

FINANCE AND ECONOMICS LEARNING EDUCATION IN THE ANTHROPOCENE ERA: EMBEDDING THROUGH SUSTAINABLE ONTOLOGY

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Abstract. Scholars have largely debated the issue of sustainability integration in the curricula of business schools and universities. But no study has taken up the issue of sustainability related to finance and economics learning. In the Anthropocene era, where humankind have transformed Earth system, the question of how finance and economics is taught is thus central. Based on a paradigmatic redefinition of sustainable finance and economic learning education, our research proposes an ontological rupture, where sustainability and living stakes embed economics and thus financial practices. We determine a new ontological perspective, crossing sciences and disciplines. Using the analytical structure from Morgan (1980), we first, identify the paradigm appropriated for a sustainable anchoring in finance and economics; second, define new metaphors to implement this paradigmatic vision; and third, present a puzzle-solving (curriculum) for master's degree in finance and economics. We preconize to develop sustainability of finance before thinking sustainable finance, to use a moving and adaptable theoretical corpus mobilizing all fields of sciences to implement this paradigmatic vision, and we challenge scholars and their individual responsibility to change their curricula.

Keywords. Sustainable finance; sustainable economics; sustainability; Anthropocene; learning education; pedagogy; ontology; metaphors; puzzle-solving.

I've seen many reports, but nothing like the new @IPCC_CH climate report, an atlas of human suffering & damning indictment of failed climate leadership. I know people everywhere are anxious & angry. I am, too.

Antonio Guterres, UN secretary-general, February 28, 2022¹

The reaction of the UN Secretary General to the publication of the latest IPCC report (2022) is unequivocal. The conclusions are alarmist: irreversibility of the consequences of climate change and systemic effects on natural ecosystems, increasing standard deviations between minimum and maximum temperatures (temperature shocks), massive loss of biodiversity, rising sea levels, extreme water shocks, massive increase in extreme weather events (floods, hurricanes, cyclones, drought, fires, etc.) (IPCC, 2022). It is difficult to use the conditional today to admit that it is the hand of man that is at the origin of the degradation of the biosphere, from the beginning of the industrial era in the 19th century to the present day, accentuated since the 1950s by the ‘great acceleration’ (Steffen, Broadgate, Deutsch, Gaffney, & Ludwig, 2015a). We have thus entered the era of the Anthropocene (Crutzen, 2006; Steffen et al., 2015b), or the ‘human epoch’, in which humans, in their quest for infinite growth, have inexorably modified the earth system through the principles of extraction and terraforming. The future of humans and all living species is at stake, with some scientists claiming that the world is on the brink of, or has already entered, a sixth mass extinction (Cowie, Bouchet, & Fontaine, 2022; Kolbert, 2014).

Going back to the origin of these phenomena forces us to look at the economic model that has accompanied this drift since the ‘great acceleration’, i.e. a neo-liberal vision of the economy in which the financialization of companies and society governs exchanges, strategies and social relations (Christophers, 2015; Davis & Kim, 2015; Lagoarde 2015; Sawyer, 2013; van der Zwan,

¹ <https://twitter.com/antonioguterres/status/1498256378506448899>

2014). In this period of radical climate and ecosystem uncertainty, and in parallel with the development of the “financial hyper-reality” (Schinckus, 2008: 1076), sustainable finance has been democratised in investment processes, moving from a niche strategy to a mainstream and integrated approach (Revelli, 2017). Investing in environmental, green, social and human rights strategies is now an integral part of the language used by financial actors to identify virtuous, non-controversial and useful projects for our societies. In spite of this awareness, the situation remains salient: when the Global Sustainable Investment Alliance (GSIA, 2020) has announced that one in three assets worldwide (or more than US\$30 trillion) would be managed sustainably or responsibly, the sustainable finance gap has never seemed so wide. Of the world's 75 largest asset management companies, 38 (including the world's six largest, BlackRock, Vanguard, State Street Global Advisors, Fidelity Investments, Capital Group and JPMorgan Asset Management) are reported to be neglecting the ecological and social damage of their investments (Nagrawala & Springer, 2020). Less than 1% of investment funds would also be aligned with targets to limit global warming to 1.5°C, offering instead a perspective of +2.75°C (CDP, 2021). Facing the predicted tragedy of horizons (Carney, 2015) it would rather be a matter of re-embedding the financial industry in a sustainable and ethical vision (Revelli, 2016) and in bio-geophysical and social constraints (Galaz, Crona, Dauriach, Scholtens, & Steffen, 2018; Nyström et al., 2019).

