to play a larger civilian role only when an activity cannot be provided by the market' (Etzkowitz, 2008, p.16). This puts the government in the role of coordinator and promoter of cooperation among the spheres (Etzkowitz, 2008, p.73). It eschews linearity (the idea that science leads to commercial application in a straightforward way), instead suggesting a continual movement through the interaction of the three spheres.

In this interaction, including the movement of personnel across the spheres, understanding of the other institutions and creativity arises (Etzkowitz, 2008, pp.9 and 23). It also relaxes the linking of research activities with academics, policy with government and production with industry. Instead, it posits that such activities can occur in any of the actors, such as a public research laboratory or an industry-led regulatory body. Thus, it indirectly addresses problems of collective action: 'The firm is thus transformed from a competitive unit related to other firms solely through the market to a Triple Helix entity increasingly based on relationships with other

firms as well as academia and government' (Etzkowitz, 2008, p.58). The Triple Helix can work on any level, including the regional one.

Such views have certainly affected and reflected policy changes. For instance, the expectation that universities can also act as entrepreneurs (Etzkowitz, 2008, p.2) reflects growing efforts by universities to set up patents and spin-off companies for research they develop. The movement from sponsoring science parks with government leadership around a particular industry to technology incubators, spaces created by government where nascent firms, entrepreneurs, venture capitalists and researchers can personally interact, also shows the acceptance of Triple Helix ideas.

The limitations of the ubiquitous Triple Helix Model

In a sense, we could say that the Triple Helix moves beyond economic growth as a goal to one based more on fostering creativity and supporting 'natural' cooperation through facilitating regular interactions of innovators. This may be more healthy and realistic in the sense that innovation and change in industries is anything but a predictable, linear process, but on the other hand, how can one really measure whether such efforts are leading to progress? Unless we posit creativity as an end in and of itself, the underlying goal is still the creation or development of industries that will bring revenues and employment. In a competitive world, this should mean global market share, but Triple Helix authors do not suggest this or any other clear measurement criteria, a problem shared with the NIS approach. The end result is policies that develop Triple Helix-inspired activities as an end in and of themselves, without regard to the effectiveness of public expenditures on such efforts.

There appears to be insularity within the Triple Helix community that could make policy application more fraught. As Leydesdorff, one of the progenitors of the approach, writes (2006, p.67):

> I have argued that the Triple Helix can be elaborated into a neo-evolutionary Model which enables us to recombine sociological notions of meaning processing, economic theorizing about exchange relations, and insights from science and technology studies regarding the organization and control of knowledge production. The further codification of meaning in scientific knowledge production can add value to the exchange. This Model can serve as heuristics, but should not be reified.

The problem of differing context for the Triple Helix is one shared by all models of behaviour, but it has led to a variety of challenges to the theory. One such set of challenges suggests that there are other spheres of action that have to be considered in innovation. Some authors suggest transnational social circulation, of personnel across borders as one missing piece (Datta and Saad, 2011). Others suggest it is 'society' writ large, including social and cultural movements, that changes the objectives and perceptions of innovation (Marcovich and Shinn, 2011). Still others argue for NGOs and local communities (Yang *et al.*, 2012). Another set of suggestions seeks to add potential dynamism to the Triple Helix; for example, through linking it to complex adaptive systems and evolutionary change theories (Viale and Pozzali, 2010). Other authors amplify the problem even further:

> to sum up, the presence or absence of a Triple Helix system and whether it has 'thick' or 'thin' innovation structures is a function of the quality of engagement of each of the three elements in the Model, and of a particular geographical context, its labour

> availability and social and physical infrastructure and position within broader systems of innovation. (Lawton Smith and Bagchi-Sen, 2010, p.809)

Such efforts are more likely to water down any policy development as they limit further the possibilities for empirical testing.

While the Triple Helix approach therefore has undoubtedly helped us to better grapple with the complexity of innovation, it still needs further development to help as a policy tool. We may acknowledge the importance of the three spheres of action, but we do not know whether they are *sui generis* or can be created. For the key Triple Helix theorists, the university seems to be the key originator of innovation, though each sphere's institutions should adjust their roles to become more like the others, allowing for overlap and understanding. Etzkowitz (2012, p.13) says, 'the first phase of entrepreneurial science is the internal development of academic research groups as "quasi-firms". The second phase refers to academic participation in the externalization and capitalisation of knowledge in tangible products …'. MIT is the model of how the Triple Helix should work in practice (Etzkowitz 2002). According to Etzkowitz's theory (2003), as universities and governments become entrepreneurial, firms will move closer to the academic model in training and sharing knowledge.

However, in practice we see very few MITs or Stanfords spinning off start-up companies. Such advice offers little guidance for contexts which lack powerhouse technology-oriented universities. Furthermore, the Triple Helix ignores incentives and power relations among the actors. Academics are driven primarily by publication pressures, not by commercialisation possibilities. Industry is not united, but made up of competing firms, none of which naturally wants to share any advantageous knowledge with the others. Government is made up of politicians who seek re-election and therefore generally lack the ability and capacity to consider long-term development goals. The difference in incentives means the easy rapprochement among the three spheres may not work in practice. Some case studies reveal that knowledge asymmetries can reduce the incentives for cooperation (Cooke, 2005, p.1130). As Jensen and Trägårdh (2004, p.513) state:

> … cooperation is complex, dynamic and ambiguous. It means different things to different institutional actors (depending on status power or view of independence, for example). Those in power often regarded cooperation as uniquely valuable in addressing what has to be done in a changing world. Those without power see it as a way of distracting attention from many economic, legal, institutional and financial constraints that homeless organizations and post Modern societies face. Hence, achieving the ideal of synergetic cooperation is not easy, since it requires integration between different logics.

Instead of natural cooperation, then, we are more likely to see negotiation, especially in the early stages of industrial development.

Key authors, such as Leydesdorff (e.g. Leydesdorff and Sun, 2009; Shapiro, 2011) document the Triple Helix primarily through patent and citation searches, a useful but evidently limited method of understanding innovation in practice. In general, the Triple Helix lacks a clear link between theory and testing upon empirical data (Shinn, 2002; Broström, 2011). These miss the human element of the entrepreneur and how he/she can develop and spread ideas. Innovation and diffusion of innovation go well beyond patenting activity, as we can see with advances in Chinese capacity in a variety of industries. One can therefore have a good formal innovation

system, but fail in innovation in that entrepreneurship is a bottom up process starting with an individual (Brännback *et al.,* 2008, pp.260 and 275). As Wixted and Cozzens (2007) point out, the standard mode of measuring innovation by research expenditures, patents and citations, is severely lacking in grappling with the inter-sectoral and inter-temporal nature of innovation creation and diffusion. They suggest careful case studies as a better approach. Lundvall (2010, pp.318, 320), one of the progenitors of the NIS approach, states that the Triple Helix overemphasises formal learning and underplays the value of experience-based and tacit learning ('doing, using and interacting'). In more recent work, Etzkowitz and Dzisah (2008) suggest the need for circulation of elite personnel among the three spheres, but there must be more to developing healthy interaction than this. In sum, we need to investigate empirically how innovation actually happens, not just as a flow of ideas or personnel, but as applied to a situation in which competitiveness of an industry is enhanced.

Even if research prowess in a particular industry can be created, what is the best way to ensure that it stays at the edge of innovation? Though we know there should be some interaction, we do not have a sense of the ways in which that interaction can be best facilitated or how to develop the 'hybrid forms' of institutions that cut across the spheres. There have to be 'bridging assets' across the spheres for coordination to occur (Brännback *et al.,* 2008, p.271). Given the lack of empirical testing, as Cohendet and Meyer-Krahmer (2005, pp.100 and 107) put it, 'our policy conclusions are selective, preliminary, and inevitably lack very specific proposals within detailed policy actions'. Another fuzzy area is the relative role of the policy sphere. Is it to step back and simply ensure research and training are useful to industry, and that industry is willing to support research and reward breakthrough efforts, or can government play a more guiding role in directing funds towards particular types of research and industries? The Triple Helix does not address the situation of catching up, based on path dependency. In that sense, we do not know if all Triple Helices are created the same, or if the quality of coordination and level of support can be improved to the point of out-competing other Triple Helices and therefore catching up.

The major aim of our case studies is to map out the Triple Helix in practice, and to see if there are patterns in the organisation and interactions of different actors across the different spheres of research, policy and production that help explain the relative success or failure of innovation. We want to get a sense of how coordination across the three spheres is organised and maintained, as failure to innovate, leading to failure to compete, would suggest coordination breakdowns. It is particularly important to address how late entrants set up and adjust their Triple Helices to catch up with market incumbents and how they develop or learn the innovations that help them to make up ground.

Why study the global wine industry?

