Chapter 8

Towards an Ecology of Cooperation

> William Blake asked the tiger: "In what distant deeps or skies .bumed the fire of thine eyes?" What struck him in this way was the cruel pressure, at the limits of possibility, the tiger's immense power of consumption of life. In the general effervescence of life, the tiger is a point of extreme incandescence. And this incandescence did in fact bum first in the remote depths of the sky, in the sun's consumption. Georges Bataille, *La Part Maudite, The Accursed Share*

We began the last chapter with the observation that the neoclassical (read: neo-Walrasian) paradigm offers little use in developing suitable theories to account for outcomes in organizations based on certain normative frameworks, such as the cooperative principles and values. In particular, it offers no robust tools to analyze qualitatively different *hierarchies*, such as inalienable versus translative hierarchies. Mainstream management theory is only slightly better in this regard [Biggiero, 2016]. Therefore, we developed tools to distinguish between two main types of hierarchy and connected these with the DCMs. We now intend to advance this relational epistemology and methodology into the realm of the organizational environment. If firms are anticipatory systems, as we argued in the prior chapter, then we must focus on the environment influencing and shaping their expectations and beliefs. [Pfeffer and Salancik, 2003]

This chapter envisions returning to the concept of *macroculture* introduced in 6.1 above. In particular, it does this by replacing the concept of *national accounts* with that of *ecology* as the central anchoring point for a *relational* approach to macroeconomic analysis. In this way, we are able to move

beyond the formal definition of economy and can speak of a *substantive* macroeconomy, encompassing sectors like the care economy and others not necessarily dominated by monetary transactions [Polanyi, 2018]. In order to achieve this, we are interested in investigating the contribution a concept like Robert Ulanowicz's *ascendancy*, which encompasses notions of growth and development, has in facilitating a focus on *macroculture* in macroeconomics. Moreover, we will also attempt to connect this notion with existing attempts to integrate *network analysis* into economic analysis and reasoning[1]. These discussions will prepare the ground for our later discussion of the research agenda we introduce in Part III.

Since most cooperatives are operating in a market environment[2], we thus must study how they coordinate their activities on the basis of principles *in and despite such an environment*. This chapter will thus be split in its focus, on the one hand, on how cooperative principles are communicated in a dissipative environment like national, or global, markets. At the same time, the chapter will discuss the potential for extending the reach of the principles into the domain of scientific discourse in an autocatalytic fashion. Each of these discussions, while distinct, concerns the ecology of cooperation in its ability to flourish in an uneven playing field.

At the same time, the chapter will consider possible synergistic prescriptions to curtail the asymmetric impact of market forces on such cooperative forms of organization. This latter ambition includes a dual focus on both the networks of relationships that occur based on particular logics or propensities *and* how these manifest in the physical and spatial environment in which such organization occurs. Methodologically speaking, we are interested in searching for an empirical basis of cooperative macroeconomy in network theory and ecology. Part of this move will involve re-inventing "embedding" as a causal concept.[3] This will involve viewing, e.g., the cooperative principles as attractors (in the sense of dynamical systems) or redundancies (in the sense of information theory) that are tied to certain logics in particular species of circumstances. By doing so, they simplify an indeterminate universe of experiences to a manageable degree with respect to those parameters of interest (usually ones tied to accountability, equity and inclusion).[4]

In part, the focus on redundancy is facilitated by the increasing uncertainty

[1]See, e.g., [Biggiero, 2016] for a succinct overview of such attempts.

[2]Social cooperatives and those with a fixed association with key stakeholders, e.g., municipalities, charities, etc., naturally serve as exceptions to this dynamic.

[3]The preparations for this have already been made in the prior discussion of notions like *relational governance* and in the discussion in 6.6.4.

[4]As has been pointed out, autocatalytic processes feature mutualism as their normal state. [Ulanowicz, 2009].

that comes along with higher levels of complexity and abstraction, such as the level of the environment, as we are discussing here. Given that uncertainty, not only people, but also organizations, stand to gain from pooling resources and insuring themselves against volatile outcomes. Thus, macroeconomies are not the result of "mere" aggregation of individual behaviors as has been supposed by neoclassical economists. Instead, "the macroeconomy" is also the result of emergent phenomena, in particular, the desire to reduce *organizational* uncertainty by moving certain cognitive elements beyond the individual. Thus, the reduction of uncertainty plays a central part in guiding aggregate, i.e., macroeconomic, behavior. This involves as well questions of transforming qualitative into quantitative change, and vice versa..

It is to this discourse that the chapter seeks to contribute. Like Bataille's tiger in the introductory quote, this chapter is accordingly one of the more experimental in this volume, in that it asks how flows of resources between firms, including income, can promulgate transformative change in social processes. It thus attempts to contribute to the shift away from static, mechanical pictures of social systems as agglomerations of self-interested agents and towards a view of interdependent, complex and – above all – emergent systems with significant system-level characteristics. Following the logic of Bateson, who "was calling for a complete overhaul of how we look at the world, one informed by the image of the ecosystem rather than that of the machine"[Ulanowicz, 2009, p. 2], we also seek to adopt the *ecosystem* category as one that offers useful tools for understanding and analyzing organizational activity in the context of changing environments. As we have discovered above, the ecosystem of the cooperative economy, on the one hand, necessarily incorporates place, typically the domain of the municipality – the *polis*. On the other hand, and importantly, it can be situated within what has been called a *Triple Helix*, an emergent domain of discursive knowledge. [Leydesdorff, 2021]

Thus, the outline of this chapter is as follows. We begin by introducing the imperfection principle, which will provide the context of justification for the remainder of the chapter. After this, we discuss the importance of distinguishing between market forces and market transactions, a useful step in further developing a relational methodology. Thirdly, we introduce some basic notions from network and complexity theory, as well as ecology, including *ascendancy*, conditional entropy, uniqueness and AMI (mutual information), synthesized in the rubric of *process ecology*. After this, we attempt to interpret cooperative principles 6 and 7 as attractors (our attempt to "re-invent" embedding). After this, we synthesize the discussion of principles 6 and 7 with that of the prior principles and ask what sort of ecosystem the principles create or render possible, and furthermore, if one can measure particular

aspects of their discrete contribution to this process (i.e., looking for principles-related measures).

Finally, we attempt to derive a *cooperative n-tuple helix* framework for strengthening cooperative research ecosystems, entertaining as part of this development a discussion of the importance of mutually beneficial dynamics (synergies) for both harmonizing, relationalizing and strengthening cooperative approaches to economy. In the conclusion, we attempt to sum of the contributions of this chapter by asking whether self-organization (viz. cooperative organization) is a useful concept to interpret aspects of human ecology.

8.1 The Imperfection Principle

The first order of business is to establish a context of justification for such an endeavor. This involves underlining an epistemic standpoint that challenges the assumption that perfectly competitive markets are a sufficient basis for economic analysis. In fact, as [Shaikh, 2016] suggests, the assumption of perfectly competitive markets is unrealistic, and requires "irrational expectations"[Shaikh, 2016, pp. 346-349].[5] To emphasize the great chasm between the theory of complete markets and the reality of firm and household behavior in the market, Greg Dow shows that "in an environment of complete and competitive markets, control rights can be assigned to any set of input suppliers (or output demanders) without endangering allocative efficiency." In fact, "the LMF [labor-managed firm] exhibits the behavioral and efficiency properties of the Walrasian firm."[Dow, 2018, pp. 61f.]

Thus, "[a]ny theory claiming to explain the empirical asymmetries between KMFs [capital-managed firms] and LMFs must specify one or more departures from the framework of complete and competitive markets." [Dow, 2018, p. 7] If it is the case that firms are not price-takers, entry is not free, sunk costs are not irrelevant and scale economies and working capital matter, then this circumstance surely has a role to play in the rarity of LMFs in most contemporary economies. Therefore, "[t]he task facing both advocates and skeptics of workers' control is to identify market failures that differently affect labor-managed and capital-managed firms"[Dow, 2018, p. 62]

This principle disconnects us from any last vestiges of the neoclassical model in our efforts to construct a cooperative economics. As we will learn in this chapter, much more effective in analyzing really existing cooperative enterprise, and for developing useful theories for entrepreneurship, innovation – and, in particularly, in order to devise suitable macroscopic theories of

[5] Shaikh, in fact, refers to the model of perfect competition as a "Garden of Eden" myth.

cooperation (resting on the basis of the final two cooperative principles, which we have saved for this chapter) – an ecological framework appears more suitable. This framework is compatible with the relational economics we advocate for in this project, as well as being compatible with the notion of the moral economy of labor and the civic economy of provision.

We develop the central categories of this analysis below.

8.2 Markets and Macrophenomena

One of the important lessons of the preceding chapters is that *context matters*. The ontological individualism of the neoclassical, Walrasian worldview not only *disembeds*, but also *decontextualizes* social behavior and so rests on a rather "primitive Utilitarianism"[6]. Context matters both for agency and for interpreting both it and communication. One important such phenomenon for our present discussion is the market. When studying systems, one generally has to decide which elements of such phenomena one interprets as being exogenous and which as endogenous to the system. From an ecological view, as we advocate for in this chapter, much of what is considered exogenous in traditional economic reasoning is endogenized. For instance, As [Fligstein, 2018, p. 4] points out, "Competition and technological change are themselves defined by market actors and governments over time. These forces are not exogenous to market society, but endogenous to these social relations".

Thus, it is the level of social analysis (context) that determines whether certain elements are to be taken as given or can themselves be considered variable parameters. This observation applies to phenomena like profit and other regulative elements of the market, as well as to contract and other coordinating elements. The view we advocate for in this section will attempt to take the lessons learned in the preceding chapters and to synthesize these with the imperfection principle outlined immediately above. The greater goal will be to lay out a relational economics vision for a cooperative ecology *as* macroeconomy.

We continue immediately below by specifying the distinction between market transactions and market forces, relating this discussion to the distinction between relational transaction and exchange transaction. Next, we introduce the concept of *negotiated coordination*, which we compare with Wieland's notion of *cooperative organization*. We proceed to argue that these terms are isomorphisms. We conclude the section by discussing the impact of negotiated coordination on uncertainty. Our argument is that negotiated coordination

[6]Cf. [Pistor, 2020].

serves to reduce uncertainty (by distributing or delegating decision-making locally).

8.2.1 Market Forces vs. Market Transactions

We have already reviewed the criticisms of Williamson in 2.3.1. Along similar lines as [Dow, 2021] and [Biggiero, 2016] (see Chapter 7), Pat Devine argues against the juxtaposition of market and hierarchy. Responding to Nove's question, 'There are horizontal links (market), there are vertical links (hierarchy). What other dimension is there?', [Devine, 1988, p. 235] responds that "although there is no other dimension, vertical links do not have to be authoritarian and horizontal links do not have to be market-based." And in a passage recalling Ostrom's appraisal of the standard view as a Scylla and Charybdis of market and state, Devine continues that "The two standard models of how this coordination of production can be achieved are the model of administrative command planning and the model of the invisible hand or market forces" (Id.):

> In command planning, the centre in principle works everything out in advance and issues instructions to each enterprise such that between them they produce the aggregate output required. Coordination takes place *ex ante*. In a market economy, each enterprise decides separately to produce what it expects to be able to sell at a profit. Relatively profitable industries attract enterprises until the additional supply causes profitability to fall; relatively unprofitable industries lose enterprises until the reduced supply causes profitability to rise. Coordination takes place *ex post*. (Id., p. 236)

[Devine, 1988, p. 236] makes the distinction between "market transactions" and "market forces":

> Market exchange, the sale and purchase of commodities, does not imply the operation of market forces, in which production and investment decisions are made atomistically and coordinated *ex post*. The use customers make of their purchasing power in choosing between the output of different production units generates information that is relevant to investment decisions. The way in which that information is used, however, will depend on the economic system. It may be used by each individual enterprise separately to decide to reduce or expand its own production, in ignorance of what other enterprises are doing. It may, in theory,

> be used by a command planner to change the instructions issued to the enterprises involved. It may, alternatively, be part of the information available to production units and their negotiated coordination bodies when making decisions about production and investment. (Id.)

Therefore, for Devine, "the argument that only market forces can generate information about consumer or user preferences is based on a confusion of market forces with market exchange."

Indeed, one should keep this distinction in mind when considering macroeconomic phenomena, as "what the market resolves" may not be identical to the socially desirable. Similarly, while "centralized command planning necessarily suffers from information overload and is therefore unlikely to be able to make effective use of" information, according to Devine, an inverse problem of pure market coordination is that "atomized decision-makers... are necessarily unaware of what their rivals are intending to do and therefore the aggregate outcome of their separate decisions will only correspond to what is needed by chance." (Id.) Just as accountability follows from a transparent flow of information, a logic of cooperation can overcome the information deficits of pure market exchange or the information *deluge* of central planning.