Protecting our future generations in this new world means engaging at the root, that is, at the very source of education on sustainability issues (Alcaraz & Thiruvattal, 2010; Aragon-Correa, Marcus, Rivera, & Kenworthy, 2017; Starik, Rands, Marcus, & Clark, 2010). Although sustainability education is becoming democratized in university and business school curricula, it is still in the minority in economic and financial disciplinary fields (Belinga & Morsing, 2020), mainly focused on the learning of the principles of neoliberal finance (Fotaki & Prasad, 2013;

Ghoshal, 2005). Similarly, sustainable finance would be part of the dominant paradigm, in a search for financial materiality (Crona et al., 2021), thus defining the concept of neoliberal green or sustainable finance (Dwizok & Jäger, 2021; Leins, 2020). The question of the values carried by the teaching of sustainable economics and finance remains central, as it governs the question of the paradigm itself and the ontological posture. How to make finance work for sustainability, and how to teach it?

In this research we propose a holistic reflection of the vision of sustainable economics and finance learning education, in a vision of embedding in the sense of Polanyi (1944, 2001). We anchor the question from a paradigmatic point of view, in order to ultimately propose a method for implementing a curriculum, in a logic of strong sustainability, where finance becomes the tool. Our contributions are 1) theoretical, as they allow the ontological and epistemological anchoring necessary for a strong sustainability vision, in a field where scientific research is non-existent; 2) practical, as they offer the possibility for the academic community to seize this paradigmatic vision in the pedagogical contents via a turnkey curriculum; 3) methodological, as our approach provides the keys and metaphors necessary to implement the vision and then the identified contents.

We proceed according to Morgan's (1980) approach which sequences the definition of a paradigmatic approach in three steps (metatheoretical assumptions, metaphors, puzzle-solving): 1) the definition of the metatheoretical assumptions and the paradigmatic anchorage related to the teaching of sustainable finance 2) the identification of a language allowing this paradigmatic anchorage, through the proposal of a set of appropriate metaphors (complex thinking, transdisciplinarity, hierarchy and resilience, *philia* and impact); 3) the formalisation of a puzzle-solving in relation to this ontological and paradigmatic vision, through the proposal of a turnkey

teaching curriculum for the master's degree. We then conclude with a series of proposals for the democratisation of this vision in the teaching programmes of universities and business schools.

CHOOSING A PARADIGM

Is sustainability compatible with the neoliberal financial paradigm?

The foundations of economics and finance education are based on neoclassical economic and financial theory (Belinga & Morsing, 2020; Giacalone & Promislo, 2013; Lagoarde, 2015). This economic vision of a rational world with an optimal equilibrium was then equipped with an arsenal of tools enabling it to legitimise the strength of financial markets, such as the ‘portfolio theory’ (Markowitz, 1952), the ‘Capital Asset Pricing Model’ (CAPM) (Sharpe, 1964; Lintner, 1965), the ‘market efficiency’ (Fama, 1970), the ‘option theory’ (Black & Scholes, 1973) as well as the ‘agency theory’ and its principle of maximising shareholder value (Jensen & Meckling, 1976), thus generating a performative or self-predictive theoretical field (Callon, 1998; MacKenzie, 2006; MacKenzie & Millo, 2003).

The neoclassical paradigm is based on three key concepts that underpin its meta-theoretical assumptions: objectivism, reductionism and instrumentalism (Lagoarde-Segot & Martinez, 2021)², which are said to have the function of embedding economic reality in the financial (Polanyi, 1944, 2001). The self-fulfilling prophecy of classical financial theory makes it the dominant system, in a positivist and deductive epistemological logic, at odds with social and ecological reality (Galaz et al., 2018; Nyström et al., 2019).

² According to the authors (2021: 2), “objectivism is the notion that financial markets exist as natural and external entities, independently of the representations that individuals have of it. Reductionism is the belief that the whole is no more than the sum of its parts. It assumes that large entities (such as society or the Earth system) have no real substance, which rules out any possible top-down causation. Finally, instrumentalism is the notion that assumptions based on wildly inaccurate description of reality are sound so long as they permit to calculate an equilibrium position”.

Ultimately, the dominant orthodox paradigm (Fotaki & Prasad, 2015) of neoclassical financial theory has generated a financial *logos* (Walter, 2016), resulting in the creation of a mathematically complex ‘econophonic’ language (Giacalone & Promislo, 2013), with ramifications now deployed in the political and practical sphere via technocratic financial regulation (Marti & Scherer, 2016), but also in teaching and research (Audebrand, 2010; Giacalone & Promislo, 2013; Lagoarde-Segot, 2015; Tourish, 2020; Wang, Malhotra, & Murnighan, 2011). Questioning the content and practices of finance education can thus shed light on the “shaping” of new financial actors. It also allows us to understand whether, in higher education, the concept of sustainability is intrinsically embedded in the social reality defined by the dominant neoclassical financial paradigm, or whether it is embodied in an ontological perspective where Earth ecosystems represent the higher order system (Dron, 2015; Lagoarde-Segot & Martinez, 2021; Simon, 1962).