In a series of recent studies, the Organization for Economic Cooperation and Development (OECD) embraces the importance of good governance of innovation systems, moving beyond the market-based approach (OECD, 2005). Malerba (2004), through a number of extensive empirical studies of sectors, concludes that while innovation systems vary considerably by sector, the way that any sector is organised (including policies) does matter. For example, the aerospace industry is more likely

to be marked by vertical integration and concentration than the wine industry. As he and his co-authors note, 'the probability of having competitive firms and networks depends upon the type of "institutional package"' (Coriat *et al.*, 2004, p.390). As Cooke (2007, p.222) further notes, the incentives for cooperation may vary considerably by type of sector. A sector where firms have asymmetric knowledge advantages or capabilities (e.g. fashion design) will lead to very different forms of cooperation from one where more open knowledge (e.g. IT) systems benefit firms. In fact, he suggests that the asymmetry of knowledge may help to explain differing levels of development at the macro as well as the micro levels (Cooke *et al.*, 2007, p.31). Previous research has found such effects for social networks. Molina-Morales and Martinez-Fernandez (2007, p.190) conclude that 'The balance between interfirm cooperation and competition … warrants more research attention …', along with an analysis of 'how local institutions vary in terms of the scope of the activities they carry out'. One should expect then, that the type of cluster will vary by sector, and quite likely, evolve over time, as several recent empirical studies show (He and Fallah, 2011).

As Malerba (2007, p.21) has pointed out, there is an ecosystem in each sector of technologies, demand, firms, regulators and researchers that is created through the interaction of various agents *within* each sector. Thus, a focus on any particular actor will miss the performance of the system. The level of knowledge of consumers, the level of competitiveness, the existence of linkages to global knowledge and the path dependency of a working base within that industry (Malerba, 2007, pp.13–17) are just a few reasons why sectoral fates can differ widely within a country. As Malerba and Vonortas (2010, p.308) note, 'the importance of the institutional setting can not be overemphasized', particularly when there are emerging technologies where existing assets of incumbent firms are not helpful (and may be a hindrance). All of this suggests the need for careful studies of the Triple Helix that control for sector, but also take into account the particular context of the industry. Unfortunately, knowledge about the role of institutions specifically in aiding technology creation and diffusion within the wine industry is quite limited.

The wine industry is a worthy target for studying such issues because it has undergone a remarkable transformation over the last three decades (Hira, 2013). The wine industry has always been dominated by the large Western European producers, particularly France. Yet, from the 1980s, in line with general increases in world wine consumption, new producers from Australia to South Africa have burst onto the scene. This signals a massive upgrading in learning for what was once considered an industry mastered over centuries of knowledge and experience, and limited to certain favourable locales, as reflected in the term '*terroir*', referring to the combination of local conditions, including soil, that give a wine appellation its supposedly unique character.

The literature on technological diffusion in the wine industry is fairly limited, but there are a few empirical studies that give an idea of the ways that new knowledge leads to quality upgrading in this ultra-competitive field. Simpson's (2011) magisterial review of the emergence of the global wine industry at the turn of the twentieth century demonstrates that institutions have long been a key component for success in the industry. As examples, he notes (pp.129–30) the movement towards regional appellations in 1905 France arose to distinguish quality Bordeaux from cheap imitations. After the Second World War, these grew to include restrictions on grape varieties and production processes. Similarly, the worldwide phylloxera blight in the late

1800s pushed European producers towards public support of scientific research to aid the industry, and collective efforts to contain the disease. As countries such as Portugal moved into the growing export trade (principally to the UK), national trading companies were often set up. Even in the New World, institutional roots sink deep. Tax support, regulation of wine content and the development of joint marketing companies date back to the 1860s in Napa Valley, California. Wine professionals in Australia date back to the 1890s when Arthur Perkins, a French graduate, was appointed to Roseworthy College in 1892. However, attempts to improve quality through public regulation broke down leading to a focus on the export of bulk wines. In Mendoza, Argentina, an industry effort to reduce fraud led to the establishment of the Centro Vitivinícola Nacional, which paid the federal government to conduct inspections. Yet, it is only in the last four decades that New World producers have been able to produce quality wines.

In these last four decades, the rise of the New World producers, from California in the 1970s to Australia and Chile in the 1980s, to New Zealand, Argentina and South Africa in the 1990s, has been remarkable. It can be linked in part to the catalyst of the UK supermarket chains beginning, in the 1980s, to carry and promote New World wine (traced to licensing changes in the 1970s), which spurred on Australian and Chilean success (Anderson, 2004, p.4). The US wine industry's growth can also be traced to a new middle class market at home. Indeed the wine market went from less than 10% of global production being traded to around 40% in the early 2000s, matched by a growing number of large cross-country acquisitions (Anderson, 2004, p.7). This remarkable turn of events has already been linked directly to technological upgrading efforts to improve both process and product (Giuliani *et al.*, 2011, p.2; Hira, 2013), yet whether there are patterns in the way the institutions are set up (institutional architecture) across the rising stars remains obscure. Recent studies do provide some important clues. As Anderson (2011, p.79) notes:

> To build and retain a competitive edge internationally, strategies are needed to obtain and make good use of available information faster and at a lower cost than do competitors, to generate new knowledge pertinent to domestic producers, and to cost-effectively disseminate that among the country's firms. The information required relates not just to consumer, retailer and distributor demands but also to appropriate new technologies as they affect all aspects of grape growing, winemaking, wine marketing and associated financing. Much of the pertinent information and knowledge has a public-good nature.

In a study of Italy and Chile, Giuliani (2007a) finds that unlike the horizontal matrix system envisioned by the national innovation systems literature, in the wine industry knowledge flows are lumpy. A small set of firms dominates the sharing of knowledge, even though many more participate in regular business transactions. In a subsequent study (Giuliani, 2010, p.267), she points out that surveys reveal that knowledge networks (sharing of knowledge) are quite distinct, and usually more limited in wine clusters than in business networks (transactional relationships). Thus, she concludes that in any cluster there will be 'knowledge leaders' who have less cognitive distance from each other and external agents than others in the cluster. They will be firms with strong knowledge bases (ability to carry out and absorb R&D); through reciprocity, knowledge will flow first among them before being absorbed by the rest of the cluster.

If large firms tend to dominate R&D, as Giuliani's work suggests, why do they need local institutions for support? In an age of global consolidation of the wine industry, including large multinational firms (such as Constellation) sharing information, international consultants, and ubiquitous and in-depth knowledge via the internet, why bother with the expense and transactions costs of creating large local bureaucracies? The literature that studies this question gives several answers, the primary one being that it is not accurate to think of intra- and extra-firm sources of innovation as being incompatible. Rather, the answer will depend on the degree to which firms within a cluster have knowledge that is considered valuable to other local firms. Firms with extra-cluster ties may serve as knowledge brokers for the cluster, introducing new ideas and practices from its other networks essential for 'cluster absorptive capacity' (the ability to keep up with cutting edge knowledge and practices) (Giuliani, 2005, 2007b; Bell and Giuliani, 2007, p.217). The potential value of local knowledge logically extends from the nature of any agricultural enterprise; local conditions vary and, in a commodity-type product, differentiation is the only way to increase prices and so revenues and profits. In the wine industry there is no question that some knowledge sources need to be local to take advantage of what most winemakers point to as the key source of differentiation, and so competitive advantage, namely *terroir*.

The analysis of the role of MNCs in technology transfer is decidedly mixed. Economists generally reinforce the basic idea that foreign competition improves local productivity (Hoekman and Javorcik, 2006, p.4). Ciravegna and Giuliani (2008, p.257) conclude, in an empirical analysis of the Costa Rican IT sector, that 'MNCs do transfer knowledge to other firms in the country but this knowledge tends to diffuse within an enclave for foreign firms, with only a small number of domestic firms benefiting from it'. However, they also find that MNCs have an indirect impact in fostering upgrading in domestic firms. Probably the best way to reconcile these two views is to state that foreign investment may be beneficial *if* there are appropriate complementary domestic policies to ensure domestic firms are able to contest markets and upgrade to global standards (Hira, 2007).

A local university or research organisation performs an essential function as the broker between outside and inside knowledge and adaptation to local conditions, ensuring that all firms have access to that knowledge through training personnel. The result of university–industry linkages has been the creation of what the industry calls 'flying winemakers', international consultants who are hired to pass on the latest techniques and detailed advice to ambitious winemakers, generally in the New World (Cusmano *et al.*, 2011, p.33).