Thus, the charge is that the coincidence of market outcomes and socially beneficial outcomes is the exception and not the rule. An example of the distinction is the attempt to price the "ecological services" of bees in coffee versus pineapple production.[7] The ability to internalize nature into the economic system via pricing ecological services is of limited utility and often results in "fickle" or brittle stalemates, lasting only as long as particular ecological factors provide measurable economic benefit to humanity. Moreover, there is a degree of arbitrariness in valuing nature: "whether or not the natural environment may be monetized, and how the process of valuation will be carried out, emanates by and large from the offices and conference rooms of public agencies and from behind the judge's bench."[Fourcade, 2011, p. 1731]

Thus, to return to Devine's initial question, and in order to connect it to Elinor Ostrom's focus on individual CPRs: does Ostrom's logic of self-organization over and against the Scylla and Charybdis of market and

[7] As Macauley suggests, "market-based mechanisms for conservation are not a panacea for our current conservation ills."[McCauley, 2006] To tie Macauley's criticism with a classic from the ecology literature, Lynn White, Jr. argued forcefully in a lecture later published in *Science* the deep ties between modern ontology, epistemology and ethics and a particular religious vision rooted in the Biblical idea of man as distinct from nature.[White, 1967] White advocates for a view embracing humanity's role as "steward". This perspective can be applied to organizations like enterprises, as well, as [Hancock, 2017] attempts.

government allocation scale up to the inter-organizational environment? Can one envision an elective, de-centralized manner of coordinating activities and organizing economic activity? We review Devine's answer to these questions next and attempt to connect it with our greater purpose of systematizing a relational approach to the cooperative economy.

8.2.2 Negotiated Coordination and Resource Dependence

[Devine, 1988] suggests the name "negotiated coordination" (NC) for non-dictatorial, decentralized networks of relationships of interdependence. As opposed to the information overload of command central planning and the information anemia of the market mechanism, "[n]egotiated coordination, by contrast, allows decentralized decision-making that is able to take account of all the information available and arrive at a coordinated aggregate response that reflects the interests of all those affected." (Id., p. 237) The process works by operating by different logics at different levels. At the level of the organization, "production units are responsible for their day-to-day activities, for the use they make of their existing capacity. They set prices equal to long-run costs, calculated on the basis of socially determined primary input prices and their prevailing level of productivity [...] The principal responsibility of production units is to use their existing capacity to meet customer demand." (Id.)

As firms are in the best position to determine their local capacities and estimate their ability to meet demand, it is actually socially beneficial to make such decisions at the organizational level. As Devine concludes, "Since the pattern of consumer and user demand is the quantitative reflection of collectively and individually determined priorities, meeting it represents a first approximation to the way in which existing capacity can best be used in the social interest." (Id.) A second approximation, in accordance with Devine's perspective, would see the governing bodies of firms, organized along manners outlined in Chapters 6 and 7, process this information in accordance with, e.g., the values and principles outlined in 7.6.3. Accordingly, "the key issue for production units is to use their capacity to further the social interest *as they see it*, within the framework of the laws, regulations and guidelines arrived at through the self-governing political process." [Devine, 1988, p. 237, emphasis added]

Moving up a level, decisions regarding investment should be made outside of individual firms. Such decisions would be carried out by *negotiated coordination bodies*, which are described by Devine in the following way:

> The composition of negotiated coordination bodies would be determined by applying the basic principle of self-government, representation of all affected interests, and would therefore vary according to the characteristics of the activity involved. Thus, negotiated coordination bodies for nationally organized activities would be made up of representatives of the following: all the production units in the branch of production; the national negotiated coordination bodies for major supplying and major user branches; government and functional user bodies and national consumers' organizations; the sections of the national planning commission concerned with sector coordination, major new investment and regional distribution; the relevant regional planning commissions; and the relevant national level interest and cause groups, including of course the trade unions. (p. 232)

Therefore, negotiated coordination bodies (NCBs) do not refer to any discrete phenomena, but depend on the industry or sector in question and are organized along the typology of consensus and the logic of discourse. Delegating investment decisions to the higher level NCBs "enables investment decisions to be coordinated *ex ante* in the light of all the relevant information." This, to some, quite radical judgment is made on the basis that the quantitative information privy to individual organizations isn't sufficient to make long-term investment decisions that affect not only the firm's stakeholders but als the general community. Thus, in keeping with the "public organization" advanced in Chapter 7,

> Investment and expansion, or lack of investment and contraction, affect regions and localities, interests and causes, workers in different production units, in ways that are qualitatively different from the effects of changes in the use made of existing capacity. At the same time, new trends in demand and foreseen changes in technology have to be taken into account, as have expected changes in relative scarcities and prices due to planned major investment elsewhere in the economy. (p. 237)

As can be shown from studies of innovation dynamics, innovation strategies are often developed without considering the best organization of metrics, often leading to a furthering of uneven development[8]. Decisions taken centrally

[8]Cf. [Leydesdorff, 2021, pp. 115ff.], who argues in the case of Italy that the most suitable framework for innovation dynamics would see the country split along a North-South axis, and not along regional divisions, as is currently the case in both EU and Italian innovation policy.

"would not be implemented centrally".[9] Therefore, negotiated coordination differs from centralized planning "in that decisions about investment within a branch of production are decentralized to the negotiated coordination body for that branch, which involves all production units in the branch and is able to make full use of all available information." [Devine, 1988, p. 237]

It also differs from exchange directed by market forces "in that investment decisions within a branch of production are coordinated *ex ante*, on the basis of all the available information, not *ex post*, through attempts to correct wrong decisions that were made on the basis of only part of the available information." According to Devine, the process of NC differs from both in that it features DCMs and is organized along inalienable hierarchies. This decentralized yet coordinated approach emphasizes relational contracts, therefore focusing on the decision-making *process* as a balancing act of multiple rationalities and logics, i.e., via a discursive rationality where "the people affected by investment decisions are the people who make the decisions, consciously, in the light of an awareness of their mutual interdependence." (p. 238) Moreover, this process allows actors at each level to use their relative informational advantages to achieve both individual and collective desires and needs. In short, it

> encourages people to transcend their narrow self-interest and has a transformatory dynamic. Thus, it provides better information than the other models and moves beyond coercion towards the self-development of self-activating subjects. (Id.)

Thus, it appears that Devine would answer Ostrom's questions in the affirmative. That does not, however, answer the question of how such a scaling of self-organization can occur. We have attempted to answer this question for the organizational level in the preceding chapters. In order to address it on the inter-organizational level, we next connect Devine's analysis with the *resource-dependence theory* developed by Pfeffer, et al.

Pfeffer

Devine's subsidiaric and discursive approach shares much with Pfeffer's approach, which, similar to that later championed by [Granovetter, 1985] and inspired by [Polanyi, 1944], "view[s] organizations as being embedded in networks of interdependencies and social relationships". [Pfeffer and Salancik, 2003, p. xi] Due to this environmental or "external" focus, Pfeffer's management theory emphasizes the dual notion that organization continually re-negotiate

[9] Cf. [Devine, 1988, p. 195].

their environment and that simultaneously the environment influences them in executing this task. In fact, this perspective can be called a "second-order cybernetic" approach, as we will learn shortly in 8.3. Nevertheless, for the time being, we connect NC to some of the main points in Pfeffer's analysis.

First, the notion of interdependence should be mentioned. Pfeffer suggests that "In social systems and social interactions, interdependence exists whenever one actor does not entirely control all of the conditions necessary for the achievement of an action or for obtaining the outcome desired from the action." [Pfeffer and Salancik, 2003, p. 41] Pfeffer subdivides the concept further into *behavioral interdependence*, where "the activities themselves are dependent on the actions of another social actor" and *outcome interdependence*, where "the outcomes achieved by A are interdependent with, or jointly determined with, the outcome achieved by B." (Id.) Pfeffer uses a poker game as an example of behavioral, and a market as an example of outcome interdependence.

Another parallel between the two approaches is Pfeffer's focus on interconnectednes between organizations. In particular, in another nod to the proceeding discussion of "second-order cybernetics" and process ecology, Pfeffer emphasizes that interconnectedness has both positive and negative implications for focal organizations: "the greater the level of system connectedness, the more uncertain and unstable the environment for given organizations." (Id., p. 69) Therefore,

> [i]n a system with n elements, the number of possible connections between the elements is: $\frac{n(n-l)}{2}$. If each link were actually effective, if the system were tightly interconnected, then any disturbance entering the system at any point would quickly affect every element. If the system were loosely coupled, on the other hand, disturbances would have more chance of being localized, and the system would be more stable and more certain. (Id.)

There is a dialectical trade-off between environmental stability and those system dynamics that drive innovation, meaning that "[s]ocial stability is not favorably perceived by those attempting to introduce change." (p. 70) Both innovation and "adaptation is likely to be easier in a loosely joined system." (p. 69) At the same time, more formal connections (of whatever type or quality) between organizations increase the predictability of each organization's environment and reduces the need for organizations to vertically concentrate ownership and control. Therefore, while increasing interconnectedness constrains individual organizations in their ability to change aspects of the environment, it simultaneously "is a substitute for concentration in that both assure predictability and provide increasingly powerful levers for change." (p. 70)

At the same time, organizational actions to reduce interconnectedness at the present moment "may, in the long run, increase the interdependence among environmental elements". (Id.) It is easy to see the relation of this complex of perspectives relates to the notion of NC advanced by Devine. In particular, we argue that the main common denominator entails the observation that the trade-off that increased unpredictibility on the one hand and increased system vulnerability on the other have can best be circumnavigated via active stakeholder dialogue and a view to long-term relational contracts, including informal contracts. Both perspectives appear to desire overcoming the – apparent – dilemma between market or government coordination by seeking a "third way" that seeks to regulate and coordinate activities at the most *effective* level[10].

Another parallel idea to NC is Pfeffer's focus on the so-called *negotiated environment*. According to Pfeffer, organizations continually re-negotiate their environment to reduce resource dependences and to "stabilize the transactions through some form of interfirm linkage." (p. 144) While these forms of coordination, or what [Wieland, 2018] would refer to as *cooperative organization*, vary, they all have "the advantage of being more flexible than managing dependence through ownership. Relationships established through communication and consensus can be established, renegotiated, and reestablished with more ease than the integration of organizations by merger can be altered." [Pfeffer and Salancik, 2003, p. 144]

Such linkages, which can, e.g., include co-optation[11], which we discuss in 7.7.4, provide focal organizations with certain advantages, including "information about the activities of that organization which may impinge on or affect the focal organization"; "a channel for communicating information to another organization on which the focal organization depends"; "an important first step in obtaining commitments of support from important elements of the environment"; and "a certain value for legitimating the focal organization." (p. 145)

In closing, one of the most important distinctions that Pfeffer's work makes, and one which is of absolute centrality in deriving a theoretical basis upon which to erect a cooperative economics, is that between *organizational efficiency* and *effectiveness*. The former, which Pfeffer describes as "an internal standard", measures "[h]ow well an organization accomplishes its stated, or implied, objectives given the resources used" (p. 33). Due to

[10]The contribution the present work seeks to make to such perspectives is emphasizing not only the role *communication* has in facilitating such a discursive approach, but also the role that *cooperation as a logic* can have on generating new opportunities to generate ascendant macrocultures along such lines.

[11][Pfeffer and Salancik, 2003, pp. 161ff.]

efficiency being an internal standard, it is "problematic to interpret in social systems because the direction of benefit is open to question." (p. 34) Moreover, "[y]ears of Taylorism, scientific management, and now operations research and management science have led to the maximization of efficiency as a value. After literally decades of management ideology venerating efficiency, efficiency has come to be a valued social ideal." (p. 35). Pfeffer and others have questioned the benefit of such a view.

In keeping with his "external" perspective, Pfeffer therefore advances *organizational effectiveness*:

> When individuals and organizations consider what is being measured or produced, they are concerned with effectiveness rather than efficiency. Effectiveness is an external standard applied to the output or activities of an organization. It is applied by all individuals, groups, or organizations that are affected by, or come in contact with, the focal organization. Effectiveness as assessed by each organizational evaluator involves how well the organization is meeting the needs or satisfying the criteria of the evaluator. (p. 34)

Effectiveness is therefore clearly a more complex indicator, and the discussions Pfeffer leads on the topic make clear that in a knowledge-driven economy, where nonlinear dynamics prevent easy calculation of "marginal rates of return" and services are frequently tailored to particular customer segments, or even individually, that an external measure is needed. Moreover, "[i]n many instances efficiency of the product is not a criterion, and what is being produced, rather than the ratio of output to input, is of more concern." (p. 35) *Relational goods* like education and healthcare are two such domains, but many others come to mind, including the experiences people have on online platforms[12].

8.2.3 Negotiated Coordination as Uncertainty-Reducing

Neither Pfeffer nor Devine explicitly mention cooperatives or the cooperative principles as tools to realize such negotiation of the environment, but it is clear when juxtaposing the discussions of the preceding chapters with the ideas that Devine and Pfeffer present that the cooperative principles are well-equipped to coordinate such multi-level activity. They appear to serve at the same time as coordinating tools and as criteria of organizational efficacy. To return to

[12][Srnicek, 2017] and [Eisenmann et al., 2011] have shown that efficiency is not a good criteria in such environments.

the language of Kant from 6.5.5, we can refer to them as *intersubjective logics*. They also act in a manner related to Aumann's "coordinated equilibrium", signaling "like-mindedness" to others in the network. All of these attributes are uncertainty-reducing.

As opposed to standard exchange contracts, they appear to serve as relational contracts, which extend to general categories of behavior and activities. Thus, similarly as [Granovetter, 1985] discusses, loose networks of long-term repeated interactions between organizations are not regulated, in the first instance, by contract, but by a moral economy: status, reputation, norms all play roles in guiding business relations among suppliers of intermediary components to their industrial clients, for instance. Thus, focusing, in modeling and analyzing social or public action, on such loose networks of reciprocal relations would be something negotiated coordination would facilitate. This relational contract aspect of NC is clearly also uncertainty-reducing, in the same manner as meteorologists provide general bands by which to estimate the risks that weather patterns pose to particular regions.[13]

Lastly, we relate negotiated coordination to (non)ergodicity. In particular, as commented above and as argued in [Peters and Adamou, 2015], certain forms of cooperation are uncertainty-reducing in that the average long-term returns from a more stable income from a shared pool is higher than volatile returns from individual pools.