Embedded in a financial rhetoric, sustainability would thus be seen as an externality to be valued and monetised, in order to understand whether its cost is compatible with the quest for infinite growth and maximisation of shareholder value. As stated by Lagoarde-Segot & Martinez (2021: 3), neoclassical financial paradigm uses a sample of metaphors such as “‘financial repression’, ‘agency problem’, ‘signaling’, ‘efficiency’, ‘deviation’, ‘equilibrium’, ‘rational bubble’, ‘black swan’, ‘wilperformance’ and, more recently, ‘sustainability’”. Sustainable indicators and factors would thus be integrated as market signals used to financial analysts’ investment narratives (Leins, 2020: 71), transforming the normative quest for investment moralization into a speculative valuation practice (Revelli, 2016, 2017). In a logic of brandisation (in conjunction with the concept of financialization)³ (Willmott, 2010), the financial industry, but

³ Willmott (2010) explains how the notions of brand equity and brand value have changed from a “product” vision (the effect of brand awareness on the brand’s marketing vision with consumers (image, personality, etc.); financial

also media such as *The Financial Times* or *The Wall Street Journal* (Leins, 2020: 76) integrate the term sustainability in their agenda to differentiate and to bring sustainable finance out of its niche and into the mainstream (Revelli; 2017). The green investment paradigm would thus be “reductionist, normative, disembodied, ahistorical and depoliticizing” and would constitute a new headlong rush (Magalhães, 2021), as it would lay its foundations on financialized roots whose objective remains the business-as-usual, thus acting as the determinant of corporate social responsibility (CSR) and sustainability policies (Banerjee, 2008; Scholtens, 2006).

The neoclassical paradigm is based on a very simplified equation: in order to maintain an infinite growth perspective, shareholder utility must be maximised in a strategic vision that considers nature and the biosphere as a simple resource used to meet the growing demand for biomass (Nyström et al., 2019). It is necessary to maximise consumer utility via marketing strategies (Arvidsson, 2009; Willmott, 2010), and thus to consolidate the productivist model based on resource extraction. In this vicious circle for natural ecosystems and virtuous for the financial industry, this decoupling is reinforced by the power of the concentrated and hegemonic (Gramsci, 1948-1951) financial giants, which have a considerable influence on the phenomenon of climate disruption and destabilisation of biomass (Galaz et al., 2018).

Promoting sustainability in finance and economics curricula would involve reversing the dominant neoclassical paradigm. Marshall, Vaiman, Napier, Taylor, Haslberger, & Andersen (2010: 478) argue that “a paradigm shift is underway—one that necessitates the transformation of the conduct of commercial enterprise and the content of business curricula. The new paradigm incorporates a sustainability mandate, refuting clearly the old thinking of limitless resources,

support given to a product, service, or company in terms of revenues, potential revenues, reputation, prestige, etc.) to a financial vision of a “market” where the exclusive objective is to generate optimized cash flows to maximize shareholder wealth through marketing strategies.

unbounded growth, and technologically derived solutions”. Thinking about the reconstruction of academic paths in finance and economics therefore implies engaging in a heterodox and critical vision that counters the neoclassical financial paradigm and its culture of greed in education (Wang et al., 2011).

Teaching finance and economics in a heterodox and pluralist paradigmatic view

Our perspective is to anchor our vision in a vision of heterodoxy that integrates ecological and social reality into economic reality, *i.e.* thinking differently about sustainability, taking it out of the dominant neoclassical paradigm. The *critical management studies (CMS)* (Alvesson & Willmott, 2003) allows for a heterodox approach to management and business issues. Its aim is to develop a less partisan managerial stance and a pluralist vision that integrates knowledge from critical social science traditions to rethink and develop management theory and practice. In the *CMS* stream, Parker (2003: 204) points out that traditional theory is flawed precisely because it trades on the myth of “identity thinking” which characterizes positivist versions of theory. The positivist epistemological current, with its deductive deterministic view, cannot reduce social explanation to a deduction of events from a set of individual conditions and laws of constant conjunction (Lawson, 1997). The difference between orthodoxy and heterodoxy is thus established at the ontological level, in the observation and definition of the basic structures of reality, where the concept of ‘social ontology’ would oppose the orthodox neo-classical ontology, defining the social domain as emerging from human inter(action) capable of affecting it causally (Lawson, 2006).