The New World leader in research institutes is the Australian Grape and Wine Research Development Corporation (GWRDC), which is the single source for industry-focused R&D, ensuring coordination, and funded by the 'highest levy' in the world on the industry (Aylward 2003, p.43). The galvanising effort to conquer export markets made innovation a centrepiece of the industry (Aylward, 2007). Nonetheless, Aylward notes that not only larger firms, but also regional concentration may lead to uneven diffusion (2005). He finds that South Australian firms, where most of the support institutions are based, perform substantially better in terms of exports than other regions, while they access research services at twice to seven times the rate of other firms. They also have higher levels of inter-firm cooperation. Similarly, Smith and Marsh (2007, pp.228–36) point out that prior to Australia's boom, there was a consolidation in the industry around four major producers. The key was the ability

of these producers to bring along the others and government around a shared vision of export success, as reflected in the 1996 document *Strategy 2025*, which embraced innovation and product quality as its core values. This led to a concerted effort towards applied R&D, new training programmes at universities and a variety of export support mechanisms.

Giuliani's work on learning in the Chilean wine industry also reinforces the importance of support institutions. She finds that there is a high degree of interaction between Chilean wineries in Colchagua and two university-based wine research centres, with more than 50% of wineries surveyed reporting having received technical assistance from them. However, the contact is mainly for learning and problem solving purposes, rather than through joint research. The success of the cluster is based on deliberate design towards promoting these types of interactions (Giuliani, 2005b, pp.169–70).

Yet, university knowledge only gets an industry so far. The level of tacit knowledge, given the micro-conditions of winemaking, is not to be underestimated and underscores the desirability of having researchers familiar with the particular local conditions, and of local firm–firm knowledge. A study of northern California winemakers and vineyard managers revealed that their education at UC Davis in winemaking was good background knowledge, however 'what seems important is less one's degree than one's actual experience, and one's professional network through which one acquires a specific set of skills and understanding through conventions' (Guthey, 2008, p.142).

McDermott's work on Argentina directly links the efforts of public–private research organisations to success in the wine industry and suggests a path forward through 'participatory upgrading', as described in detail in the case study which follows. He notes (2007, p.126) that organisations (such as INTA Mendoza, IDR, and ProMendoza):

> pioneered new detailed mappings of the microclimates for grapes and other agricultural products; databases on best practices (internationally and subregionally), harvests, and product markets; training programs for different sectors and zones; as well as teams of experienced consultants …. By 2000, ProMendoza had helped almost 1,000 firms from various sectors participate in international trade fairs and maintained an annual budget of almost $2 million.

The most stunning aspect of McDermott's work is that he points out that San Juan, a neighbouring province, chose the *laissez faire* route, and thus provides a control case for how government intervention, in the guise of public–private partnership, works. His findings about Mendoza institutions resonate with the patterns we found in our successful cases. They were set up as inclusive and open repositories of public knowledge for the industry. These institutions included mixed membership, boards and funding from business, sectoral associations, government agencies and a university. Part of their activities included problem solving for stakeholders. As McDermott *et al.* (2009, pp.1271, 1278 and 1280) summarise:

> Mendoza overcame such barriers (social fragmentation in producer communities) by creating new GSIs (government support institutions) with distinct governance principles that helped firms' access to a variety of resources by acting as social and knowledge bridges among the communities …. First, in combining the material and informational contributions of the public and private participants, the public–private institutions

> gradually built up knowledge resources at a scale, scope, and cost that had not existed before or in other provinces and that the government and the associations could not have provided individually …. [These institutions] built programs to help firms learn from one another and create new relationships.

The authors thus signal that institutional arrangements may be the foundation of Mendoza's success in international competitiveness. In conclusion, it is clear that developing knowledge flows and support institutions is vital to wine industry competitiveness, but whether there is a systematic framework to understand them is unclear in the existing literature.

How to map out the Triple Helix for an industry

Up to this point, we have shown the importance of innovation, the gap in terms of theories about the role of policy and institutions, and thereby the potential role that the Triple Helix could play in filling that gap. However, we also saw that the Triple Helix is still in its early stages, and therefore has not moved much beyond suggesting the criteria for interaction, mainly focusing on the role of the entrepreneurial university as a source of action. More limiting still is the way that the Triple Helix is depicted, when we know from our review of innovation in the wine industry that the situation is far more complicated. Most Triple Helix depictions (see Etzkowitz and Leydesdorff, 2000, p.111) look something like Figure 1.

Discussions then centre around how the Triple Helix suggests a movement away from either a *laissez faire* model of no coordination (or just market transaction-based ones), or a state-dominated model. But we simply do not know if this model holds up in practice. In short, if we know interaction is important, we should study the ways that the Triple Helix is set up in practice, and how institutions interact, what we might call the 'institutional architecture' of an industrial ecosystem. One can imagine that the institutional architecture of different systems could differ by sector; for example, within aerospace the state would occupy a larger role than in textiles. Moreover, one can see, as suggested by the Triple Helix authors, the functions of each sector would start to meld, as in universities becoming part of industry through spin-offs. Therefore, I suggest a new way to map out the different spheres to acknowledge these possible variations.

I suggest that we depict the research function by a circle, keeping in mind that industry and government can also research; the industry (production) functions by a

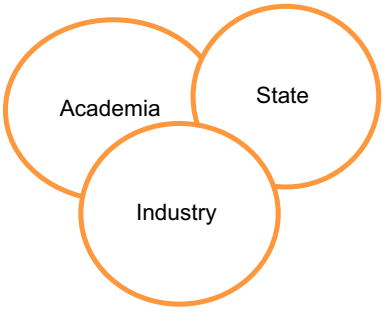

Figure 1. Traditional Triple Helix depiction

triangle; and the government (policy, decision making) function by a square. This mapping technique allows us to identify the key and peak organisations by function regardless of their origins in academia, industry or the state. Secondly, I suggest that we colour the industry-led associations yellow, academic-led organisations blue and state-led organisations red. Thus, we could have an industry laboratory depicted as a yellow circle, the academic spin-off company as a blue triangle, government-run laboratories as red circles and state-owned enterprises as red triangles (colours are displayed in figures in the online version of this article). Figure 2 shows a prototype diagram.

We created maps for many of our cases using exactly this technique, as depicted below. In the wine industry studies, we also found a number of hybrid organisations, such as mixed government–private industry tourism boards, and academic–private industry–government industry coordination boards. In these cases, we mixed the primary colours, so that government–industry mixed organisations would be orange, government–academic funding organisations purple and academic–industry mixed laboratories would be green. Where all three spheres mix into an organisation, we have coloured it grey. For easy identification, I suggest simply using a diamond for all mixed organisations, though hybrid shapes could also be used. Such efforts help to depict the complexity of actual interactions in the Triple Helix in practice. The last thing I suggest for the diagrams is to depict formal links between organisations through an intersection of the two shapes, as given in the example in Figure 3.

Using these techniques, we can begin to map different institutional architectures for different Triple Helices. Our case studies do this for late developing wine industries, but the same techniques could be used for any industry. We can then use such maps against competitiveness indices to see if the Triple Helix seems to explain success or failure, as well as if there are common architectural patterns, useful 'institutional designs' if you will, for different situations. Each case study contains an introduction to the origins of the industry, a profile of its overall competitiveness and growth, and an examination of each of the Triple Helix spheres, discussing the role of key institutions as well as their interaction. The main contribution of the case studies, as discussed below, is to reveal the deep complexity of interactions well beyond that suggested by the Triple Helix progenitors, and that the underdevelopment of one or more Triple Helix institutions, or of coordination among them, creates impediments to industry growth and competitiveness. This will allow us to see which Triple Helix architectures create the most competitive sectors in which situations.

Figure 2. Suggested improved Triple Helix units

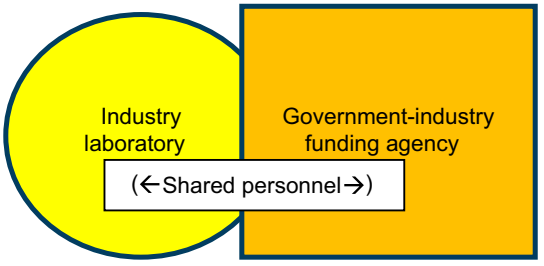

Figure 3. Hybrid coordinating institution with formal ties to private research organisation

Comparing wine industry performance

There are three key aspects of competitiveness in the wine industry: price, quality and brand recognition. We can recognise that there is a significant group of consumers everywhere who prefer to buy local, even paying higher prices, especially if they can meet the owner and see a story behind the wine, but revenues and industry growth will necessarily be limited to tourists. Even tourism may be limited if the wine is uncompetitive with cheaper and better imports, once the novelty of local tasting wears off. Therefore, the only sure signal of long-term competitiveness in the wine industry is the ability to export. From a competitive advantage point of view, we can see that bulk producers, such as Algeria, Central Asia (Georgia and Moldova) and Eastern Europe, can grow grapes and produce wine at least as cheaply as anyone in the world, reflecting more sunshine, cheaper land and lower labour costs. Therefore, we should expect their export revenues to be higher. However, we should also recognise that the overall size of the market has been changing. In some Western European markets, such as France and Italy, and in Latin America, markets have been declining. However, the overall world wine market has increased. In order to control for changes in market size, therefore, market share is a better indicator of relative performance.