We see from the discussion immediately above how, under an "external" view, NC-like relational contracting makes sense for individual organizations. It does so by filtering uncertain processes in various public ways so that each organization benefits in the long-term, whether they are entrants or established players. Having concluded this discussion, in the following section we suggest the language of *process ecology* for measuring the degree of benefit from informal relational contracts like negotiated coordination.

8.3 Process Ecology

We now have a picture of the manner in which a relational economics view based on notions like negotiated coordination can contribute to stable, long-term relationships between organizations. We must now turn to the task of how to measure such forms of cooperative organization. Without such concrete adaptations of the concepts we have just introduced, they remain mere metaphors or heuristics. If we are able to apply some metrics to

[13]NC provides similar "bands" in which organizations accept certain foundational shared values and coordinate those aspects of decision-making that make sense to coordinate at higher levels. We will come to refer to these bands as "propensities" below.

the level of coordination among nominally autonomous organizations or federations of organizations, then we may be able to say more about the precise benefits different degrees of cooperative organization may bestow on particular organizations. This would also enable us to translate some of the elements of discursive rationality into the bureaucratic rationality employed by many governments today[14].

As societies and institutions evolve, both social and individual, public and private, needs change. As society in general changes – and especially as more complex and interdependent societies like the current global community change – their institutions necessarily also change, adapt and maintain certain characteristics they possessed previously. Part of this involves institutional values. One macroculture is replaced with another, modified culture. There is often a question of which culture provides the better footing for meeting both long-term and shorter-term interests. Given the fact of limited foresight and the general indeterminacy of future events, it is sometimes hard to find suitable criteria on the basis of which to collectively or individually choose among different options for coordinating activities. The notion of *process ecology* can help here.

In a nutshell, it is an attempt to trace out an alternate vision for the analysis of complex systems, based on a self-described shift from the "Eleatic" to the "Milesian" way of thought. The former is associated with Plato who was concerned with forms and "essences", while the latter is associated with Heraclitus, whose perspective is is best represented by the famed quite "all is flux". [Gadamer, 1991] Many, including Karl Popper, have traced out the tradition of skepticism from Heraclitus' view that *logos* orders phenomena "like the strings of a lyre." Similarly, Whitehead's process philosophy similarly is an extension of the Milesian focus on *process* instead of laws. [Whitehead, 2010]

The trend in recent years in economics and other social sciences has been towards complexity theory and towards generally more regard for embedding economic theory in the natural ecosystem of which it forms an interminable part. *Green capitalism*, *ecological economics*, *degrowth* and any number of other paradigms have arisen in recent decades to fill the void which neoclassical economics and its ontological individualism displays with respect to understanding causation in dynamic ways, as well as in conceptualizing change. In many ways, the problem with the atomistic view was not entirely perceptible in past stages of economy, with their emphasis on homogeneous production processes of interchangeable goods. However, such a reductionistic approach is no longer in keeping with the demands of the plethora of organizational types and ambitions in existence today, let alone to describe the inter-organizational

[14]Cf. 1.2.2 above.

linkages in existence in many industries. [Biggiero and Magnuszewski, 2021]

[Ulanowicz, 2012, p. 1] begins his exposition of this new paradigm by pointing to the conservatism inherent in science viz. its frequent reticence towards nonreductinistic thinking: "So great, in fact, is the disdain for [...] early attempts at biological explanations that considering nonreductionistic causality still appears taboo to the majority of biologists." This scenario is not different in economics, where much effort is still expended nowadays in discovering appropriate "microfoundations" for various phenomena, whereas it has been shown that complex processes generally require notions of causality at the systems-level.[15]

In the interests of adequately describing macro-cultures and macro-processes, Ulanowicz offers a view couched in what is referred to as an *ecosystems metaphysic*, which attempts to move away from dealing with "natural laws" and focuses instead on "configurations of processes". (Id., p. 116) This is achieved by means of a phenomenological approach to thermodynamics and a physical description of system-level flows.[16] Ulanowicz suggests that it is often enough to study these system-level flows to gain a deep understanding of causal processes at a macroscopic level. However, much of modern science, even social science, was built up on or reconstructed from deterministic foundations of mechanical causality, which forgets that "[t]here are innumerable examples of systems of equations, such as those describing the many-body problem that appear to be deterministic; but in reality, they give rise to behavior that cannot be distinguished from chaos" [Ulanowicz, 2012, p. 3]. This blind spot in many of the life sciences for macroscopic phenomena leads to an overemphasis of atomistic or molecular analysis. This detracts from pragmatic understanding of cause and effect, as "What is at issue, however, is the *magnitude* of the effect that any single causal factor may have in the realm of natural phenomena."[Ulanowicz, 2012, p. 2, own emphasis]

Moreover, within the "microfoundations" camp, there often is a lack of coherence on core principles: "[i]t is as much by default, as by any causal ties, that higher level phenomena are still usually referenced back to biomolecular events."[Ulanowicz, 2012, p. 5] However, such efforts are frequently unnecessary and also on occasion harmful to the generation of new knowledge. Ulanowicz describes *autocatalysis* – which we return to in detail below – as such a phenomenon, where in fact causation occurs on a higher order than the individual components of the autocatalytic chain. Thus, "contingencies that facilitate any component process will be rewarded, whereas those that interfere

[15]Cf. [Chvykov and Hoel, 2021] or [Shaikh, 2016].

[16]In other words, process ecology is grounded in general descriptions of thermodynamic reality and not in describing the working of reductionistic models.

with facilitation anywhere will be decremented".[Ulanowicz, 2016, p. 367] Process ecology can help navigating the context of justification we outlined at the beginning of this chapter and in so doing facilitate a systematization of thinking regarding cooperative organization.

This section is structured as follows. We begin our overview of process ecology by first reviewing the concept of the *Aleatoric* and its concordant shift from "Eleatic" to "Milesian" thought styles. We then look at the opposing process of *autocatalysis*. Then we review the three main propositions upon which process ecology rests and outline the corollary shifts this entails. Next, we introduce one of the central categories of process ecology, and one that relates to the notion of macrocultures introduced in Chapter 6: *ascendancy*. It is this notion which promises to provide us with a metric that we may apply to phenomena like the cooperation principles in their impact on coordinating activities, beliefs and preferences. Next, we review the unique notion of *propensity* which process ecology promotes. We close with a discussion on (thermodynamic) irreversibility and what it entails for what [Ulanowicz, 2009] refers to as "metaphysical patience".

8.3.1 The Aleatoric

[Ulanowicz, 2009, p. 40] suggests that "[i]f we are to entertain any hope of understanding how things change in the world (beyond mere change of position), it quickly becomes apparent that we need to move beyond the limitations of the Newtonian worldview." Ulanowicz reminds his reader that the Newtonian worldview "owes much to the Platonic or Eleatic school of Greek thought that centered discourse on unchanging 'essences' as the element of primary import." In remarks similar to Popper's appeal to skepticism in 2.2.2, Ulanowicz records that "the Eleatic school did not comprise all of Hellenistic thinking." An alternate tradition is the Milesian school, whose most famous exponent was Heraclitus, whose well-known statement, πάντα ῥεῖ, means "all is in flux" (or "all changes").

The historical opposition of the Eleatic and Milesian worldviews can, according to Ulanowicz, be seen in the two opposing categories of "state" versus "process variables". While historically, within scientific discourse, the former have had the dominant position (in part due to their ease of use, for instance the fact that "they are perfect differentials"[17]), "With the burgeoning interest in networks, wherein flows are accorded parity with states (nodes), it becomes likely that the groundwork in thermodynamics may soon shift in

[17][Ulanowicz, 2009, p. 41]

favor of flow variables." (Id.) While the two views first appear irreconcilable[18], "the stranglehold of essentialism on scientific thought" has been broken with Darwinian "descent with modification". However, although "[c]hange became possible, [...] its radius was circumscribed. Darwinian change acts only within type (species), and the process is not open to the generation of new types (speciation)." (p. 42)

This observation is relevant not only for biology, but has implications for all behavioral, social and complex sciences. Particularly, it points to one of the foundational antagonisms "between chance and the goals of science":

> Whereas science aims to codify, simplify, and predict, the interjection of chance into the narrative results in conspicuous exceptions to regularity, complications in specifying the system, and degradation of the ability to predict. (Id.)

This antagonism manifests itself in the near-universal application of probability theory to scientific discovery. Raising an issue we addressed in Chapter 6, Ulanowicz observes that applying probability theory "forces one to accept a set of assumptions regarding how chance is distributed, e.g., normally, exponentially via power-law, etc." Moreover, "probability theory can be used only after a more fundamental set of assumptions has been accepted. These essential preconditions are rarely mentioned in introductions to probability—namely, probability applies only to chance events that are *simple*, *generic*, and *repeatable*." Simple events are atomic in nature and occur at the smallest scale of observation; generic refers to the observed phenomena being homogeneous in quality; and repeatable means that the phenomena must be observable in infinitely repeatable situations[19].

However, much of the physical world does not fit these criteria and "matters cannot always be considered simple." [Ulanowicz, 2009, p. 43] This leads Ulanowicz to conclude that "[w]e are unable to encompass true *qualitative* change within the description of nature because we have turned a blind eye toward the existence of complex chance events." (Id. own emphasis) Thus, it is arguable that complex events like the conversion of an enterprise from CCM to DCM, or even a meaningful analysis of the effectiveness of different DCMs operating in an inalienable hierarchy are likely the result of both complex *intentional* as well as complex *chance* events and processes, thus eliminating the relevance of a (frequentist) probabilistic methodology in shedding light on such scenarios.

[18] Ulanowicz stated that "Tellegen's theorem demonstrates that under some assumptions (e.g., linearity) states and processes achieve full parity." Source: personal communication with Robert Ulanowicz.

[19] Cf. also [Kaplan, 2014].

In this vein, physicist Walter Elsasser's pioneering work concludes that "complex chance events prevail everywhere there are living systems. More surprising still, he implied that they perfuse nature and even overwhelm the number of simple events by comparison." (p. 43) This becomes especially clear in Elsasser's attempts to use combinatorics to study the number of possible events comprising the universe. He concluded "that at the very most, 81 x 1025, or 10^{106} simple events could have transpired. One can safely conclude that anything with less than one in 10^{106} chances of reoccurring simply is never going to do so, even over many repetitions of the lifetime of our universe." (p. 44)

According to Ulanowicz, Elsasser's conclusion relates to complex systems like the cooperative economy by way of *uniqueness*: "[i]n particular," he writes, "one asks how many different types or characteristics are required before a random combination can indisputably be considered unique." That number is surprisingly low: only around 75 unique components render a particular system unique.[20] It is easy to demonstrate that this observation applies to virtually all social systems, including the cooperative economy.[21] Here, as elsewhere in the social realm, "singular events are not rare; rather, they are legion!" [Ulanowicz, 2009, pp. 45-6]

Ulanowicz argues that "Elsasser robbed us of our innocence" and underlines "the ontic nature of chance", i.e., "that chance is not merely an illusion to be explained away by the operation of laws." This implies "that the world is not a seamless continuum", that in fact "[t]he fabric of causality is porous" (p. 47). Therefore, "the universe is not causally closed, but open in the sense of Popper and Peirce." So, the question must be raised, if the standard frequentist approach to probability is of no use in measuring aspects of relational or cooperative governance, or assessing the effectiveness of this versus that policy with respect to a discourse ethic, then how do we proceed?

[20] "[B]ecause the combinations of types scale roughly as the factorial of their number. Because $75! = 10^{106}$, whenever more than seventy-five distinguishable events co-occur by chance, one can be certain that they will never randomly do so again." [Ulanowicz, 2009, p. 45].

[21] One has only to attempt to analyze the levels of interdependence in a single agricultural cooperative, whose output depends not only on each of the workers, but also on an ensemble of suppliers, from machine-goods, farm equipment, seed, fertilizer, as well as logistics and transport, buyers, etc. One has only to think of Adam Smith's example of the pin factory: the division of labor makes simple chance an obsolete category for systems analysis. [Biggiero, 2001].

8.3.2 Propensities

Ulanowicz argues that this porousness does not imply that the laws of causality are violated. Instead,

> the proposal at hand is simply that physical laws are incapable of *determining* what we see in the living realm— that the combinatorics of complexity simply create so many possibilities, or degrees of freedom, that any physical laws can be satisfied in a vast multiplicity of ways. Another way of saying the same thing is that the realm of biology is *underdetermined* by physical constraints. (Id., p. 48)

In other words, nature and living systems are rife in heterogeneity, which may remain hidden. (p. 50) The conclusion one must arrive at is that "one cannot formulate a law in the Newtonian sense that would relate to operations among heterogeneous biological classes." (Id.) This fundamental heterogeneity "overwhelm[s] law" in the sense that a law cannot differentiate between the multiple (historical) paths a system actually took to arrive at a particular state. This indeterminacy renders much of the mechanistic language of modern social science (read: economics) "metaphorical at best". (p. 51) Citing Karl Popper, who "felt it was wrong to stretch the narrow notion of force to pertain to complex situations, where (again!) it could possibly lead one astray from what was really happening", Ulanowicz suggests that one should adopt instead the language of *propensities*:

> [i]f A happens, there is a propensity for B to occur, but B need not follow each and every time. The situation then becomes more like "If A, then B; if A, then B; if A, then B; if A, then C(!); if A, then B, etc."