Sustainability cannot be inscribed in a deductive logic but in an ontological heterodox paradigm in the line of Lawson's social ontology, where social-ecological facts cannot be guided

by a theory and mathematical tools that presuppose reality. Thus, to refute the dominant neoclassical financial paradigm, in a Popperian logic, to show critical realism and to be part of a heterodox vision commits to draw a new ontological and epistemological thought. As Kuhn (1962) states, “to reject one paradigm without simultaneously substituting another is to reject science itself”. Thus, it would be a matter of rejecting a paradigm “of conventional technocentrism and antithetical ecocentrism on grounds of incongruence” and favouring “a more fruitful integrative paradigm of ‘sustaincentrism’” (Gladwin, Kennelly, & Krause, 1995: 874).

The enlightenment of ‘ecological financial theory’ or EFT (Lagoarde-Segot & Martinez, 2021) as a heterodox paradigm seems also interesting and appropriate. Through its ontological ‘ecological’ perspective, it allows us to profoundly question the very foundations of neoclassical financial theory (objectivism, reductionism, instrumentalism). Firstly, EFT re-establishes the Earth system as the first-order system and thus puts sustainability back at the heart of the issues (figure 1), contradicting the concept of objectivism that defines the financial economics sphere as a concrete and independent reality. The Earth system (which includes the biosphere, atmosphere, hydrosphere and geosphere) embeds the production systems (market and non-market activities in a context of social norms, culture, rules and laws) as a sub-system on which they depend, but also the financial system, which is itself a sub-system of the production system. In EFT, the objective is therefore for the financial system to serve the production system, which must be aligned with the resources and limits of the Earth system.

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Insert figure 1 about here
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Secondly, EFT proposes the concept of holism to counter the principle of reductionism. Holism argues that ‘the whole is more than the sum of its part’, in contradiction to the reductionist

view of individual or corporate behaviour, as described by Jensen and Meckling (1976)⁴ in neoclassical financial theory, among others.

Finally, EFT challenges the concept of instrumentalism as described by Friedman (1953)⁵, Sharpe (1964)⁶ or Stigler (1984)⁷ through the principle of realism, criticising the deductive principle based on unrealistic assumptions that result in a distortion and abstraction of reality, and stating that “when abstraction loses touch with reality, science becomes dogmatism” (Georgescu-Roegen, 1971: 319). Table 1 below summarises the set of presuppositions made by EFT in opposition to neoclassical financial theory and transcribed in economics and finance education.

Insert table 1 about here

Ultimately, it is the students who are imbued every day with the bucket of neoclassical financial theory (Giacalone & Wargo, 2009; Henisz, 2011) and its materialist (Giacalone & Promislo, 2013), instrumentalist and reductionist universe, in a ‘Chicago-style’ version (Fourcade & Khurana, 2013: 122). Economics and finance teachings reject the uninitiated in mathematics, stochastics, econometrics, modelling and statistical tools, complexify language to the point of blurring the understanding of reality and the socio-economic and geophysical systems with which

⁴ “*The firm is (...) a legal fiction which serves as a focus for a complex process in which conflicting objectives of individuals are brought into equilibrium within a framework of contractual relations*” (Jensen & Meckling, 1976: 311).

⁵ According to Friedman, in *Essays in Positive Economics* (1953), the realism of the assumptions is of little or no importance: economics is above all a predictive science, and if false assumptions (about the rationality of agents) lead to correct predictions, then its goal is achieved.

⁶ “*The proper test of a theory is not the realism of its assumptions but the acceptability of its implications*” (Sharpe, 1964: 434).

⁷ “*It is not economics that is wrong, it is reality*”. George Stigler's response in 1952 to Maurice Allais' presentation “*Fondements d'une Théorie Positive des Choix comportant un risque et Critique des Postulats et Axiomes de l'École Américaine*” at the international congress “*Fondements et Applications de la théorie du risque en Économétrie*” organised in Paris (in proceedings of the conference “*Fondements et Applications de la théorie du risque en Économétrie*”, CNRS, 1953).

“*So economics is an imperial science: it has been aggressive in addressing central problems in a considerable number of neighboring social disciplines, and without any invitations*” (Stigler, 1984: 311).

it is supposed to interact, ultimately creating a factory of nonsense (Tourish, 2020). Simon (1986: 23), when asked whether he rejected the foundations of microeconomics as taught, replied:

“If it is wrong, why not throw it away? Yes I am throwing it away. I think the textbooks are a scandal. I think to expose young impressionable minds to this scholastic exercise as though it said something about the real world, is a scandal [...]. I don't really expect economists to purge their texts of these invalid theoretical elements, certainly not soon”.