As is well-documented in the literature, there has been an overall net decline in market share by European countries for newer producers. Yet, the question of which new producers are gaining deserves more attention (before we attempt to identify institutional explanations for such performance). We utilised FAOSTAT, the online database of the Food and Agricultural Organisation of the United Nations, as our source, examining the export value of wine ($1000 units) for various years. We used these data to calculate the world market share by country, as reflected in the following tables.

Table 1 examines world market share by country for three different years, 1960, 1990 and 2008. What is remarkable first of all is the incredible growth in the overall export volume over time – the size of the world wine market has grown enormously over time, reflecting increases in demand. We note in the first transition, 1961–90, the free fall of North African countries, particularly Algeria, from being leading producers to relatively insignificant producers, with European countries such as France, Italy and Spain capturing market share. European quality producers still remain dominant today, as reflected in absolute exports. In the next transition, from 1990 to 2008, we see the rise of Spain, stable market share for Italy, but a major shrinkage of French and Portuguese shares. In the last period, we can see the impressive rise

Table 1. Exports (US$) and market share in the global wine industry, 1961, 1990, 2008

Countries	1961	World market share (%)		1990	WMS 1990 (%)		2008 export value	WMS 2008 (%)
World	536,193	100	World	8,139,854	100	World	29,619,992	100
Algeria	189,820	35.40	France	4,254,690	52.27	France	10,000,600	33.76
France	145,553	27.15	Italy	1,432,810	17.60	Italy	5,277,540	17.82
Spain	29,194	5.44	Spain	580,561	7.13	Spain	2,856,430	9.64
Italy	29,000	5.41	Germany	493,290	6.06	Australia	2,146,060	7.25
Portugal	26,664	4.97	Portugal	422,810	5.19	Chile	1,352,830	4.57
Tunisia	19,034	3.55	USA	127,995	1.57	Germany	1,126,770	3.80
Bulgaria	17,607	3.28	Bulgaria	110,000	1.35	USA	962,172	3.25
Germany	12,739	2.38	Australia	92,364	1.13	Portugal	851,038	2.87
Hungary	12,595	2.35	Hungary	75,957	0.93	South Africa	758,991	2.56
Morocco	11,904	2.22	Greece	64,742	0.80	Argentina	641,391	2.17
Romania	11,077	2.07	Chile	51,578	0.63	New Zealand	599,167	2.02
South Africa	4837	0.90	Algeria	23,850	0.29	Switzerland	145,862	0.49
Australia	2910	0.54	South Africa	21,281	0.26	Bulgaria	109,134	0.37
Greece	2412	0.45	Argentina	19,594	0.24	Hungary	98,583	0.33
Israel	691	0.13	Switzerland	11,454	0.14	Greece	80,577	0.27
USA	690	0.13	New Zealand	11,091	0.14	Romania	53,593	0.18
Chile	384	0.07	Romania	11,048	0.14	Israel	21,733	0.07
Switzerland	351	0.07	Tunisia	4884	0.06	China	20,640	0.07
Turkey	168	0.03	Israel	4101	0.05	Canada	20,598	0.07
Mexico	37	0.01	Morocco	4074	0.05	Lebanon	13,095	0.04
Lebanon	13	0.00	Brazil	3665	0.05	Morocco	11,031	0.04
Argentina	11	0.00	Turkey	2709	0.03	Tunisia	10,969	0.04
Brazil	0	0.00	China	1433	0.02	Turkey	7964	0.03
Canada	0	0.00	Canada	1349	0.02	Brazil	7667	0.03
China	0	0.00	Mexico	1107	0.01	Mexico	3076	0.01
New Zealand	0	0.00	Lebanon	1100	0.01	Algeria	1956	0.01

Note: Sorted from highest to lowest, not all countries included. World market share is calculated by dividing annual export values ($1000) by world market totals.
Source: Food and Agriculture Organisation.

of the new producers, including the US (California), Australia and Chile. South Africa, Argentina and New Zealand seemingly come out of nowhere to register impressive gains.

To put relative losses and gains into clearer perspective, we also calculated the differences in market share over time, as reflected in Table 2. We see here the remarkable gains by both the new European powers and the emerging New World producers as North African and Eastern European countries lose ground. The trend shifts in the 1990s as the traditional powerhouses of France, Portugal and Germany lose market share to the upstarts. This suggests that comparative advantage (as measured by exports in the wine industry) is more a function of quality than of comparative advantage in costs.

Given that wine is not only a commodity but also a product marked by differentiation in quality (however perceived), it is even more important to take note of quality trends, to the extent that they can be measured. This is all the more urgent since an increasingly competitive globalised wine industry is awash with volume, so producers who do not have comparative advantage need to move out of bulk markets

Table 2. Change in world market share, 1961–2008 and 1990–2008

Difference in WMS 1961–2008 (%)		Difference in WMS 1990–2008 (%)	
Increases in market share		**Increases in market share**	
Italy	12.41	*Australia*	*6.11*
Australia	6.7	*Chile*	*3.93*
France	6.62	*Spain*	*2.51*
Chile	4.5	*South Africa*	*2.3*
Spain	4.2	*Argentina*	*1.92*
USA	3.12	*New Zealand*	*1.89*
Argentina	2.16	*USA*	*1.68*
New Zealand	2.02	**Insignificant change**	
South Africa	1.66	Switzerland	0.35
Germany	1.43	Italy	0.22
Insignificant change		Canada	0.05
Switzerland	0.43	China	0.05
China	0.07	Romania	0.05
Canada	0.07	Lebanon	0.03
Lebanon	0.04	Israel	0.02
Brazil	0.03	Mexico	0
Mexico	0	Turkey	–0.01
Turkey	0	Morocco	–0.01
Israel	–0.06	Brazil	–0.02
Greece	–0.18	Tunisia	–0.02
Significant declines		Algeria	–0.29
Romania	–1.88	Greece	–0.52
Hungary	–2.02	Hungary	–0.6
Portugal	–2.1	**Significant declines**	
Morocco	–2.18	*Bulgaria*	*–0.98*
Bulgaria	–2.92	*Germany*	*–2.26*
Tunisia	–3.51	*Portugal*	*–2.32*
Algeria	*–35.39*	*France*	*–18.51*

Note: Differences = market share from current year minus previous year; significance assigned at 1% change.
Source: Calculations from Table 1.

through quality improvements (Hira, 2013). The source of (perceived) quality is brand recognition. Malbecs can be produced in a variety of places, but only Argentina is able to sell high volumes at high price points. Quality in wine is as much about reputation as it is about an objective scale. Quality improvements would indicate that local institutions are working to improve both wine production processes and brand recognition (marketing).

Given the tens of thousands of different wine brands that supposedly can vary from one year to the next, an information system for quality in wine markets is vital. This information system includes appellation, whereby the source region of a wine helps to set the value and price, suggesting consistent quality and *terroir*, or local conditions that produce distinctive qualities. It also includes the vital role of reviewers, such as Robert Parker, who rate wines, giving signals to distributors and consumers and helping to set prices. To engage with quality, we examined *Wine Spectator* ratings for a variety of producers, as reflected in Table 3. *Wine Spectator* is widely regarded as the leading journal of the wine industry, and it has the only global historical database of ratings. The ratings in *Wine Spectator* follow a 100-point scale, with 90 widely considered as marking a great wine. In order to get a sense of the emergence of each industry on the global stage of wine competition, we indicate the year of the oldest vintage. We also give the overall proportion of all wines rated 90 or above. We then examine the proportion of selected years over time to see if there are indications of quality improvement.

We notice that France and Germany are the clear world leaders in producing high quality wines, with Germany's quality improvement especially remarkable. Italy, Portugal and Spain have relatively stable performance, with Spanish wines gaining 90 point ratings about half as often. However, what really cements the foregoing analysis is the fact that Argentine, Australian, New Zealand, South African and US (California, Oregon and Washington State) wines are all competitive and improving, though New York wines are not. Chilean wine is less highly rated, reflecting its position in the value category, though our index demonstrates improvement over time. While the Canadian sample is too small to say much, there is evidence that Ontario ice wine has achieved a consistent quality reputation; five of the 13 wines reviewed are ice wines. Very few other Latin American, Eastern European, North African/Middle Eastern or Central Asian producers are rated, which we take as a sign they are not considered to be important producers. Israel appears to be just emerging; Bulgaria, Greece and Hungary, although long time producers, are insignificant. While one can argue about the extent to which small producers, such as British Columbia, are adequately represented, relatively small producers, such as Oregon, do appear. Oregon's success in producing high quality, world-renowned Pinot Noirs has undoubtedly helped it improve its price over time.