That is, as opposed to mechanistic causes leading to deterministic outcomes,"propensities represent constraints, albeit imperfect ones, capable of holding systems together." The concept of propensity introduces ambiguity and indeterminacy into the analysis, important qualities within the complex domain of social sciences. That is, "propensities impart adequate coherence to a system to keep [it] from immediately disintegrating when impacted by most arbitrary singular events." (p. 55)

The question of how one represents propensities in practice in order to analyze their workings on systems is an important one. In particular, and relevant for the current topic, "propensities never exist alone but always stand in relationship to other propensities. We ask, therefore, whether the juxtaposition of propensities might possibly serve as an appropriate

counterweight to the ubiquity of radical chance." (p. 58) It is this notion of *propensity ensembles* that leads us to the next topic of *autocatalysis.*[22]

8.3.3 Autocatalysis

Propensity and the aleatoric appear then to be two sides of processes that regulate change in complex systems. Two other phenomena that facilitate these elements are *causal circuits* and *feedback*. The two concepts are related, with causal circuits entailing "concatenations of events or processes wherein the last element in the chain affects the first—what commonly is known as feedback." (p. 61) Bateson has argued that "[i]n principle [...] a causal circuit will generate a non-random response to a random event."(Id.) Therefore, causal circuits "have the capability to endure because they can react nonrandomly to random stimuli."

The question then becomes how to introduce feedback into scientific analysis without resorting to circular logic. (p. 63) Ulanowicz suggests that "[b]y gathering all feedback into a single postulate [...] one excises circularity with one fell swoop from all subsequent arguments." Combining such an approach to what is called "second order feedback"[23], we get *autocatalysis*:

> Autocatalysis is a particular form of positive feedback wherein the effect of every consecutive link in the feedback loop is positive. Such facilitation need not be assumed obligate and rigid, as with mechanical systems. There simply needs be present the propensity for each participant to facilitate its downstream member. (p. 64-5)

Autocatalysis displays a number of properties, including being growth-enhancing; providing a formal structure in which processes and events may configure; being "capable of exerting *selection* pressure upon its own ever-changing constituents." That is to say, the selection pressure "arises from within the system" (p. 68). Autocatalysis can be represented by a simple graph like Figure 8.1. A system of the sort

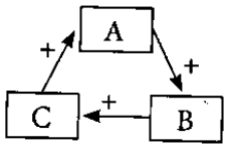

Figure 8.1: A simple graph representing a catalytic cycle with three components, from [Ulanowicz, 2009, p. 65].

[22] In 8.4, we again return to the notion of *propensity ensembles*, which we use to describe the working of the cooperative principles.

[23] This tradition was largely initiated by [Bateson, 2000].

which this graph represents, and which immediately resembles the DAGs we introduced in 6.6.4[24], "tends to *import* the environment into the system or, alternatively, *embeds* the system into its environment." (p. 69)

Autocatalysis is a central category in ecology, and it represents a central category of system-level agency, a concept capturing the centripetality inherent in all stable complex systems. Being a system-level quality, "the drive to increase such activity is strictly a consequence of the relational structure of the whole." Bertrand Russell referred to this form of centripetality as "chemical imperialism"[25]. Autocatalysis and centripetality imply that "competition is derivative by comparison. That is, whenever two or more autocatalyic loops draw from the same pool of resources, it is their autocatalytic centripetality that *induces competition* between them."

It is hard to stress how radical this observation is. It means, among others, that "a configuration of processes can, as a whole, strongly affect which objects remain in a system and which pass from the scene." (p. 74) As can be expected,

> [t]his observation inverts, to a degree, the conventional wisdom that it is objects that direct processes. The processes, as a union, make a palpable contribution toward the creation of their constituent elements. This reversal of causal influence lies at the crux of process ecology, and it extirpates the Newtonian stricture of closure.[26] (p. 75)

This observation should render many neoclassical economists rather uncomfortable. It directly contradicts the central role which competition has in social systems like the economy. In fact, according to the process ecology perspective, "mutuality manifested at higher levels fosters competition at levels below". (Id.) Competition arises because two mutualistic ecosystems are competing for the same scarce resources. Carrying this observation to its conclusion, it implies that there can be no competitive market without the overarching networks of mutually beneficial relations we call society. This fact calls on us to reorient the economic in a way that explicitly acknowledges these factual interdependences, as we have argued in 7.7.4.

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[24]The main distinction is that an autocatalytic is not *acyclical*; it is thus a *directed cyclical graph*, whch, while it does not lend itself to direct causal analysis using the methods specified in 6.6.4, can be broken into parts, which themselves consist of DAGs. One example of an approach to this end is the Bellman-Ford algorithm [Oldham, 2001]. The Simplex Algorithm [Dantzig and Johnson, 1964] is another approach.

[25]Russell, cited in [Ulanowicz, 2009, p. 72-3].

[26]Cf. also the discussion of the *ecological metaphysic* in [Ulanowicz, 2012].

8.3.4 Three Propositions

We are now ready to introduce the main concepts that undergird process ecology. In the following section, we then apply the lessons to derive a method which Ulanowicz has ingeniously developed, followed by some concluding comments.

Asking questions such as how things can change leads one to acknowledge the aleatoric: "[i]f an event is unique for all time, it evades treatment by probability theory. Now if the density of unique events overwhelms that of simple ones, as it does in complex systems, then most of reality lies beyond the ken of probability theory." [Ulanowicz, 2009, p. 46-7] In such cases, we must speak of *radical contingency*, which leads to the first proposition:

> I. The operation of any system is vulnerable to disruption by chance events. (p. 47)

Cooperation can be such a chance event, as [Axelrod and Hamilton, 1981] has shown. Note that we speak here of systems as ensembles of processes possessing varying degrees of uniqueness. Talking about laws and mechanisms in such instances appears misleading at best. Thus, we cannot speak of a "law of cooperation", only particular tendencies (cf. logics) that comprise both formal and informal, institutional, organizational and individual attributes and *relations* among those attributes. Abandoning the Eleatic thought style for the Milesian is called for in such situations. [Biggiero, 2016, p. 23]

The second question scientists ask is how things persist? How does order appear out of the aleatoric, for instance, in the form of a *regime* of cooperation? The notion of propensities that we have developed, and the concurrent ideas of causal circuits and feedback appear to sufficiently answer this question. Accordingly, asymmetric shifts in system dynamics cause persistent changes in the structures of those systems. (p. 60) Maintaining the Milesian focus on process and "[r]ecognizing that stationary forms are subsequent to movements and processes, the question could be rephrased as the following: what process or combination of processes might yield ordered form out of chaotic substrate?" (p. 61) Therefore, the fact that autocatalytic processes react non-randomly to chance events provides the answer to why things persist:

> II. A process, via mediation by other processes, may be capable of influencing itself. (Id.)

Thus, "[t]he action of autocatalytic feedback tends to import the environment into the system or, alternatively, embeds the system into its environment." (p. 69) In the case of cooperation, the chance events that led

to its emergence as an ascendant macroculture can then be formalized to engender cooperative processes as normalized reactions to a multiplicity of events. Doing so requires the importation of the environment, as seen in the importation – albeit in a circumscribed form – of the earnings–costs logic in the second and fourth cooperative principles.[27]

At this point we have a basic cybernetic framework to describe system dynamics and interpreted those dynamics for the cooperative economy, but one element is still missing: that autocatalytic processes cause persistence of systems does not yet describe how the unique identity of various systems comes about. How does a beehive differ from a coral reef, and how does a consumer cooperative in post-war South Korea differ from one in contemporary Switzerland? They differ in their respective histories, which have been influenced by particularities partial to the locality in question. These histories are encoded as information within the various laws, statutes and norms that regulate the respective organization. Therefore, the third postulate is that

> III. Systems differ from one another according to their history, some of which is recorded in their material configurations. (p. 69)

Therefore, relating the third postulate back to our main subject: "[i]n many ways, the structure of activities within a society embodies the history of that society every bit as much or more than the aggregate DNA of the individuals that make up the community." (Id.) The role of information in this process is central, and we return to it in the next section.

These three postulates taken together mean that a shift away from both the Newtonian and the Darwinian "windows" (cf. thought styles, paradigms, logic of discovery) require similar corollary shifts in the focus of analysis. Thus, the three propositions engender three associated shifts:

> 1. In order to understand living systems, emphasis should shift away from fixed laws and toward the description of *process*. (p. 117, own emphasis)

This first shift means that the focus should be placed on what Popper called "propensities", which he described as "not mere possibilities but [...] physical realities." [Popper, 1990, p. 12] instead of fixed laws. Ulanowicz importantly points out that "propensities never occur alone". (Id.) Therefore, a focus on juxtapositions or *ensembles of propensities* will help understand

[27] Cf. discussion of the respective principles in 7.6. In particular, phrases like "fair rate", referring to "the lowest rate which would be sufficient to obtain the necessary funds", [Rodgers, 2015, p. 32] come to mind.

various complex systems like the cooperative economy. The reader can perhaps already infer that we intend to interpret the cooperative principles as such an ensemble.

Before moving on to this task, however, two more corollary shifts must be introduced. The second, which flows from the first, states that

> 2. Relevant agencies in living systems reside more with configurations of propensities than with explicit physical forces or their attendant objects. (Id.)

This second shift merely underlines the shift from object-based to process-based thinking. This shift, which "occasions a major reorientation in our thinking", means that "configurations of processes or propensities rather than objects become the focus of our attention in explaining how and why things happen in" studying complex systems like the economy. (Id.) It is easy to recognize that this process-based view aligns with the relational perspective, which also emphasizes process and places *relations* at the center of analysis.

Lastly, there is a shift from equilibrium to "second-order cybernetics" thought styles. These emphasize the influence of opposing tendencies and should therefore play a central role in economic analysis generally, but are particularly important in analyzing the cooperative economy. The shift entails acknowledging that

> 3. Patterns and forms in the living realm result from transactions between agonistic tendencies. Processes that build organized activities are continually being eroded by dissipative losses. While these tendencies oppose one another in the near field, they are seen to be mutually obligatory under a wider vision. (p. 118)

This shift can be summarized with the heuristic, "never... push single goals too far because doing so invariably leads to system catastrophe." (Id.) This third corollary shift cannot be strongly enough emphasized, and underlines the shift in thinking since roughly the advent of the Club of Rome in 1972. [Meadows et al., 1972] Taken together, the three propositions and the three corollary shifts reorient analysis of complex social systems like organizational networks based on relational contracting in a way enmeshed in "second-order cybernetics". This means we are aware of and embed feedback effects between system and components into the analysis, instead of considering such aspects *post hoc*, as within the domain of ontological individualism[28]. As such, a useful next concept to discuss is *ascendacy*.

[28] See, e.g., the criticism of [Farjoun and Machover, 1983].

8.3.5 Ascendancy & Overhead

> "The observable drives of living systems towards coherency, efficiency, specialization and self-containment are argued to be implicit in the 'principle' of optimal ascendancy."
>
> –Robert Ulanowicz, *Growth and Development*

Ascendancy offers a useful concept for describing transformative processes involving growth and change. It does this particularly by analytically bringing together the concepts of growth and development. Thus, not physical (or metaphorical) notions of equilibrium, but notions of higher-order interactions of networks of flows are emphasized in their implication for system change. This is seen by Ulanowicz not as a challenge to but a fruition of the Darwinian paradigm. "'Fitness' as used by Darwin has always prompted the question 'Fit for what?' Community ascendancy imparts an appropriate direction to the fitness of a population without necessarily implying a fixed goal in the teleological sense."[Ulanowicz, 2012, pp. 7ff.] That is to say, a system-level focus on the antagonistic interaction between the aleatoric and autocatalytic processes under the particularities of systems' historical trajectory give one unique insight into a wide range of parameters.

The basis of ascendancy is dual. The first element, *average mutual information* (AMI) is a reflection of the fact that "a system must attain a certain level of complexity before it can interact with its environment in a way that increases its own organization." (p. 80). Precisely speaking, AMI is "a logarithmic index from the mathematical field of information theory, as a functional measure of 'organization.'" (p. 81)[29] To this "size-oriented" quality comes the second element, *conditional entropy* (CE), which is equivalent to the notion of *redundancy* introduced above. CE "gauge[s] the system-wide of parallel connections."

Both of these indicators relate to Shannon's contributions to information theory [Shannon, 1948] and to MacArthur's attempts to quantify overall system complexity based on Shannon's formula [MacArthur, 1955][30]. In advancing prior contributions, the utility of AMI and CE is to disentangle which part of the quantified complexity refers to organized, and which to organized, components. [Ulanowicz, 2009, p. 82] Therefore, the benefit of research like Atlan's, as synthesized and advanced by Ulanowicz, Leydesdorff and others, is to demonstrate "that complexity can be parsed into two distinct components: one that aggregates all the coherent constraints inherent in the

[29] Among the first to record this aspect was [Atlan, 1974].

[30] cf. [Krippendorff, 1974] for an algorithmic application to the analysis of meaning in higher-order networked contexts.

system and a complement that pools all the disorganized and unencumbered complexity." (p. 83) This unique result derives from the particular quality of information theory, which "uses the same mathematical terminology to treat both constraint and indeterminacy." (Id.)