Thus, the teaching of economics and finance would seem to resemble more a political philosophy, an ideological dogma (Ghoshal, 2005) than a desire to describe the real world.

The answer certainly lies more in transdisciplinarity (Laasch, Moosmayer, Antonacopoulou, & Schaltegger, 2020), where economics and finance education must be at the crossroads of all the social and natural sciences of which it is a part, with sustainability as a guiding principle (Bagley, Sulkowski, Nelson, Waddock, & Shrivastava, 2020; Gasparin et al., 2020; Sidiropoulos, 2014; Starik et al., 2010).

REWRITING METAPHORS

Complex thinking

The ‘complex thinking’ developed by Edgar Morin in his book *Introduction à la pensée complexe* (1990) allows us to understand the importance of moving away from a reductionist and simplified economic and financial vision. ‘Complex’ does not mean ‘complicated’. From the Latin *complexus*, which means ‘woven together’, complex thinking engages a reflection that allows us to understand reality and to bring ideas together by grouping concepts rather than by fragmenting thought and reality into small pieces and into quite distinct disciplines. Morin (1990) invites to distinguish without disjoining and associate without identifying or reducing, *i.e.* avoiding

explaining a complex phenomenon by proposing simplified answers. In his book *La Méthode 4. Les Idées*, Morin (1991) states that we are only at the preliminary stage of the constitution of a complex paradigm which itself engages the advent of a ‘paradigmatology’, or paradigm of paradigms, a convergence of thought that would control all discourses, in an “awareness of the community of earthly destiny” (Morin, 2008: 2379), linked to ecology. Thus, ecological awareness manifests itself to all in a paradigm encompassing all paradigms.

It would thus be necessary to reject the paradigm resulting from rational and Cartesian classical Cartesian thought, based on the principle of separation, which remains dominant. In Morin's philosophy, education separates rather than to connect, and must now make it possible to do this effort of conjugation and connection in all scientific disciplines, because the whole encompasses all scientific fields. To think complexity, complex thinking is needed. Complex thinking involves understanding the relationships between the whole and the parts, but also between the parts themselves. It is rather a question of conceiving the complex network between the parts of the whole, the cement or invisible link between ideas, which Morin defines as the noosphere, *i.e.* the mutual implication between the parts, the network of immaterial ideas, whose noology is science, and Popper's third world⁸ the synonym.

This principle of mutual involvement brings us back to the principle of pluralism and therefore of fundamental interdisciplinarity. According to Morin, complex thinking involves interrelations between currents of thought and influences. Complex thinking is about bringing thoughts together in a ‘dialogic’ (Morin, 1982), *i.e.* in a cooperative rather than competitive vision, where the duality of thoughts and concepts does not disappear in unity, but on the contrary allows

⁸ Karl Popper (1972) explains that the world is made up of three ontologically distinct sub-worlds (or worlds): the first is that of the physical world (physical states), the second that of the mental world (mental states) and the third that of the world of the intelligible or of ideas (the world of possible thoughts, of logical relations between theories).

them to reinforce each other (the whole is more than the sum of its parts, without the parts losing their DNA).

Morin (1982) also explains how science and education need to embrace the concept of uncertainty, which is inherent in life itself, in a non-partisan and non-binary philosophy distinguishing between right and wrong or good and bad. In other words, it is about teaching to live (Morin, 2014). It is therefore necessary to teach by decompartmentalising, dismembering, assembling, linking, introducing contradiction and favouring the linking of antagonistic concepts to serve a whole, by overcoming and accepting the radical uncertainty and by accepting the error inherent in a complex subject. The epistemological consequence of complexity is that the sciences must cross and link disciplines to determine what is the whole to observe.

Transdisciplinarity

Morin (1994) states that the disciplinary boundary, its own language and concepts will isolate the discipline from others and from problems that cut across disciplines. Hyperspecialisation, *i.e.* splitting the discipline into sub-disciplines, would make it impossible to reconstitute the whole and thus to assemble the sum of the parts to generate a whole. Morin's words in complex thinking invite pluralism, diversity and the interweaving of disciplines, as developed by Michel Serres throughout his work, especially in its thinking on 'passages' in *Hermes V* (1980: 18):

“The passage is rare and narrow... From the sciences of man to the exact sciences, or inversely, the path does not cross a homogeneous and empty space. Usually the passage is closed, either by land masses or by ice floes, or perhaps by the fact that one becomes lost. And if the passage is open, it follows a path that is difficult to gauge.”