Taking these cues about differential performance together, we can sum up our main observations from the data tables: even in well-established industries, such as wine production, incumbent producers can lose market share over time; and producers who gain world market share appear to be those who are able to raise their quality. And, as quality improves, so do price points (price per bottle), revenues and profits, just like any other differentiated good, such as luxury cars. Notably, even if you continue to improve quality, as France has, you may lose market share if lower cost producers, such as Argentina, can also improve quality. The emergence of new quality competitors has not yet created any shakeout, as wine demand has also been increasing worldwide. However, the possibility is real if even lower cost producers

Table 3. Wine spectator ratings over 90 overall, 1990 and 2007

Country	Oldest vintage	Total entries	# > 90	Proportion	1990 total	1990 >90	1990 proportion	2007 total	2007 >90	2007 proportion	Increase 1990–2007
Argentina	1977	3746	467	12.5%	18	0	0.0%	505	84	16.6%	16.6%
Australia	1955	11,664	2547	21.8%	161	13	8.1%	506	139	27.5%	19.4%
Bulgaria	1985	95	0	0.0%	4	0	0.0%	4	0	0.0%	0.0%
California	1892	52,228	9595	18.4%	1527	188	12.3%	3035	950	31.3%	19.0%
Canada	1989	450	63	14.0%	3	0	0.0%	34	13	38.2%	38.2%
Chile	1979	5487	343	6.3%	88	0	0.0%	434	42	9.7%	9.7%
France	1771	69,051	17,803	25.8%	1940	648	33.4%	3967	1504	37.9%	4.5%
Germany	1893	9463	4044	42.7%	344	126	36.6%	770	482	62.6%	26.0%
Greece	1981	726	22	3.0%	2	0	0.0%	66	1	1.5%	1.5%
Hungary	1972	262	119	45.4%	8	0	0.0%	7	0	0.0%	0.0%
Israel	1981	537	115	21.4%	4	0	0.0%	60	2	3.3%	3.3%
Italy	1941	37,349	8055	21.6%	850	168	19.8%	2050	451	22.0%	2.2%
New York	1980	2874	73	2.5%	15	0	0.0%	363	11	3.0%	3.0%
New Zealand	1986	3748	573	15.3%	19	1	5.3%	264	45	17.0%	11.8%
North Carolina	1987	114	0							0.0%	0.0%
Oregon	1980	5690	1434	25.2%	80	3	3.8%	329	83	25.2%	21.5%
Portugal	1802	3901	764	19.6%	71	3	4.2%	288	84	29.2%	24.9%
South Africa	1975	4262	612	14.4%	41	0	0.0%	315	71	22.5%	22.5%
Spain	1879	9119	1173	12.9%	134	9	6.7%	421	49	11.6%	4.9%
Switzerland	1991	109	3	2.8%	0	0	0.0%	0	0	0.0%	n/a
Virginia	1983	539	1	0.2%		0				0.0%	0
Washington	1985	6925	1908	27.6%	73	13	17.8%	573	283	49.4%	31.6%

Note: Number and proportion of wines from a region receiving over 90/100 points, the mark of a high quality wine.
Source: Calculations from *Wine Spectator*.

in Eastern Europe, Central Asia and North Africa can improve quality or demand drops or plateaus. This brings us back, then, to our central question of whether the improvements in quality in the emerging quality producers mirror improvements in Triple Helix institutions.

Summary of case study findings

Three helices but one leader

The case studies that follow collectively reveal that reputation develops partly from marketing, but mostly from creating flows of specialised production knowledge throughout the sector, supporting the general principles of the Triple Helix about knowledge circulation. As one pioneer interviewed in Oregon put it:

> When the French came in with new ideas, they forced everyone to up their game. That only happened because we shared the new techniques and clones with them. In turn, the group of competitors was over time able to adapt that imported knowledge to local conditions, through a period of furious experimentation and exchange of ideas.

We also find support for the idea that lack of Triple Helix institutions corresponds to low quality. Wine industries, such as that of Québec, can often be *sui generis*. They are created by local entrepreneurs with little backing, at least initially, on the basis of preference for local production. The free market does spot opportunities for those who are nimble and have the means and visions to find them. In cases where one or more spheres are missing, such as Algeria or Georgia, with little research capacity and poor marketing coordination, the industry struggles to improve quality. Achieving quality requires a well-trained workforce, researchers and extension agents who can translate global into local knowledge, and an industry association that promotes inter-firm ties and tacit sharing of knowledge. However, just achieving quality is not enough. It is equally important to have a collective promotional institution to establish and enforce quality standards, to push for specialisation in a grape variety or type, and then to create brand recognition through success in overseas markets. Brand recognition on a wider scale necessitates coordinated, collective action. Ironically, success overseas seems to work hand-in-hand with the ability to compete on a domestic level for higher price points. Specialisation allows the development of expertise that is not easily reproducible, and the maintenance of competitive advantage at higher price points. However, specialisation and recognition of it are not easily achieved; they require not only ongoing in-depth research for quality improvement, but also enforcement across an industry, since one bad batch or free rider can ruin everyone's reputation. A consensual long-term strategy appears to make a crucial difference, as does the fact that exporting changes the dynamic from local competition to local cooperation for global competition. Such elements are lacking in all of the cases we examined that were faltering, from Algeria to Baja California to Central Asia.

The balance of spheres implied by the Triple Helix also holds true – with one caveat. In cases such as Bulgaria, where there is a strong state push but not enough private sector leeway, success is limited. In cases such as Ontario, the weakness of private industry organisations (reflected in internal divisions) is matched by weak state policies towards coordination. In the Canadian case, then, there is policy stasis leaning towards protection as incumbent beneficiaries retard further evolution of the

industry. Since incumbents dominate the scene, they complain to policymakers that volume is too low to warrant any measurement by global market measures. This is a cover for a protectionist argument. The problem with this approach (beyond the subsidisation of many consumers for a few producers for a net loss) is the questionable claim that without protection there will be no local industry. In fact, we have seen that there are small producer cases, such as Washington State, Oregon and New Zealand, that are globally successful. In these cases, the industry begins with protection, but is weaned off and directed towards export through state leadership. Therefore, a central issue for the Triple Helix is capture of the policy process by a handful of dominant firms, echoing Giuliani's findings about the uneven landscape of firms in Chile and Italy.

During Spring 2012, we conducted an online survey with directors or chief personnel from each of the key Triple Helix institutions for the cases we studied. The results reinforce our observations about the complexity of coordination thus far. We translated the survey into Spanish and Portuguese for the Latin American cases. In total, we received 33 responses to the English language survey, five from Mexico and Argentina, and seven from Brazil. Our response rate was roughly 20%; it is notable that we received far more responses from the success cases. Apart from Israel, we received no responses from Eastern Europe/Central Asia or Middle East/North Africa, indicating institutional problems.

In terms of factors for industry success, most considered *terroir*, proximity to markets, partnership of academic, public and private sectors, shared strategic vision, and access to new technologies to be important factors. Proprietary knowledge and age of industry were almost evenly divided between those who think these important and those who do not. Size of industry was considered by most to be just somewhat important. This suggests that the basic elements laid out in the Triple Helix are recognised as significant by industry.

An almost even number considered their levels of coordination to be weak or average (9% and 42%) as solid and outstanding (39% and 9%). There was no clear geographical pattern to these responses. This suggests that there is either a subjective element and/or coordination is sometimes exclusionary. It also suggests that an even deeper level of analysis than the one we conducted in our studies is needed, to examine participation within each sphere (intra-sphere coordination). Indeed, in all of our cases, there are ongoing problems of how to develop a fair system of participation for firms, universities, and regional and local policymakers. Almost all said industry should take the lead. Almost all said the same about which actor does take the lead: 58% said grape-growers and winemakers often coordinate, while 33% said they did sometimes. Echoing this finding, in regard to a levy system to support industry associations, there were mixed views: 45% voted for universal membership and a common levy; 18% for one industry but voluntary membership; 27% for multiple organisations with mandatory fees; and just 9% for multiple organisations and voluntary fees.

We can now spell out the caveat to how the Triple Helix really works. Despite the importance of having all three spheres play a role, the only real institution capable of coordinating these aims is the state. Etzkowitz is wrong in suggesting leadership by entrepreneurial universities is the key catalyst; in the cases we studied, universities play an important but complementary role in innovation. In some cases, such as New Zealand, industry takes the lead, but it is the state that heads the charge and provides the glue that keeps firms on the same page, working towards long-term

industry competitiveness. In a sense, the state provides the regulatory authority for the Triple Helix institutions to work together for collective goods. In cases where the wine industry falters, the state is overbearing, as in Eastern Europe or Central Asia. However, in other cases, where the state takes a backseat, such as South Africa and New York, quality also suffers. Thus, whether the state is in partnership with industry, and possibly academics, or is running a central coordinating body, there needs to be a leader for the Triple Helix, not the spontaneous coordination theorists imply.