The fact that the two measures, AMI and CE, are complementary has a number of interesting results. The most significant of these is the mutual determinism (we have spoken above of *agonic* relations) of the two indicators:

> If this overall complexity should happen to hold nearly constant [...], then any change in the AMI would have to take place at the expense of the conditional entropy and vice versa. That is, to the degree that complexity does *not* change, the two measures are agonistic and mutually exclusive: AMI tracks a system's organization, while the conditional entropy traces its relative *disorganization*. (p. 84)

These two forces are, however, just one part of the knowledge one needs to fully analyze complex systems. For instance:

> a well-organized system has an advantage over one that is less structured, but it might still be overwhelmed by another system that is less organized but bigger or more active. Conversely, a vigorous system could be displaced by one that is smaller or less active but better organized. To prevail, a system usually requires a modicum of both size and organization. To fully capture the nature of an ascendant system, it becomes necessary to incorporate both size and organization into a single index. (p. 85)

This parameter Ulanowicz argues can be found in the *total system throughput* (TST), a term discussed, e.g., by Finn and Hannon in the 1970s[31]. Combining these values – TST and CE – gives one a measure Ulanowicz refers to as *ascendancy*. Ascendancy "intend[s] to capture in a single index the potential for a system to prevail against any real or hypothetical contending system by virtue of its combined size and organization." The revolutionary nature of this term cannot be overstated. While Bateson argued that ecology[32] consisted of two distinct and irreconcilable "faces" [Bateson, 2000, p. 460], the index "helps [...] to mitigate Bateson's conundrum: ascendancy simultaneously embodies both the economics of material and energy (the magnitude of their activities) in the system as well as the economics of information inherent within the structure of those activities." (p. 87)

[31] cf. [Barber, 1978].

[32] And it must be noted that Bateson interpreted the term "ecology" very broadly.

The concept of ascendancy thus gives us a tool by which to simultaneously describe the attributes and the relationships of a complex system.

Overhead

Ulanowicz emphasizes that "increasing ascendency is not the only tendency at work in the dynamics of developing or evolving systems."[Ulanowicz, 2009, p. 88] Indeed, CE speaks to a central role for disorganized elements in the resilience of systems. Indeed, part of resilience entails the ability or "freedom of a network to adapt to novel and unforeseen perturbations." (Id.) As stated previously, there is no "essence" to cooperation: it is a logic that must be reconstituted with respect to new scenarios and developments, and exists in a synergistic relation to other logics like novelty production or profit-maximization. It appears intelligible therefore that Ulanowicz interprets the dual forces of ascendancy and overhead as complementary. "Because ascendency represents the organized power being generated by the system and overhead gauges those activities that are not currently organized but could be entrained into its organization, the sum of these two indices is seen to represent the full capacity for system development." [Ulanowicz, 2009, p. 89]

The interaction of these tendencies also reveals a path by which such systems tend towards stability: both ascendancy and overhead draw from the same limited resources, so at some limit, one cannot increase the one (e.g., order) at the expense of the other (e.g., possible alternative configurations). "This limit owes in part to how finely the available sources of resources can be divided." (Id.) Therefore, at some point in the growth and development of a system, the complementary forces of order (ascendancy) and disorder (overhead) becomes antagonistic. After this point is reached, "[e]ither may continue to grow at the expense of the other." (*Id., p. 90*) This observation reveals a very real opposition in the world of complex systems, like the economy. Thus, "[r]eal systems are the result of an ongoing transaction between the opposing tendencies of both ascendency and overhead to increase." (Id.) The Apollonian and the Dionyisian exist in a tentative symbiosis, as long as a system's complexity is increasing, else one increases at the expense of the other[33].

Ulanowicz criticizes the failure of many scientists to incorporate this opposition into their models. "Too many persist in thinking that one can

[33]Nietzsche speaks in *Die Geburt der Tragödie* of the opposition between "a decadent morality" and the "Jasagen ohne Vorbehalt". [Nietzsche, 1985, Vol. 1, p. 579]. Thus, Nietzsche's view could be interpreted as a cybernetic one, disclaiming any fixed "essences", but resulting from a continual agonic process of opposition. [Murphy, 2010, p. 307].

have one's cake and eat it, too—that systems can be designed that are both high performance and low risk." [Ulanowicz, 2009, p. 90] One sees this, e.g., in economics, where "the competitive edge goes to products that are simply made and hastily assembled, etc., etc." Therefore, efficiency alone is a poor measure of a system's resilience and in order to usefully analyze processes like the success of economies in realizing goals like sustainable development, one must turn one's "attention to the nature of the agency behind [the economy's] increasing order, but [...] always in the context of a universe that is *transactional* at its very core." (*Id., my emphasis*) The reader must recognize the similarity between this perspective and that offered by Pfeffer and Devine above.

Synthesis

True persistence needs both adaptation (resilience) and transformation. "Too much of anything isn't a good thing", as the adage goes. Systems that emphasize efficiency at the expense of redundant connections (efficacy) become "brittle" in the language of Crawford Holling. As [Ulanowicz, 2009, p. 94] argues, "although the growth and persistence of living systems are driven by structure-building autocatalysis, if efficiency crowds out too much of the remaining stochastic, inefficient, and redundant pathways, the system will respond calamitously to new disturbances." Therefore, there is a trade off between efficiency and adaptation, as we have just observed. This is well known in a number of fields, including computer design[34].

A transactional universe – and a relational economy – exhibit characteristics like increasing order and a dialectical antagonism between order and a degree of redundancy. However, this antagonism is itself part of the ordering process and that can first be recognized at a higher level of organization. This is the Goldilocks phenomenon we have referred to continually throughout the present work. States [Ulanowicz, 2009, p 94],

> That the larger picture of dialectics goes beyond simple antagonism is an observation attributed largely to Georg Wilhelm Friedrich Hegel. Hegel noted how opposing tendencies can become mutually dependent at some other level of consideration [...]. Such dependency at higher levels circumscribes the antagonism between ascendency and overhead.

Whitehead's notion of process philosophy is another testament to such interdependent emergence. Whitehead argued that "[t]he art of progress

[34]Cf. [Ulanowicz, 2009, p. 94].

is to preserve order amid change, and to preserve change amid order." [Whitehead, 2010, p. 515] This idea represents the dialectical synthesis attempted by Ulanowicz and others well. According to such a worldview,

> If the system performance (order, ascendency) should become too great at the expense of overhead (freedom, reliability), the configuration becomes "brittle" [...] and inevitably will collapse due to some arbitrary novel perturbation. Conversely, if the system should become too disorganized (high overhead and little ascendency), it will be displaced by a configuration having greater relative coherence (ascendency). [Ulanowicz, 2009, p. 95]

The economy can and should be interpreted in such a way, as ecological economists have argued for decades [Daly and Farley, 2011]. Viewing the economy as a complex of processes involving both ordering and disordering activities, of both *ascendancy* and its concurrently necessary *overhead*, as featuring both aleatoric and autocatalytic processes and events in exchange with one another, would go a vast way to increase the degree of *relevance* of economics discourse without necessarily sacrificing the degree of *rigor*. Unfortunately, these two values are often assumed to be implicitly at odds. [Argyris and Schön, 1989] They are not necessarily, and ignoring or reducing the dynamic complexities of the real world can have dire consequences if such models have real-world consequences, as do those of economics:

> As mentioned, many economists pursue the goal of market efficiency to its monist extreme. In the process, they ignore that which imparts reliability to a community, such as functional diversity and equity of wealth [...]. With their zeal, they unintentionally set society up for a fall. If the reader takes away only one idea from this whole thesis, it should be that pursuing a single (variational) goal, while failing to consider its agonistic counterparts leads invariably to a bad end. Directions are essential elements of the evolutionary drama, but, like the propensities that give rise to them, they *never* occur in isolation. [Ulanowicz, 2009, p. 95]

A cooperative economy, lodged in a relational perspective, is in a better position to accommodate the pluralistic demands multiple stakeholders emanate. It should therefore be the goal of governments worldwide to ensure that their cooperative sectors receive sufficient support to become self-sustaining systems that have reached sufficient magnitude, and whose internal connections have become sufficiently redundant, such that they can remain resilient and adaptive to external changes. Measures like ascendancy and overhead can help provide targets for policy.

When Growth, When Ascendancy?

Ulanowicz elaborates the idea that systems typically grow at any cost in their early, chaotic stages and later place more emphasis on ordering processes. "In fact, during early stages of development, when T [the size of the network, as measured by system throughput or flows] dominates the increase in A [ascendancy], the optimization of A is virtually indistinguishable from the Lotka maximum power principle [...] During the later stages of maturation, as network configuration becomes more important, the nature of ascendancy as a work function[35] becomes more apparent."[Ulanowicz, 2012, p. 130] This has dramatic implications for the cooperative economy, which we address in the next section.

Mathematically described, Ulanowicz describes this process by a function similar to Equation 8.1:

$$A = WT, \tag{8.1}$$

where A refers to the ascendancy of the system, while T and W are the size and the degree of ordering (work) inherent in the system. Taking the total differential, we get

$$dA = WdT + TdW. \tag{8.2}$$

According to Ulanowicz' reasoning, during early stages of ascendancy, the first term on the right side of Equation 8.2, emphasizing the dependence on size, dominates the expression and at latter, maturer, stages, the second term on the right, emphasizing the contribution of work (organization), dominates the expression.

A hypothesis worth pursuing in the construction of an independent co-operative economics is the question regarding whether the above schematic can help shed light on some contemporary crises and debates. For instance, another way of representing the present conflict between economic growth and ecological degradation is as the result of a "monistic" focus on growth at the expense of development. In other words, much present economic policy arguably ignores the last term in Equation 8.2, TdW. An increasingly interdependent global economy based on increasing the "wealth of nations" creates a system too brittle to mitigate the negative effects it introduces into the environment. Such a hypothesis would suggest that focusing on the W function would provide a foundation for shifting toe economy to increased resilience.[36] We pursue such a hypothesis below. First we make some general observations based on the preceding discussion.

[35]Work in the physical sense is defined as an ordering process.

[36]An example of such a shift can be found in authors like Yochai Benkler, who have called for a focus on "the wealth of networks". Cf. [Benkler, 2008].

8.3.6 Irreversibility and Metaphysical Patience

One could argue that one of the reasons for shifting our view of the social context of agency and for preferring more distributed decision-making in organizations is the flattening out of the discount rate towards long-term orientation and away from time-inconsistency, whether hyperbolic or quasi-hyperbolic, as discussed in Chapter 6. In this section, we give two justifications for this shift. They are the irreversibility of large-scale thermodynamic processes (like those leading to climate change) and the concurrent notion of *metaphysical patience*.

The non-ergodic, complex quality of human social system renders any "easy" (in the sense of monocausal) solution to problems within such systems suspect. To take an analogy from cancer research, "[t]he worry is that an exaggerated confidence that human physiology is genetically driven could divert needed attention from the focus that cancer is fundamentally a system-level disease." [Ulanowicz, 2009, p. 153] There may be many organizational phenomena that are similarly driven by system-level agencies that cannot be captured by resorting to micro-level foundations. In particular, notions like the "human rental contract" discussed in Chapter 5 come to mind. To return to the cancer metaphor, "[b]y thereby widening our search, we are more likely to encounter effective treatments, which might include system-level therapies such as those that involve the immune system." (Id., p. 154) Orthogonally, it may be socially desirable to reform the human rental contract by actively promoting cooperative and democratic enterprise, thereby facilitating the growth and development of a new understanding of enterprise governance over the long term.

As opposed to a single individual suffering from cancer, the human ecosystem is embedded in and dependent on a fragile global ensemble of interdependent ecosystems. Considering the contemporary scientific consensus of the combined threats of overpopulation and ecological devastation[37], there is a need in the contemporary world to order many social processes at system-wide scales. In fact, we must also mention the notion of redundancies whose impact and purpose lies beyond our comprehension[38].

This observation calls for a metaphyisical patience , or a "willingness [...] to admit that we inhabit, as Ilya Prigogine (and Stengers) put it, a world of radical uncertainty." [Ulanowicz, 2009, p. 156] Such a world view would attempt to organize human social activity in such a way as to reduce human encroachment upon natural ecosystems to an accommodating minimum. It

[37]Cf. [Wilson, 2016].

[38]Cf. E.O. Wilson's notion that 80% of species have not been discovered or studied, footnote 37, Chapter 3.

thereby relates to Popper's notion of *intellektuelle Duldsamkeit*, introduced in 2.2.2. Each of these perspectives appears to support a search on the part of scientists and the broader human community as to how to organize the remaining incursions on the natural biosphere in a democratic manner. Because constraints promote scarcity, which in turn raises the specter of competition for scarce resources, human intelligence needs to create systems for fairly allocating such resources via an active multi-stakeholder dialogue, thereby enabling the mutualism that underlies natural (including human) systems to operate synergyistically. Notions of stewardship, discussed above, can facilitate this process.

The next section represents the culmination of Chapters 6, 7 and the preceding discussion in this chapter, an attempt to apply the various tools we have developed there towards understanding how cooperative enterprise can serve as a tool for organizing such system-level shifts towards a more just, sustainable economy.

8.4 Cybernetic Feedback in Cooperation

In this section, we begin to near the end of the theoretical rainbow. Our intent in this section is to draw a point on the way in which cooperative principles can serve as a tool to promote ascendancy. They can do so by acting to promote certain macrocultures and distinguish themselves particularly in the latter stage of ascendancy: *development of a qualitatively mutualistic economic substructure*. That is to say, as the developmental components of the economy take precedence over the growth components, a cooperative logic appears to be in the best position to serve as a motor of re-orienting the economy away from detrimental and towards beneficial linkages and associations.