According to Serres, Harari, & Bell (1982), the ‘truths’ function according to local, atomised spaces, randomly distributed in a plurality of spaces where each inter-space passage, in Serres’ sense, requires an additional effort of knowledge. The authors state (1982:12):

“Our textbooks teach us very early to separate those who study the humanities from those who manipulate slide rules, those who work with letters and texts from those who use numbers, those concerned with interpersonal relations from those concerned with the physical world. We have now institutionalized this separation in our universities by distinguishing between the faculty of arts (or letters, or humanities) and the faculty of sciences.”

Decomartmentalization therefore implies creating bridges between the worlds of science in order to better grasp the knowledge of the whole, which would transcend paradigmatology in Morin's sense, and which transcends knowledge. What seems obvious would be the multiplicity of “autonomous truths” (Serres, 1972: 31-32), in a principle of uniqueness, connected by unique gateways of knowledge, like an interrelated and non-interdependent network, opening up a regional epistemological field of the world of science.

Teaching the alternative, outside the status-quo, and where sciences are all crossroads and parent disciplines, engages thus interdisciplinarity (linking disciplines), but must tend ideally towards transdisciplinarity (integrating disciplines). Transdisciplinarity permits the new, the creation of knowledge, the blank canvas and the unprecedented mixture of colours that will offer a formula rich in essences, via a multitude of passages between disciplines. It is therefore a question, as Serres suggests, of making the effort of additional knowledge, or again Morin, the effort of conjugation or connection, through transdisciplinarity. The notion of effort, or transcendence, is central to the concept of transdisciplinarity. It is an attitude of searching for a

whole, a system, of fascinating complexity, a whole in which Man is only an element at the service of the whole.

In finance and economics, teaching and learning were initially built on a mono-disciplinary basis (finance or economics). It has switched to a multidisciplinary or interdisciplinary phase with a high degree of specialisation (financial analysis, asset pricing, macroeconomics, microeconomics, financial economics, econometrics, international finance, financial accounting, cash management, management control, auditing, financial modelling, business ethics, etc.) in a simplistic principle of compartmentalisation and juxtaposition, where students do not integrate the paradoxes between disciplines (for example, 'business ethics' vs. 'corporate restructuring' or 'modern portfolio theory'). The culture of economics and finance education therefore needs to move away from interdisciplinarity, which draws around it to enrich its own disciplinary field and finally look at the same object but with different perspectives (Knights & Willmott, 1997; Knights, 2008), towards a transdisciplinary framework (Gibbons et al, 1994; Knights, 2008; Laasch et al., 2020). This posture breaks ontologically with the interdisciplinary posture, since the objective will be to observe a new object, resulting from all the disciplines mobilised. This process of integrating and overcoming disciplines aims at understanding the complexity of the modern and present world, seen from a transversal perspective (Alcaraz & Thiruvattal, 2010). Many university courses claim to have a transdisciplinary approach, but in the end only offer a stacking of disciplines in a purely multidisciplinary approach. In the context of sustainability, this could mean that a course in sustainable development is offered in a curriculum of financial courses to understand societal issues, but without questioning business as usual and the growth model that consumes natural and human resources. However, if there is one area in which the transdisciplinary approach appears to be fundamental, it is in sustainability. It is therefore a question of building a pataphysical (Gasparin

et al., 2020) rather than a metaphysical vision, which leaves the traditional vision full of bad theories (Ghoshal, 2005) and proposing a sustainable and ethics-friendly worldview (Giacalone & Thompson, 2006).

Hierarchy and resilience

Transdisciplinary thinking leads us to analyse cybernetics in order to understand the complex relationships between natural, social and economic systems. Cybernetics imposes a notion of system organisation or even self-organisation (Ross Ashby, 1947, Morin, 1977), *i.e.* the system organises itself, which is the case for physical, biological or ecological systems. Simon (1962) explains this phenomenon of self-organisation in the principle of hierarchy of systems or nesting, specific to biological and physical systems. In his perspective, any system can be represented as a set of nested subsystems, where the structure of the higher system - which can be identified by its greater complexity and by the greater amount of information it processes - can thus be decomposed until an elementary subsystem is reached. According to Simon (1962: 469), the social sciences and the socio-economic sphere also have examples of hierarchies in formal organisations such as companies, governments or universities. The social sphere would therefore also be composed of complex systems such as economic or financial systems (otherwise known as ‘financystem’) (Dron, 2015). This hierarchical concept is also based on the concept of ‘embeddedness’ developed by Karl Polanyi (2001). In this natural interaction, anthropic socio-economic and financial laws are integrated into the biosphere (Nyström et al., 2019; Lagoarde-Segot and Martinez, 2021). It would imply a hierarchical re-embedding of the economic-financial sphere in criteria of social well-being and ecological constraints, as described in figure 1 in the previous sections.