This contradicts the findings of our survey, and suggests that individual actors often do not see the value of collective public policies. Without a central coordinator, we see from our case studies that collective actions can break down as members opt out of the funding systems needed for institutions. The point is seen clearly in the case of the British Columbia wine industry, which lacks both research capacity and a peak industry organisation (Hira, 2013). According to respondents, the public sector plays a wide variety of roles beyond regulation, including sponsoring conferences, marketing and export assistance, but not developing local suppliers or a qualified labour force. This finding indicates that mission overlap, where actors in one sphere adopt the objectives of the other, is much more variegated and limited than Etzkowitz suggests. It is interesting to note that the Latin American respondents think that the state should adopt a strategic and leadership position. So, here we are struck by the same basic contradiction: respondents want the state to perform key leading activities without being the formal leader.

Most respondents considered word of mouth, industry conferences, industry associations and agricultural extension as most important for knowledge dissemination. Few found other winemakers to be important, and feelings about internet sources were spread evenly between extremely important and not important at all. Respondents were evenly split between those who thought public research laboratories should develop knowledge first and then spread it through extension, and those who felt that winemakers should initiate problem solving. Several respondents commented that they felt these were compatible. However, the idea that winemakers should solve problems through their own cooperation was not supported. Again, this reveals that industry puts firm interest before collective interest, even if the value of Triple Helix principles is recognised.

The Triple Helix also understates the depth of the coordination problem. Simply having some level of coordination of the three institutions is not enough. As illustrated in the Canadian case study, there has to be both consensus around strategy and a dense network of shared personnel among the three. In the success case of Ontario ice wine, for example, pioneers from private industry played the key role in developing the technique and creating brand recognition for a new product. However, maintaining ongoing competitive advantage means specialised training and research in ice wine, specifically by developing techniques and enforcing brand recognition (given the growing fraud in the industry), and by ensuring that the highest quality standards are collectively met. The role of Brock University's Cool Climate Oenology and Viticulture Institute is central to this effort, and personnel there have both specialisation in ice wine and experience in the industry. Federal and provincial governments devote few resources to collective standards and these areas are lagging. In Baja California, the case is even more stark – the three institutions exist, but the state and researchers lack adequate resources and do not coordinate well with industry. Brazil is another example where multiple institutions exist, but poor coordination reduces effectiveness.

Two aspects appear to reflect a high level of coordination in our successful cases: a peak organisation, generally of mixed public–private–research personnel, and a mandatory levy system (state regulatory authority) that provides the funding for organisational, research, extension and promotional efforts, in effect creating a national or regional brand strategy and the push for improving quality that comes with it. We recognise the key role of foreign injections of ideas, capital and distribution networks in the pioneering stages of modern industries in a number of cases, though the level of benefits after the initial stage is less clear.

Behind institutional success, then, are informal productive personal networks of cooperation. When asked what advice he would give to other industries facing dissonance, one Oregon participant said:

> There is something in Oregon's culture which helps, but that is hardly the full story. There is continual movement towards fragmentation, including notably between Southern Oregon and Willamette, and small and large producers. Leaders of the sector need to share visions and strategy. This does not just happen on its own. It is a product of having staff people and key personalities fully dedicated to consensus-building and bridge building. Sometimes you just need to get everyone in a room and have these middlemen start to put ideas on a board until the differences can be seen to be smaller than the common interests. Having dedicated handmaidens (full-time staff) to develop the lines before you meet is extremely important.

This sentiment matches closely the notion of bridging assets across the spheres in our earlier discussion, but with the twist of ensuring that such bridges are capable negotiators with some power, not just the benign coordinators suggested by Triple Helix theorists.

Comparing institutional architectures across the cases

Using Tables 1–3 above, we can classify each wine industry into overall levels of success in global completion, with an emphasis on those which have been able to improve quality. Table 4 summarises how the level of success compares with institutional features of the wine industry from each case. For the most part, the mixed and nascent cases are producing mainly for tourists and local consumption. South Africa is the only exception (see case study details to understand why). Table 4 demonstrates our central point: the Triple Helix does seem to explain relative industry success in two ways: by the presence or absence of key institutions in each of the spheres of action, and through the ability to coordinate the industry around collective quality efforts. We turn now to some example Triple Helix maps to illustrate some features of particularly interesting cases.

Our case studies of the industries in Eastern Europe, North Africa and Central Asia all seem to lack one or more of the key Triple Helix institutions or severely underfund such institutions. The case of New York (as discussed in the US wine industries paper) is one of a high volume producer that has struggled to improve quality. Our map suggests that weak institutional architecture can help to explain why – there are no direct institutional links between industry and academics, though personal links do exist (Figure 4). Unlike other cases such as Australia, where a levy pays for research and marketing, in New York funding depends upon annual budgets.

Table 4. Comparing cases for collective public policy efforts

	Long-term strategy?	Mandatory levy?	Mixed public–private coordinator?	National branding?	Varietal specialisation?
Highly successful					
Argentina	N	N	Y	Y	Y
Australia	Y	Y	Y	Y	Y
New Zealand	Y	Y	Y	Y	Y
Oregon	N	Y	Y	Y	Y
Washington State	N	Y	Y	N	N
Mixed success					
British Columbia	N	N	N	N	N
Israel	N	N	N	Y	N
Ontario	N	Y	N	N	N
South Africa	N	Y (on exports)	N	Y	N
Limited success					
Brazil	N	N	N	N	N
Eastern Europe/ Central Asia	N	N	N	N	N
Mexico	N	N	N	N	N
Middle East/ North Africa	N	N	N	N	N
New York	N	N	N	N	N
Nascent					
North Carolina	N	N	N	N	N
Quebec	N	N	N	N	N
Nova Scotia	N	N	N	N	N
Virginia	N	Y	N	N	N

Source: Case studies.

In our mixed cases, we generally see that all three spheres of the Triple Helix exist, but they are often poorly coordinated, with divisions in one or more of the spheres. These cases seem to lack a central coordinating body and formal overlaps across the spheres, the bridging assets. These are termed ‘mixed cases’ because there is a level of recent success from humble origins, but with upward limits based on institutional blockages. On the positive side, British Columbia’s and Ontario’s VQA systems created a signal for improved quality for local customers, and helped to open exclusive shelf space for local production. In almost all the cases, tourist interest is the early foundation for regional brand recognition. With this comes greater employment and value added locally. However, unless there is institutional support to help improve the quality of the product, branding alone will be insufficient. The signal to the consumer is that there is either quality wine or no quality wine, which goes only half the distance to demonstrating global superiority through specialisation, as we see in our successful cases.

The nascent wine industry in British Columbia demonstrates severe fragmentation in institutional architecture, despite all the requisite Triple Helix institutions (see Figure 5). As discussed in Hira (2013), there are long-term personal, political and