Part of this is due to the dualistic nature of complex systems. The last of the three corollary shifts suggested the heuristic "never push single goals too far because doing so invariably leads to system catastrophe" and in many ways, the era of growth-fueled advancement of human economies has outlived its greater social and environmental use. [Dietz and O'Neill, 2013] A shift towards more effective organization, along the lines of DCMs and elective hierarchies, taking into account the trade-offs of singular focus, appears to be a promising solution. We suggest that notions like ascendancy, propensity ensembles and autocatalysis can help actually measure the contribution such shifts can have on the stability of the greater systems in which they occur.

The section is organized as follows. Immediately below, we return to the exercise begun in 7.6.3, interpreting the last two cooperative principles in their impact on organizational agency. After completing this task, we attempt to

interpret the cooperative principles as propensities in the manner introduced above. Following this, we attempt to interpret the cooperative principles in general as a form of negotiated coordination. Finally, we study the potential to implement applications of the notion of ascendancy to "translate" the benefit the cooperative logic generates into a measurable quality.

8.4.1 Modeling, Redux

In this section, we return to the discussion of 7.6.3, of attempting to model the cooperative principles as coordinated equilibria. However, we wish at present to shift to an ecological perspective, thus, in the place of "coordinated equilibrium", we attempt to interpret principles 6 and 7 as *propensities*.

8.4.2 Cooperation among Cooperatives

The sixth principle, cooperation among cooperatives, states that

> "Co-operatives serve their members most effectively and strengthen the co-operative movement by working together through local, national, regional, and international structures."

It represents a realization that "co-operatives must explicitly nurture and support one another" [Rodgers, 2015, p. 72] and was adopted at the Vienna Congress in 1966 as a "clarification" of the cooperative principles. The 1966 report stated that "[...] we have thought it important to add a principle of growth by mutual co-operation among co-operatives." Moreover, the report states,

> [...] although the principles originated as rules governing the relations of the individual members of co-operatives with one another and with their societies, their application is not confined to primary societies. They should be loyally observed by institutions which represent the co-operation of co-operative societies rather than of individual persons [...] The idea of a co-operative sector in the economy is too often an intellectual concept without a corresponding material reality, simply because of the lack of unity and cohesion between the different branches of the movement. [...] If the co-operative movement is to rise to its full stature, either within each country, or internationally, [...] co-operative institutions must unreservedly support one another." (Id.)

The *Notes* describe it as "a practical expression of the co-operative value of solidarity" that "shows two dimensions of the nature of co-operatives." These

are the *economic* and the *social* logics. Therefore, "[i]n joining a co-operative members are not only helping to build their own co-operatives but the wider co-operative movement [...] to create wealth for the many, not personal wealth for the few." Moreover, in a statement reminiscent of the discussion of Pfeffer's notion of inter-organizational interdependence, the notes state that "the normative approach, subject to compliance with anti-competition and anti-trust legislation, is for co-operatives to co-operate with each other in competitive markets through forming co-operative groups, secondary co-operatives and federations to realise the co-operative advantage and create common wealth for mutual benefit."

In terms of realizing the 6th principles, the *Notes* emphasize the dual nature of the principles: it first specifies a reason for higher-order cooperation: according to the *Notes*, "creat[ing] economies of scale and build mutual representative strength." The *Notes* mention that such ambitions require "a difficult balancing of interests", as such coordination must be counterbalanced with "maintaining independence and member democratic control." (p. 72) The means suggested are general, but differ from the extremes of either mergers or loose collaborations as seen in the world of investor-owned enterprise:

> This 6th Principle is about working together continuously to the same end, not simply about occasional collaboration. Collaboration, though similar[,] works for a single defined objective, whereas co-operation is a more intense commitment and longer term engagement to achieve shared goals. (Id.)

Thus, cooperation involves *relational contracts*. These are, simultaneously, "a crucial part of expanding the co-operative enterprise sector of the economy, both nationally and globally" and "require sacrifice to achieve shared goals." (p. 73) Such a high-level endeavor therefore "takes time, resources, and problem-solving skills." (Id.) We see here again reference made to the dual traits of *cooperative rent* and *costs of cooperation*. The *Notes* describe a number of key features of inter-cooperation: a) *Openness and transparency*; *Accountability*; *Representation*; *Flexibility*; *Reciprocity*; and *Adherence to the Co-operative Identity*. (p. 73) These traits should be seen as extensions of the conditions described in Chapter 6, which outlined a general *logic of cooperation*, to the inter-cooperative level.[39]

The *Notes* mention several stages of inter-cooperation, ranging from "Informal project based collaborative arrangements" to "networks" and even

[39]With respect to this point, the *Notes* state, "Co-operation among co-operatives involves many of the challenges individual co-operatives face, albeit at a different scale." [Rodgers, 2015, p. 77]

cooperative federations. Each of these phenomena is characterized by increasingly formal degrees of coordination. We return to the roles these forms of inter-cooperation in the next section, when we introduce the notion of a *cooperative n-tuple Helix*. For the time being, we will merely cite the *Notes*, which suggest that "informal collaborations contribute to building trust and solidarity and can lead to the creation of formal structures to facilitate co-operation among co-operatives." (Id.)

The *Notes* specify two competing focal points of inter-cooperation, again reflecting the dual nature of cooperation, *per se*, as described above. Therefore, efforts at inter-cooperation tend to "focus on one of two types of activities. They tend to focus either on the economic dimension of co-operatives, to trade goods and services, such as Coop2Coop trade, or on the social and political dimension of joining forces for networking purposes and to advance shared interests." (p. 74) Nevertheless, inter-cooperation provides a foundation for integrating these focal points. A quote from the UN Food and Agricultural Organization (FAO) represents this well: "Through the device of federation, co-operatives are able to organize very large-scale business operations at the national – or even international – level without detriment to the democratic control of the primary co-operatives by their own members." (p. 75)

Moreover, it provides discursive grounds for communicating the cooperative principles across the business community. As the *Notes* claim, "the application of this 6th Principle enables co-operatives to achieve the strategic positioning of co-operatives as a leading business model, proudly demonstrating they are democratic institutions, leaders in stakeholder participation and in facilitating genuine community engagement."[40] (p. 77) This appeal applies especially to larger and more established cooperatives, who are in positions, e.g., to provide "[f]inancial support and assistance [...] to new co-operatives through grants or soft loans within countries or at the international level". (p. 78) But also simple Coop2Coop trade "is the most direct economic expression" of the principle of inter-cooperation. The *Notes* here draw attention to the

[40]The *Notes* continue,

> Building a strong sustainable co-operative economy is at the heart of why many people in the 21st century in numerous countries are choosing to form co-operative businesses. Co-operatives offer an empowering model based on self-help and self-reliance; a stark contrast to the consolidation of wealth and power in the hands of the small number of wealthy investors that has characterised the global economy for decades. Co-operation among co-operatives is fundamental to creating an economy in which the production and distribution of goods and services is undertaken in the spirit of mutual self-help and in the best interests of all the communities co-operatives serve. (Id.)

role of the cooperative movement in developing international standards like *Fair Trade* (Id.). Examples like *Fair Trade* show that inter-cooperation can be extended even beyond cooperatives.[41]

There is also some emphasis on *emergence* as a phenomenon in the 6th principle. The *Notes* state that while individual cooperatives can "succeed alone, [they] will only thrive and grow the co-operative commonwealth when they work together." (p. 80) A factual limit to creating such a "cooperative commonwealth" is the behaviors and attitudes the 4th principle instills. The *Notes* recognize this, stating that "[i]t is, perhaps, because each co-operative can do so much by themselves that co-operatives fail to realise how much more they can do together." (Id.) The sixth principle is central in the process of synthesizing the autonomy the fourth principle underlines with the fact that, through higher-order cooperation, cooperatives "can be greater than the sum of their parts." (Id.)

Central to inter-cooperation is the International Cooperative Alliance (ICA). ICA represents both "the largest non-governmental organisation in the world in terms of membership" (p. 71) and "the largest democratic membership organisation in the world." (p. 76) This role gives ICA a powerful position with respect to both defining and defending the spirit and letter of the cooperative principles.[42]

The *Notes* outline a number of future challenges to effective inter-cooperation: *Balancing dialogue with action*; *Effective power sharing*; *Transcending barriers*; *Transcending barriers*; *Awareness building*; *Effective communication*; *Developing a shared sense of purpose*; *Periodic assessment of the application of the 6th Principle*; *Developing effective global co-operative trade*; and *Developing effective global co-operative banking facilities and insurance arrangements*. We will argue in 8.5 that many of these challenges can be addressed by resolute commitment to what we will refer to as a *cooperative n-tuple Helix*.

[41] As per the *Notes*: "co-operative movement has, since its foundation, allied itself with and co-operated with other progressive movements and peoples working towards social justice and collective human progress. Joint campaigning work, combined with the economic work." [Rodgers, 2015, p. 80].

[42] As per the *Notes*:

> As an officially recognised global representative organisation, recognised especially through the provisions of ILO Recommendation 193, the Alliance also has the power to intercede on behalf of co-operative movements in countries where they are threatened by governments that lack understanding of the principles on which co-operative enterprise is based, a power the Alliance uses effectively. [Rodgers, 2015, p. 76]

8.4.3 Concern for Community

The seventh cooperative principle states that "Co-operatives work for the sustainable development of their communities through policies approved by their members." It is the last principle to receive recognition and was only recognized at the 1995 Congress. The *Notes* state "[t]he 7th Principle combines two elements of the Co-operative Values in the Alliance's Statement on the Co-operative Identity: those of 'self-help and self-responsibility' and 'the ethical values of honesty, openness, social responsibility and caring for others'. (p. 85) This ensemble principle arises, argue the *Notes*, "because co-operatives emerge from and are rooted in the communities in which they conduct their business operations."(Id.) Moreover, it serves as a reflection of the fact that "[t]he ethical values in the Alliance's Statement on the Co-operative Identity emanate from the special relationships co-operatives have with their communities which goes beyond simple business economics."[43]

In many ways, the 7th principle is the cooperative version of "triple bottom line" reasoning. The *Notes* comment "that [... t]he triple sustainable development logic of concern for economic, social and environmental sustainability tends to reinforce each other in that concern for social and environmental sustainability makes business sense and helps to sustain a co-operative's economic success." (p. 86) Its inclusion in 1995 coincided with multilateral dialogue at the time on "sustainable development", which connected the Smithian logic of wealth creation with logics of combating inequality and environmental degradation, i.e., balancing needs and limits (Id.).

Therefore, the text of the principle is to be read as an appeal to balance "three aspects: ecological balance, social justice and economic security. They are mutually interdependent and regenerative, hence must be pursued concomitantly." (p. 87) The text's focus on members' communities "shows that the primary emphasis of concern is for the local communities within which a co-operative carries on its business operations." (Id.) Moreover, the text again leans on the second principle, emphasizing the democratic member control over such activities. The *Notes* make clear that the wording and broader context of cooperative principles and values means "[i]t is this social dimension of sustainable development that the unique nature of co-operative enterprise has the power to deliver." The *Notes* describe the response to the devastating 2004 tsunami in Sri Lanka, "co-ordinated by the Alliance" as an example of this ability.

Another validation of the seventh principle is to be found in phenomena like

[43]Phenomena like open membership and education have already been discussed in the prior chapter, where we mentioned the fact that the Rochdale Pioneers had converted one floor of their store into a reading room for members of the community.

"Italian social cooperatives", which according to the *Notes* "are increasingly filling gaps caused by austerity regimes introduced by governments in response to increasing public debt in the wake of the global financial crisis."[44] We discussed this issue in the previous chapter and review case studies in Part III.

The purview of the seventh principle can be extended nearly indefinitely. International coordination of peace-promoting activities (Id.), good employment situations (p. 90), support for youth (Id.), contributions to efforts to stem economic inequality in the wake of globalization (p. 91), promotion of green consumerism and organic produce (p. 92) are all domains where cooperative principles, practice and the needs of the greater community can be mutualistically pursued, revealing the versatility of the cooperative logic in relationalizing with other logics. Moreover, the *Notes* make clear the synergies between these mutualistic goals and certain aspects of human nature[45] and underlines the reciprocal benefits in following such missions:

> The benefits from this responsible commitment to sustainability circle back through new members, increased turnover and higher surpluses that reinforce a co-operative's economic success. The long term sustainability of co-operatives requires a long term commitment and positive ongoing relationship with the communities in which they work. It is to the mutual advantage of communities and co-operatives alike. (p. 93-4)

The *Notes* extend the domain of consideration to concerns like the proactive adoption and support for open-source software and a renewed focus on providing essential services like health care (p. 95). In the face of the global Covid-19 pandemic and present-day debates about the accountability of online platforms, these concerns are no longer future-oriented, but very much present day challenges to fulfilling the appeals in the seventh cooperative principle. It should be stated here that recent reforms like the EU's adoption of SDG-reporting as discussed in 7.7.4 provide a foundation upon which to gauge the relative contribution of cooperatives and other forms of enterprise at meeting these goals. The cooperative sector should invest much energy and resources in convincing more jurisdictions of the benefits of such in-depth reporting.