The organised, hierarchical and nested evocation is taken up under the concept of resilience by Ulanowicz (2009) in relation to the Earth sciences, or by Dron (2015) in relation to economic and financial systems. According to Dron (2015), a natural ecosystem, resilient by default, is composed of energy and matter circulation, organised in four main principles:

- existence of feedbacks (self-regulation), referring to the cybernetic principle of self-organisation (predator-prey principle),
- principle of risk compartmentalisation based on sufficient connectivity but without generalised substitutability between hierarchical systems
- significant diversity in the types of actors, leading to a lack of interdependence of resource needs,
- closed cycles (recycling, circularity) of materials and energy to maintain vital stocks.

The natural ecosystem engages a self-organising logic where each element of the ecosystem follows a natural ordered and hierarchical path within the organisation, where the principles of pluralism, connection and risk isolation allow for a path of embedding. The parallel can thus be drawn with the 'financystem', a complex system that is non-resilient by definition, since it suffers from:

- a lack of self-regulation (non-regulated markets, tax havens, leverage, short selling, shadow banking, etc.),
- a lack of compartmentalisation, where finance connects domains in an instantaneous and universal manner, and where interconnected actors aim for the same resource (liquidity),

- an absence of diversity, through banking and financial concentration (systemic risk), standardisation of processes and tools (same rating agencies, same data, agents sensitive to the same signals, etc.),
- a lack of recycling and circularity (monetary flows diverted from the investment cycles of the real economy, tax injustice, social inequalities, etc.)

In cybernetics, the natural ecosystem collapses as soon as the hierarchical subsystem replaces an over-system (Dron, 2015; Ulanowicz, 2009). The analogy can thus be made with complex economic and financial systems. If the financial subsystem, nested in the socio-economic logic (level 1 over-system) and the biosphere or Earth system (level 2 over-system), imposes itself as the superior hierarchical element, then the ecosystem collapses (financial crisis, economic and international instability, climate and biodiversity crisis...). The financystem has imposed itself today as the system that, through its technical and technological complexity, processes the greatest amount of information, thus forcing natural and human systems to serve its cause by depleting their resources infinitely. But this hierarchical inversion puts the Earth system at risk, imposing the need to re-embed finance in economics and then in sustainability, and to inscribe this universal hierarchical law of resilience in the curricula of finance and economics education.

Philia and impact

Arvidsson (2009) defines the principle of ‘ethical economy’ as the creation of ethical value that would generate the reform of an aggressive capitalism towards an ethical capitalism devoted to the objectives of sustainability and social responsibility, in a logic of embedding. The cement enabling the ethical act would thus be defined by the author as the principle of *philia*, the main vector of impact of a transformation of values towards social relations. According to Serres et al. (1982: 12),

the principle of *philia* corresponds to the love of wisdom, as the etymological origin of the word ‘philosophy’ indicates (from *philia* and *sophia*, which means ‘knowledge’). In Aristotelian thought⁹, *philia* is virtue, in which the good of the other is considered the goal according to which man must construct his path of life and his ethical acts. Acts of *philia* thus incorporate notions of giving, of contradiction, of trust, of perfect community and social belonging, where collective well-being depends on notions of companionship and where the relationship of friendship transmits to the ‘Other’ (in the sense of Levinas, 1969).

According to Arvidsson (2009: 23), *philia* stands in direct opposition to the concept of capital and monetary accumulation, stating that “if money is liquid capital, *philia* is liquid organisation: a dispensable embodiment of one's ability to create community”. Arvidsson (2009: 22) proposes what he calls an ethical P-M-P (*Philia-Money-Philia*) circuit to replace the Marxist M-C-M (Money-Capital-Money) equation. In this triptych, social and community relations via the notions of goodwill, commitment or positive expectations generate more money (monetisation of *philia*) which in turn will be invested in community projects and in ethical collective efforts to generate positive circularity and thus more *philia*. Arvidsson proposes to rebuild a perspective that is no longer centred on price-value and thus market society (Polanyi, 1944, 2001), and where the ethical act is at the centre. This ethical economy framework would transform the capitalist and financialised logic into a system that privileges the impact of companies on society.

Philia would thus engage the principle of positive and social impact (Willmott, 2010), whose objective would be to create social value redistributed in the form of projects and ethical commitment, in a principle of circularity and recycling necessary to create a resilient community (Dron, 2015). Thus, the financial act must be seen as an act of impact whose aim is to generate a

⁹ Aristotle describes the concept of *philia* in Nicomachean Ethics VIII and IX.

process of *philia* creation in the service of collective well-being, whether through investment or financing mechanisms (Kölbel, Heeb, Paetzold, & Busch, 2020), and therefore excluding the production of negative ecological or social impacts (Galaz et al., 2018).