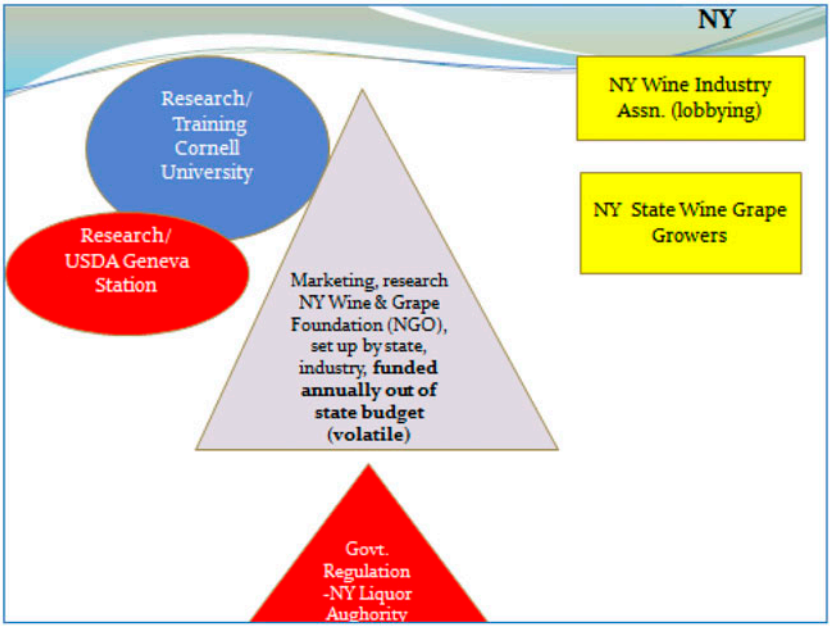

Figure 4. New York State Triple Helix – lack of funding

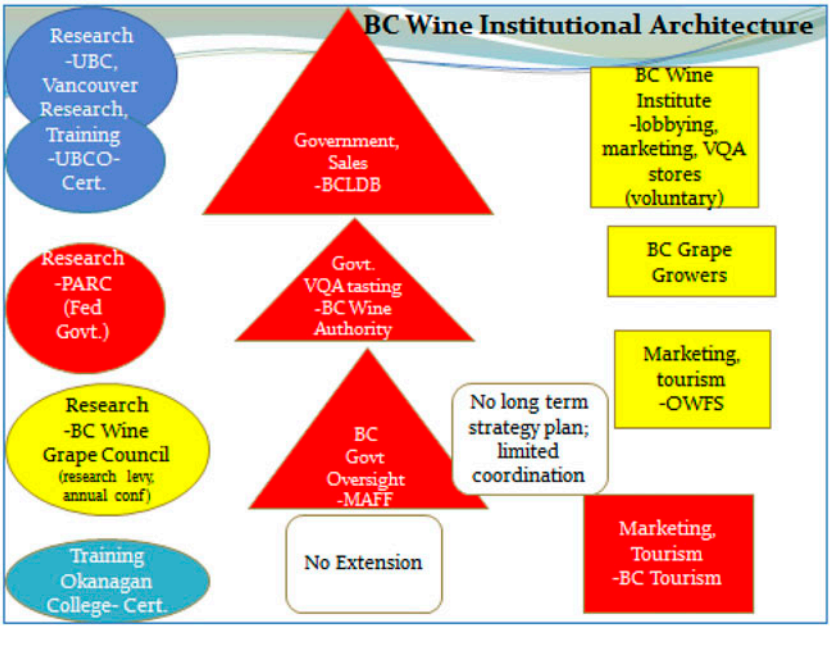

Figure 5. British Columbia Triple Helix map – industry and research separation, lack of coordination

historical reasons for this, and lack of coordination has generated basic marketing and lobbying difficulties ranging from learning how to export to ineffectiveness in pushing for reductions in inter-provincial barriers. Lack of state leadership at the provincial and federal levels has led to the industry's inability to progress.

The map of Ontario (Figure 6) shows quite a different picture. There are multiple industry associations creating coordination problems (as reflected in the case study), but there is still coordination between Brock University and the industry for research purposes. The case of South Africa (Figure 7) is unusual. As discussed in the case study, the industry has become bifurcated between large and small producers. As the former found coordination with the latter difficult, the formal coordinating institution, the South African Wine and Brandy Corporation, was allowed to expire. World class research conducted at Stellenbosch and the Wines of South Africa marketing organisation seem oriented towards helping large exporting producers.

Institutions

Among the strong cases, we see a number of formal overlaps across organisations. We also see a central coordinating body for R&D and for coordinated marketing efforts. In each case, the region has developed a reputation for high quality, usually in one grape variety, through technological innovation. High performers are responsible for a number of interesting innovations in institutional design, reflecting the need to tailor Triple Helix principles to local conditions, but in a way that follows its basic logic. Australia, with its long-term consensus building, is the outstanding example.

Regional specialisation and branding deserve special mention. Oregon's Pinot Noir, New Zealand's Sauvignon Blanc, Ontario's ice wine and Argentina's Malbec have opened up production frontiers, created a cachet around regional production,

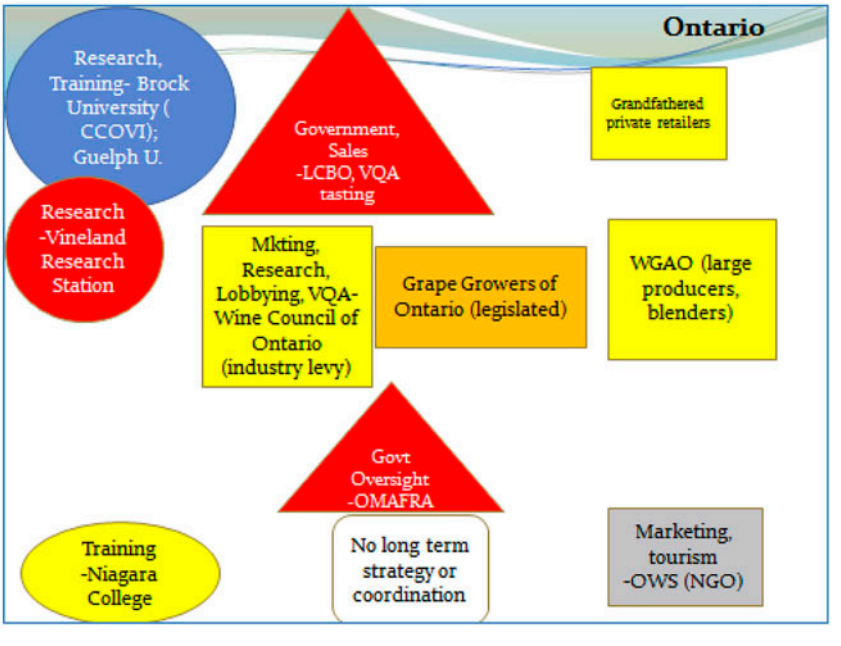

Figure 6. Ontario wine Triple Helix – industry fragmentation

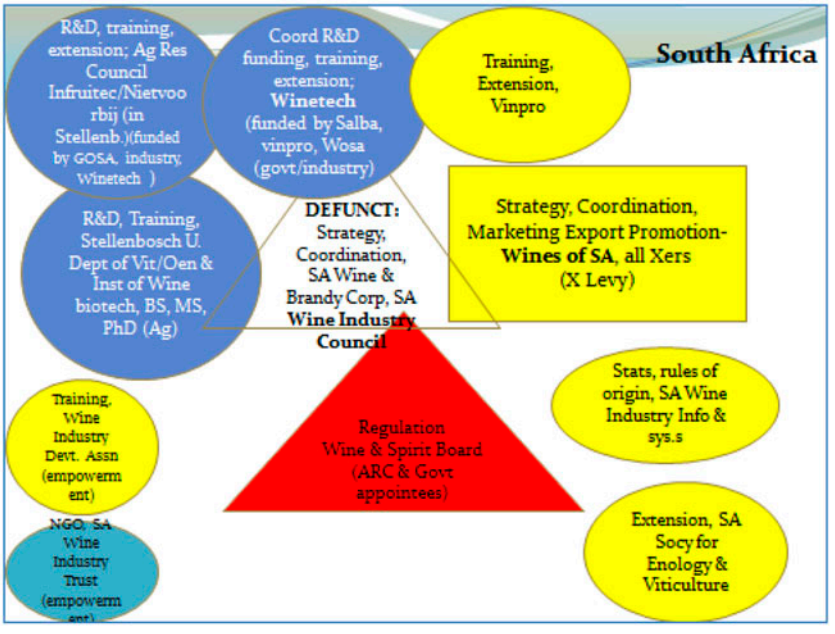

Figure 7. South Africa – bifurcation of industry coordination

and garnered higher price points for basically the same product. Experiments in New Zealand and South Africa in creating sustainability as a brand are notable. Whether national brands can splinter off into regional brands (as in Australia) remains to be seen.

Australia, New Zealand and Ontario have interesting institutional experiments in winery and grape grower relations. Australia and New Zealand use proximity and national strategy to bring the parties together, but still lack long-term coordination across sub-sectors. Ontario's singular grape grower organisation helps to solve the collective bargaining disadvantages of grape growers, but still has not cracked the problem of instituting long-term quality improvements. For the most part, successful industries seem to rely on individual efforts, personal relationships and, to a lesser extent, general agricultural extension.

The Washington State wine industry (Figure 8) has achieved some level of success at exporting, but not on the level of Oregon. It has the formal architecture for success, but lacks specialisation and is dominated by two firms. The absence of additional firms means there is limited long-term vision at an industry level for creating a regional brand. Oregon is the most interesting case for small wine growing areas with a very well-coordinated sector, both formally and informally (Figure 9). It has a number of evenly-sized firms producing world class Pinot Noir. The levy system allows the industry to push the research agenda of the Oregon Wine Institute at Oregon State University. New Zealand is a case that fits our survey results well (Figure 10). It has a strong industry lead, yet (as noted in the case study) the role of the public sector has also been crucial for injecting national interests into the trajectory of multinational-led industry growth.