[44]The *Notes* continue, "[t]he most distinctive characteristic of social co-operatives is that they explicitly define a general interest mission as their primary purpose and carry out this mission directly in the production of goods and services of general interest." [Rodgers, 2015, p. 89].

[45]We discussed many of these issues in Chapter 6.

8.4.4 Cooperative Principles as Examples of Negotiated Coordination

Here we wish to interpret the coop principles as examples of negotiated coordination (NC). In fact, the quote from the UN FAO report cited above seems to bring this to a point. The report suggests that inter-cooperation provides an impetus for scaling without losing the benefits of local information, tacit knowledge and sovereignty. The FAO Report continues, "secondary co-operative[s] can, because of [their] larger volume of business or [...] wider representational base, undertake functions, provide services, and make representations which would be beyond the capacity of all but the very largest primary co-operatives. Secondary co-operatives are a form of vertical integration providing the opportunity for economies of scale, scope for development and improved administration." [Rodgers, 2015, p. 75-6] Thus, secondary cooperatives – and especially cooperative federations – should be interpreted as a practical manifestation of the *negotiated coordination bodies* (NCBs) Devine speaks of.[46]

To recall Devine's point about subsidiarity, he argues that production units at the local level are better equipped to estimate local demand for their stocks and are therefore in the best position to realize social value *from their perspective*. Decisions in the longer-term or at greater scales, of which Devine focuses mainly on the *investment* function, frequently go beyond the purview or the resources of the individual production unit and it is here that greater social *and* individual benefit can be gleaned by transferring some decision-making capacity to NCBs. Comparing these notions with the discussion of secondary agricultural cooperatives as outlined by the UN body in the quote above, it is easy to see the isomorphic qualities of the division of labor between small- and large-scale organizations in the two assessments.[47]

NC and similar paradigms are therefore useful framing devices for discussing, assessing and communicating the benefits and costs of the cooperative principles in practice. It also represents an analytical shift away from ontological individualism and towards a dynamical worldview that considers emergent social properties in the first instance, instead of as an afterthought, as is the case with neoclassical perspectives. Such a worldview recognizes that, in many ways, as systems become more complex and scale up, the causal linkages between the higher levels become simpler [Chvykov and Hoel, 2021]. This occurs on the one hand because inter-dependencies become looser and less acute and also because coordination at higher levels is in itself a more complex

[46] I must thank Aaron Benanav for helping me make this connection.

[47] Indeed, Italy's cooperatives transfer 3% of their profits to cooperative development funds, which serve as NCBs. [Ammirato, 2018].

undertaking and elegance can be seen to be a virtue at scale. The cooperative principles can thusly be interpreted as simple signals and heuristics along which higher order organizational change can occur.[48]

Recognizing the isomorphism between the cooperative principles and NC may provide the impetus for consideration of the need for "lower order" and "higher order" principles for cooperation. We argue below that the fifth principle, education, can serve as a lever between these levels.

8.4.5 Principles as Propensities

In Chapter 6, we discussed the idea of causal equilibrium as a condition of behavior of groups. We introduced the idea of social norms as such choreographers. Here, we intend to connect this with the concept of macroculture. We are particularly concerned with connecting the two principles just introduced with the four discussed in the prior chapter. As the discussion immediately above has shown, however, the latter "ecological" principles depend upon the primary principles, one through four. We will argue below that principle five acts as a lever to connect these two sets of principles

Moreover, it would appear that the cooperative principles serve precisely as an *ensemble of propensities*, which facilitate non-random responses to environmental changes. Therefore, while investor-owned businesses may also react non-randomly to specific changes in their environment, the fact that they are only generally connected by the principle of profit maximization restricts the degrees to which they may coordinate behavior and in general limits the predictability of their responses. Cooperative enterprise, on the other hand, actively constrains itself on a number of levels which we have been outlining in general since Chapter 6.

The fact that cooperatives are democratically controlled by members means that ideally, a small cadre of elites cannot steer policies. The fact that members participate economically means that logics besides maximizing return steer investment and other decisions. The fact that they are autonomous means that policies like mergers & acquisitions are to be avoided if possible within the cooperative sector and do not become a routine. It is easy to see that these principles operate as an ensemble of constraints that channel behaviors and expectations for both members and the wider community with whom cooperatives interact. The fact that the principles specify open terrains for behavior means they cannot be modeled using deterministic or mechanistic methods. However, using information theory, Bayesian networks and a high

[48] In this sense, the cooperative principles follow Albert Einstein's dictum that "everything should be as simple as it can be, but not simpler".

degree of indeterminacy and interdependence may allow us to more concretely establish the degree of connectedness among cooperatives and the level of redundancy of interpreting the principles.

Such exercises may help both underline the strengths and identify weaknesses in the dynamics that underlie cooperative enterprise and the broader cooperative movement. We attempt such an exercise in 8.5.3. But before this, we must still introduce a central idea.

8.5 Towards a Cooperative n-tuple-Helix

Before moving on to the empirical part of this work, we wish to introduce one last concept, that of the *Triple Helix*. The idea has been championed by Dutch communications scientist and cybernetician Loet Leydesdorff and refers to a model of communication. In particular, it is a higher order model of communication that attempts to understand, interpret and develop metrics to measure the evolutionary dynamics of knowledge-based innovation. [Leydesdorff, 2021]

8.5.1 The Triple Helix

As part of a greater "communicative turn" [Leydesdorff, 2021, p. 43], which Leydesdorff attributes to the results of "the scientific-technical revolution", the nature of the logics driving production, consumption and innovation have fundamentally changed. Leydesdorff suggests that Marx was aware of these shifts when the latter wrote that "if technology could enable us to free man from work sufficiently, the nature of capitalism would change, since *the basis of this mode of production would fall away.*"[49] According to Leyedesdorff, such a shift requires a more active focus on communicative acts, on information, and the dual role of individuals as both *observers* of existing codes and *builders* of new codes. Leydesdorff emphasizes that these two roles are distinct and require the application of different logics.

As we observed above, phenomena like the cooperative principles act not only to constrain behavior; they also act as signals. This relates social norms like the cooperative principles to natural selection. However, there are some distinctions between biological evolution and the evolutionary dynamics driving processes like those the cooperative principles regulate. In particular,

> Biological selection is based on genotypes that are *hard-wired*, historically present, and thus observable (e.g., as DNA). The

[49] Marx, cited in [Leydesdorff, 2021, p. 2].

> "genotypes" of cultural evolution are codes of communication which can further be developed *because they are not hard-wired*. [Leydesdorff, 2021, p. 11]

Therefore,

> flows of communication are molded by selective codes, on the one hand, and variation, on the other. These contexts provide two analytically different perspectives on the same events; the data can be organized using different logics. From an historical perspective, one focuses on variation and agency, and the potential morphogenesis of systemic relations in the data. From an evolutionary perspective, the focus is on the same data indicating selection environments which can be specified on the basis of a reflexive turn. (Id., p. 21)

In particular, Leydesdorff argues that the term *political economy* "can be explained in terms of two coordination mechanisms (markets and governments)." (*Id., p. 22*) Meanwhile, the scientific-technological shift that inheres in contemporary discourse and practice requires a shift away from the dual-helix of government and industry. This is to a large degree because "[t]he control function is no longer carried by individual agents [...]. Functions are [instead] coded at the above-individual level." Thus,

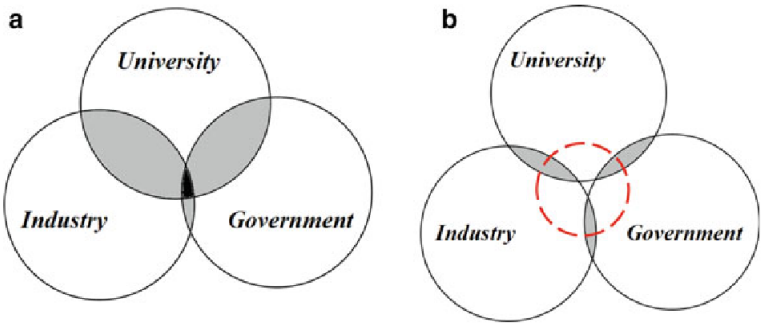

Figure 8.2: a) a traditional hypercircle representing integrative bifurcations; and b) represents both differentiation and integration in the manner of the Triple Helix, from [Leydesdorff, 2021, p. 23].

> a knowledge-based economy is the result of three coordination mechanisms interacting and operating upon one another. Interactions among three selection environments shape a triple helix with properties very different from double helices (22)

An example of what Leydesdorff means with a *Triple Helix* is represented in Figure 8.2. [Leydesdorff, 2021, pp. 23-4] expands on the concepts entailed by the figure:

> The "hypercycle"—indicated with a dotted line in Fig. 8.2—provides a metaphor for the supra-individual dynamics that give intersubjective meaning to the meanings provided by the carrying cycles. In other words, the emerging next-order-level "overlay" can contain a meta-representation of the individual representations and their interactions. This meta-representation in the hypercycle feeds back as a regime on the underlying dynamics which evolve historically along trajectories.

That means that both the cooperative principles themselves and the agency they facilitate (recall the shift from "Informal project based collaborative arrangements" to "networks" and even cooperative federations alluded to in our discussion of principle six) can entail such an "overlay". But even more interesting and significant is the potential for higher-order "overlays" where, e.g., interactions between higher-order organizations subscribing to cooperative principles and, e.g., governments and academic institutions. Following arguments that Leydesdorff provides, we may quantify the level of "bleeding over" of the logic of cooperation into the other carrying cycles. At this point, the role of *incursion* should be mentioned. Leydesdorff continues that

> This historical development is recursive: the current state of a system (x_t) is a function of the previous state ($x_{t-\delta t}$) in the historical world. However, the feedback of a hyper-cycle operates against the arrow of time: the expected state at a next moment of time (t + δt) incurs on the carrying cycles. Expectations can incur on the present system because they are no longer only subjective; the intersubjectively carried code is the operator. This incursion of a mechanism operating on the recursive (that is, historical) dynamics against the arrow of time introduces the logic of anticipatory systems. (Id.)

This process of *incursion* occurs via the effect of the "correlations among the distributions of relations" (p. 91) on expectations. These incursions occur within the individual domains, the regions outside of the (red) hypercircle in Figure 8.2, via specializations. At the same time, incursion occurs within the domain of the hypercircle, which represents the impact of synergies between the respective domains (here novelty production, profit-maximization and regulation). We see evidence of such incursion, e.g., in the EU and UN's receptivity to facilitating enforcement and expansion of cooperative activities, etc.[50] The point, according to [Leydesdorff, 2021, p. 93] is that "the same

[50]Cf., e.g., `https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0682`.

events [...] can have different meanings with reference to each of these three selection environments [while] the trilateral interactions among the bilateral ones can be expected to provide an emerging feedback on the constituent helices and their mutual interactions."

8.5.2 The Cooperative n-Tuple Helix

We wish to extend Leydesdorff's idea of a Triple Helix to an "n-tuple Helix", which can be done by adding more dimensions to the respective hypercycle.[51] However, as this dissertation concerns the *cooperative*, and not necessarily the *knowledge* economy (they are certainly related), some adjustments must be made to the remaining helices. In particular, we attempt to move in labeling away from attributes and towards outlining relationships by emphasizing the logic of each respective helix. For example, while Figure 8.2 describes one of these with the label "University", referring to Universities' functions as novelty producers, a cooperative n-tuple helix would relationalize the *educational* function of Universities in addition to novelty-production.

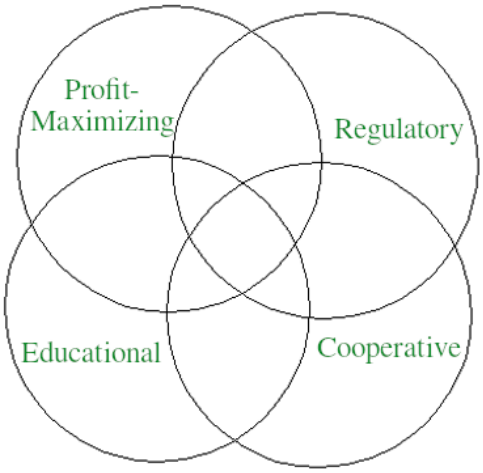

Figure 8.3: A quadruple helix adding educational and cooperational logics, adapted from [Leydesdorff, 2021, p. 23].

This scenario can be shown in the *cooperative quadruple helix* represented in Figure 8.3. Here, we see logics of *regulation*, *cooperation, profit-maximization* and *cooperation* at work. However, this representation is unsatisfying, as it still leaves out the important function of novelty production. While the cooperative logic does itself present a form of innovation, there are innovations that do not necessarily derive from a cooperative logic. In fact, as we have described throughout the text, cooperation and competition exist in an agonic relation to another and the present contribution seeks merely to compensate for the lack of attention cooperation has received in the economic literature.

Thus, the final cooperative n-tuple helix we produce is a *quintuple* helix,

[51] Cf. [Leydesdorff, 2021, p. 21], [Carayannis and Campbell, 2009] or [Carayannis and Campbell, 2010].

represented by Figure 8.4, which includes the logics of the quadruple helix in addition to the novelty-producing logic driving the evolution of the knowledge economy. This can involve technical innovation as well as network effects. The point being that a cooperative quintuple (sextuple, etc.) helix emphasizes the centrality of the *cooperative* logic's contribution to the evolutionary dynamics of complex social systems. The quintuple helix is represented by Figure 8.4.