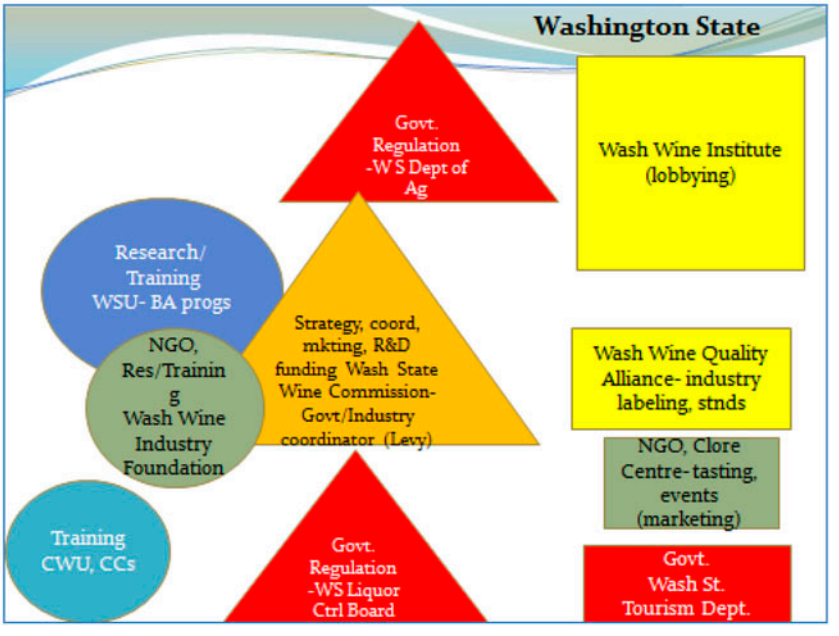

Figure 8. Washington State – coordination but limited vision

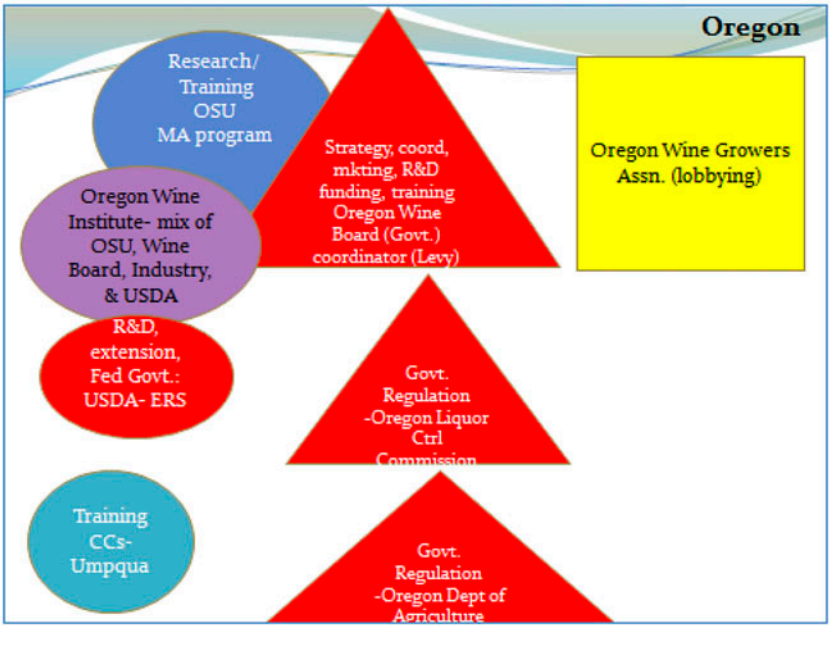

Figure 9. The institutions behind Oregon's pinot success

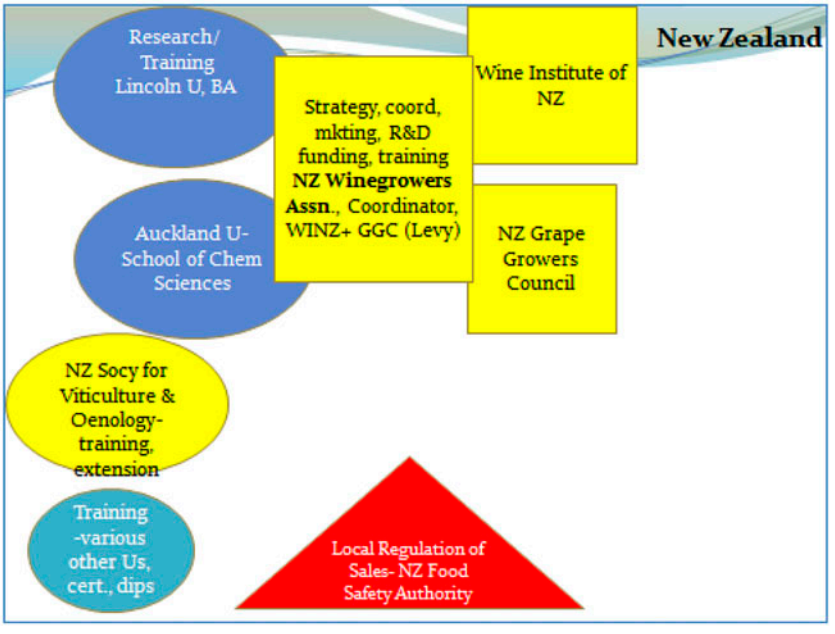

Figure 10. New Zealand's global–local matrix powers export

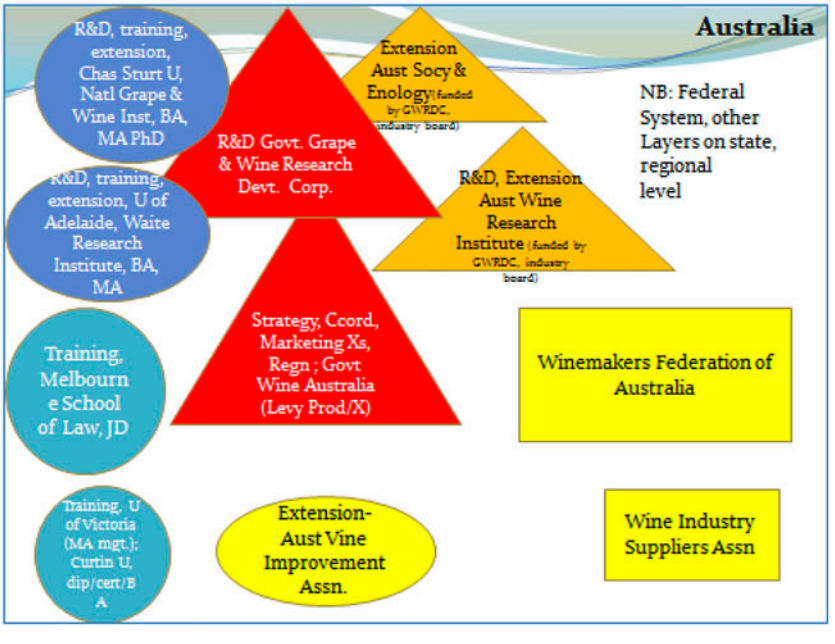

Figure 11. The *über* case – Australia's institutional webs

Finally, we turn to our *über* case, Australia, by far the largest producer we studied, and one of quite notable success (Figure 11). Like the other successful cases, Australia has explicit coordinating vehicles for its Triple Helix, but through a mixed public–private partnership arrangement. The map in Figure 11 does not do justice to the admirable complexity of the Australian system, which reaches vertically, from local to regional to national levels, as well as horizontally across the Triple Helix.

Conclusion

We have seen in this introductory paper that the Triple Helix can make an important contribution to explaining the institutional frameworks behind innovation success, but has so far lacked the tools for examining them empirically. We sought to provide the first generation of such tools through institutional mapping of emerging wine industries, finding patterns among successful industries and failures, and exposing the variations of local solutions to coordination problems. Similar exercises across other industries could yield equally interesting results, and suggest ways for policymakers to shape institutions for improving industrial competitiveness. Moreover, the case studies and maps reveal yet further layers to be mapped to understand coordination problems within specific spheres and functional actions, as well as among global partners.

We close with some memorable quotations from interviewees that underscore the importance of both formal and informal coordination around a central coordinating body led by the state with a long-term strategy based on specialisation and continuous reinforcement of collective goals.

> We always share knowledge. If there is someone new, we help them out.

> In Oregon, it's always been the 'circle the wagons' culture of cooperation and helping each other out.

> We have always had the sense of being at the frontier – you either cooperate or (you) die.

> The real secret [to New Zealand's success] is how the big guys got on the same page with the local winemakers to form a long-term strategy.

> At some point, Ste. Michelle realized that they had to help bring along the little guys, or no one would respect Washington wines.

> We have three or four things that are like heroin for the winemakers. We offer them services that they really need. We are constantly out there talking to them.

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I would particularly like to thank Steven Henderson, the editor of the journal. It is rare to have an editor who is willing to work with an author from potential contribution to actual contribution, a painstaking process. In this instance, we moved from a collection of in-depth case studies to a tightly-focused effort to build innovation theory through a stretched application of the Triple Helix framework that revealed its overall strength, but also its gaps and weaknesses. Above all, Steven pushed me to systematise the parameters of how the mapping tool we introduce here could be used to analyse Triple Helix coordination. I think the resulting analysis can be applied to any industry, building theory and helpful policies simultaneously.

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