Such a schematic can be operationalized via n-dimensional matrices and be modeled using agent-based modeling. We should state that the *regulatory* logic in this scheme is organized according to DCMs, meaning such a perspective does not necessarily require a separate vector for "government regulation", but could comprise the (dynamic) beliefs of stakeholders, to whom the recursive and incursive processes of the helix are accountable.

The reason we wish to apply both the fifth and sixth principles actively in those opportunities represented by the educational and novelty-producing carrying cycles is that these parameters are have characteristics where extra-local cooperation can be mutually beneficial and non-displacing. We learned in the discussion of autocatalysis in 8.3.3 that, while mutuality is the general rule in complex systems, two (or more) autocatalytic circuits drawing from the same scarce resource drives both systems to compete for these scarce resources. However, education is a classic non-rivalrous public good, meaning, e.g., that multiple national cooperative federations can invest in education internationally without turf warfare or competition[52], because they wouldn't automatically be drawn to compete for scarce resources and can, in fact, enjoy mutual benefits in terms, e.g., of the *economy of esteem*[53].

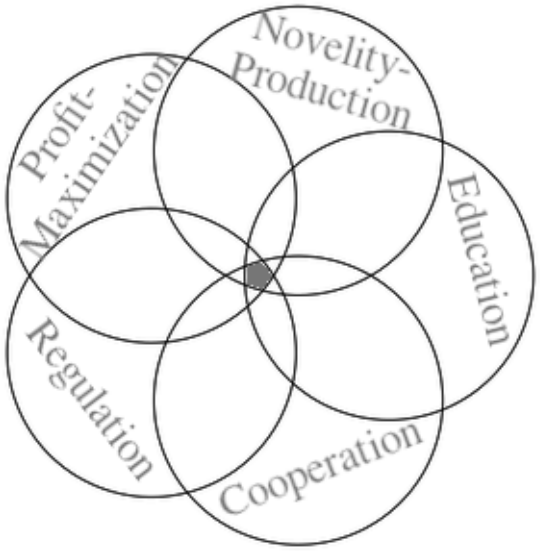

Figure 8.4: A *quintuple* cooperative helix, reintroducing the novelty-producing logic.

In essence, investing in extra-local education and training institutions

[52]Cf. [Shaikh, 2016, p. 282f.].
[53]Cf. [Warren, 2015].

appears to fulfill all three of the last principles and serve as a strong foundation of strengthening the cooperative identity and providing for the next generation of cooperative leaders, as well as actively communicating the cooperative advantage to the general populace. Here, the *Notes* are clear in comments on 6th principle: "Co-operatives need to co-operate with one another to develop co-operative movement-wide leadership; a precursor to realising wider economic, social and environmental transformation." [Rodgers, 2015, p. 78] The *cooperative n-tuple Helix* is a rubric under the guise of which more and more international cooperative federations can and are beginning to invest in the next generation of cooperative innovation, development and growth.[54]

8.5.3 Examples of A Cooperative n-Tuple Helix

> 'When a farmer ploughs a field with a big rock in it, he ploughs around the rock — close on each side, leaving a triangle of unploughed land on each end.
>
> "Mrs Frisby's house is beside the rock, and will get ploughed up — and probably crushed, as the owl said. But if we can move it a few feet — so that it lies buried behind the rock — in the lee — then she and her children can stay in it as long as they need to."
>
> –*Mrs. Frisby and the Rats of NIMH*, Robert C. O'Brien

In order to draw a line under the advances made in Part II and prepare the stage for the empirical research program developed in the concluding chapters, we now attempt to connect the theoretical discourse of the *n-tuple helix* with the concrete notion of ascendancy. In particular, in order to *measure* the contributions of the synergies of the individual cycles, we proceed iteratively, following [Krippendorff, 1974]. Using this approach, we intend to interpret analogs for TST and CE for key bilateral and trilateral relations within particular manifestations of a cooperative *n-tuple.*

An example of this can be found in the calculation of these figures for the cooperative development fund of Italy's largest cooperative federation, CoopFond. It receives funding from around 15,000 cooperatives, who each provide 3% of their profits annually for investment and development in the cooperative sector. CoopFond itself engages in investments in education, training and research and has a maximum of €2 million annually available for

[54] A recent initiative from the Spanish and Brazilian cooperative federations appears posed to push education to the foreground in all future discourse concerning the fate of the global cooperative movement.

such purposes. Using this €2 million as an indicator for the synergy between the cooperative, profit-maximizing and educational helices, we get a capacity of roughly €11,5 million and an ascendancy of €10 million, leaving only around €1,500,000 in a "reserve" state.[55] This means that, with regards to this trilateral relation, CoopFond could increase resilience by either increasing system complexity (perhaps by increasing the funding rate from 3% to 5% of profits[56]), or by diverting more of its existing capacity to such funding.

In particular, we note that the helix we depict in 8.5 disentangles both (monetary) transfers as well as *forces*, in the form of *propensities* in the *qualitative* impact that CoopFond's spending on education has on the profit-maximizing logic. The transformative potential of such an analysis cannot be overstated. One of the frequent discussions in social sciences has been that of the "two cultures" of *qualitative* and *quantitative* approaches. The relational perspective seeks to be pluralistic in the sense of embracing methodological pluralism, e.g., mixed methods approaches [Hesse-Biber, 2010], and, within such a context, the n-tuple helix depicted above can open the door to investigating qualitative shifts within *out of* or *near equilibrium systems*

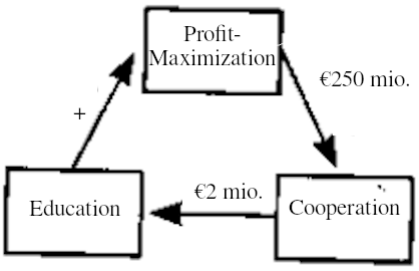

Figure 8.5: A *Triple Helix* derived from the quintupe helix above, showing the interactions (flows) between Legacoop cooperatives, CoopFond and educational projects.

Such shifts can be represented via the epistemic perspective of an n-tuple helix and the methodology of process ecology. Such an approach can be approximated, quantitatively, by a log-log measure, which can show the effect of incremental (cf. qualitative) changes. This would allow researchers to move beyond notions of "state dependence", which operate on the basis of distinct domains, possibly distinguished via psycho-social norms[57]. Most discussions of state dependence do not discuss the *how* of switches between states, which arguably requires the introduction of process parameters. Education within

[55]These are calculated using the respective formulas for capacity and ascendancy from [Ulanowicz, 2012, p. 102ff], and subtracting the latter value from the former to get the CE, or "reserve", value. We provide background on these calculations in Appendix A.

[56][Ammirato, 2018] has called for increasing the contribution from 3 to 8%.

[57]Cf. [Warren, 2015], [Bowles and Gintis, 2013] or the discussion of "non-separable preferences" above in 6.4.7.

the above helix is such a process variable, whose contribution, while not easily quantifiable, can be *approximated* via process ecology[58].

We could perform similar calculations based on bi- or trilateral relations among other cycles in the n-tuple helix. The point we wish to make is that such an analysis connects a theoretical analysis of relationships with measurable quantities that can then translate real flows into comparable – and scalable – quantities. Using such a method, both practitioners within the cooperative economy and policymakers can learn more about the resilience of their enterprises and federations and additionally plan reforms with respect to these.

The connection between system level flows, capacities and "redundancies" has been usefully applied in multiple fields, including urban planning [Kiss and Kiss, 2018], water supply [Dave and Layton, 2019] and ecosystems analysis [Ulanowicz et al., 2009]. Its application to the cooperative economy appears a promising endeavor.

8.6 Conclusions

In this chapter, we have attempted to both extend the analysis to a higher level (i.e., that of the inter-organizational landscape), while at the same time extending our context of justification to the market system itself. We therefore began the chapter by recalling Dow's *imperfection principle*, which states that explanations for the dearth of LMFs over and against KMFs must look at the nature of markets as they truly exist, which are far from displaying notions of perfect competition. The real competition we instead see is one with strong inertial forces that benefit large, concentrated enterprises and which often prevent more effective (or even efficient) organizations due to the degenerated state of the law in many jurisdictions.

Following this, we drew a line under the distinction between market *transactions* and market *forces*, suggesting negotiated coordinated (NC) as a frame in which to interpret the former in a manner independent of market forces. We compared NC to Pfeffer's *resource-dependency theory* and assessed its uncertainty-reducing qualities.

Following this, we summarized the findings of *process ecology*, outlining a number of its central categories, including the aleatoric, the notions of propensity ensembles, autocatalysis, ascendancy and overhead, and finished by connecting these themes with the notion of metaphysical patience.

[58]I must thank Robert Ulanowicz for his helpful insight in clarifying matters related to the connection of process ecology and the Triple Helix, particularly with respect to the contribution of the former to approximating *qualitative* shifts in complex systems.

We next connected the above ideas to the cooperative economy, by analyzing the sixth and seventh cooperative principles as propensities. We also interpreted the principles using the filter of NC.

Finally, we developed the concept of *cooperative n-tuple Helix* to synthesize the above discussions. Viewing the principles as elements in a process of cybernetic feedback, we derived a model following Leydesdorff, to measure the impact of the cooperative principles on a field of both specializing and integrative logics that incur on the underlying carrying cycles, one of which can be cooperative enterprise. We concluded this discussion by an application of the Cooperative n-tuple Helix to the largest Italian cooperative development fund, which is financed by an amount equivalent to 3% of each cooperative's profits.

In closing, we should ask ourselves whether, under the lessons learned and the arguments made, self-organization along the cooperative principles helps with transformation, adaptation and resilience in a changing environment? We believe it does and much research is needed to fully understand the dynamic impact and potential of the cooperative principles to promote environmentally, socially and culturally sustainable agendas. More research is also needed on rendering self-organization along these principles ascendent. We have seen in this chapter how mutual benefit may not be sufficient to break a negative spiral, but at the same time, connected back with the concept of macroculture to point a potential path towards a more pluralistic economy, centered on the logic of cooperation as a foundational principle.

The next section of the book attempts to apply some of the lessons of the preceding discussions in empirical settings.

Appendix A

Calculations for 8.5.3

Here we describe the path by which we arrived at the results in the Triple Helix example from the last chapter. We apply the methods of process ecology and proceed to calculate the system capacity, ascendancy and overhead of funds going from Legacoop, the Italian cooperative federation, to CoopFond, its cooperative development fund. In particular, these two elements would in themselves only represent a dual helix of cooperation and profit-maximization. What interests us is the inclusion of funding by CoopFond of education and research, a third helix. Thus, the formulas for calculating capacity (C), ascendancy (A) and overhead (O) are presented below[1]

$$C = K * p_{ij} * log(p_{ij} \tag{A.1}$$

$$A = K * (p_{ij}) * log(\frac{p_{ij}}{p_i * p_j}) \tag{A.2}$$

$$O = C - A \tag{A.3}$$

Regarding the parameter K, [Ulanowicz, 2012, p. 102] writes,

> The usual convention is that K defines the units of information. For example, if the base of the logarithm is 2, a single unit of K is referred to as 1 "bit" [...]. Should natural logarithms be used, K = 1 then represents one "nat" of information; when the logarithmic base is 10, K is measured in "hartleys." Early in most introductions to information theory, the base of the logarithms is specified; K is set equal to 1, and thereafter it disappears from discussion. However, Tribus and McIrvine (1971) suggest that the purpose of K is to impart physical dimensions to the index it

[1] Cf.[Ulanowicz, 2012, pp. 102ff.] or [Kiss and Kiss, 2018, p. 163].

> scales. As the total systems throughput has already been cited as characterizing the size (or scale) of a network, it is appropriate to equate K with T.

Thus, in our example of the cooperative Triple Helix we've established in 8.5.3, T is equal to the total system throughput (TST) in Legacoop, specifically Legacoop's annual profits, which, from the revenues, which in 2018 totaled roughly €25 billion, can be generated to be equal to €8.33 billion. Thus, T= €8.33 billion. Meanwhile, p_{ij} relates the flow to CoopFond to TST. It is thus equal to 3% of €8.33 billion, or €250 million. Meanwhile, $p_i * p_j$ represents individual in and outflows to the synergy in question (here, the element of p_{ij} going towards education), which is equal to €2 million yearly.

Thus, the respective formulas for *capacity, ascendancy* and *overhead are*

$$C = 8.33billion * 250million * log(250million) = 11,500,000; \tag{A.4}$$

$$A = 8.33billion * (250million) * log(\frac{250million}{2million}) = 10,000,000; \tag{A.5}$$

$$O = 11,500,000 - 10,000,000 = 1,500,000. \tag{A.6}$$

We have used just profits as *total system throughout* in this calculation. The result was a rather low "overhead". We could have derived a higher value by using the €25 billion in total revenues. The point was to show how CoopFond's impact could be increased by leeching a higher percentage of profits to efforts like education and research, thus the decision to restrict TST in this model. We could certainly re-run the calculations, replacing T=€8.33 billion with T=€25 billion and would receive a result showing a higher level of "conditional entropy", funds that are not productively employed with respect towards cooperative development. The point, however, was to demonstrate that if each Legacoop cooperative was willing to transfer a higher amount of its retained profits, that it would make the entire federation more resilient, by reserving more funds for research and education[2].

[2]As research and education cannot be quantified in their contribution to value production, I have marked the edge connecting "education" with "profit-maximizing" with a '+' to denote it as a qualitative contribution: a propensity, or force. I thank Robert Ulanowicz for engaging with me on clarifying this idea.