In the same way, teaching in economics and finance must therefore integrate a *philia* logic where finance is impact-generating, in a logic of redistribution of positive contributions and commitments. In a strong sustainability logic where finance is seen as the elementary subsystem, no education should offer a vision where finance does not serve a bioeconomic logic (Daly, 1999). Sustainability and *philia* should thus act as the transversal vectors for the transformation of educational contents and thus as the hierarchical goal.

Table 2 below details the metaphors linked to a heterodox paradigm with a focus on strong sustainability, and in opposition to the metaphors linked to the neoclassical paradigm applied mostly in finance and economics teaching.

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Insert table 2 about here
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PUZZLE SOLVING: EMBEDDING ECONOMICS AND FINANCE INTO SUSTAINABLE OBJECTIVE AND FINALITY

According to Belinga & Morsing (2020), teaching modules in sustainable finance are mainly represented either by ‘electives in sustainability and finance’ in core finance programs. Master's programmes fully dedicated to sustainable finance or dedicated tracks (offering several modules within a finance specialisation) are too few and tend to be centred on multidisciplinary rather than transdisciplinary approaches.

The objective is to build a curriculum for master's degree that transcends theoretical barriers and decompartmentalizes them. It is a question of developing a specific *praxis* in

transdisciplinarity. The theories mobilised must allow for deciphering and are only mobilised to tend towards an understanding of complex ecosystems and societal issues. They may therefore come from the natural sciences (biosciences, physics, geosciences, etc.), the social sciences (anthropology, economics, geography, history, philosophy, legal sciences, sociology, etc.) or the applied sciences (applied mathematics, management sciences, etc.). They are not intended to be dogmatic or imperial sciences (Stigler, 1984), nor are they intended to be part of a multidisciplinary logic whose sole aim is to mobilise theoretical content that is not transcended by the others.

Time 1. Managing fundamentals in a critical and sustainable appraisal

The first step is to propose, in a first block, educational contents related to the major issues of sustainability through a critical approach of the existing models, *i.e.* to identify the problems, to understand the causes, in an anthropological, sociological, historical, political, legal but also bioeconomic approach.

Anthropology of Finance. A first reading of the challenges of sustainable finance would be to understand from a philosophical point of view the mission and role of finance in the Anthropocene era.

“So, the way, I designed the class is actually social study of finance. I really teach the class like deconstructing the financial market. It’s like a social anthropology class”

(testimonial from Belinga & Morsing, 2020)

According to Ingold (2018), anthropology is the discipline best placed to answer the major questions and issues of our time, because anthropologists have, in principle, a direct grip on the world and people. Anthropology allows us to understand the interrelation and permanent knotting

between the social, cultural and natural: there is no subject independent of the world, if one is impacted, so is the other (Levi-Strauss, 1958). The neoliberal system has lost this awareness and has cut off the question of nature and culture (Descola, 2005). Thus, anthropology would make it possible to better understand human behaviour, particularly cultural behaviour, in the financial ecosystem, and thus to analyse the human relationship to money, enrichment, debt or risk, the temporalities according to the actors and the links of all these relationships with the social context. Combined with a sociological or political vision, allowing us to understand the reasons for the construction of financial institutions and structures from a neo-liberal perspective, financial anthropology would thus allow us to better define the mission of finance from a historical point of view, but above all to put it into perspective in the era of sustainability. The promise of the social sciences, in their constitutive diversity, lies above all in the denaturalising gaze they cast on finance, and thus, make it possible to envisage the springs of a contestation of the financial hold (Chambost, Lenglet, & Tadjeddine, 2019).

Epistemology and philosophy of financial models. An epistemic and epistemological reading of finance also helps to redefine the role and relevance of financial metrics, models and statistical indicators used in the practical tools of market actors. According to Belinga & Morsing (2020: 17), some pedagogical contents are starting to integrate “*for instance ethical and epistemological issues in finance. [...] Lectures deconstruct financial markets as well as financial techniques, to understand their assumptions and question their relevance. These lectures aim to stir critical thinking*”. An example of epistemological and philosophical reflection on financial practices could be around the performativity of financial mathematics (MacKenzie & Spears, 2012; Chiapello & Walter, 2016; Walter, 2016) and more specifically the importance of the use of appropriate statistical distribution law in risk models and their fit with sustainability (Walter,

2020)¹⁰ To analyse the very foundations of the models and their relevance to an object (sustainability) different from the financial object, Walter (2020) mobilises, among others, the philosophy of science and more particularly the epistemological work of Quine (1961) on the role of abstract entities in mathematics (speculating on the mechanism by which objects of one kind or another come to be posited), as well as on the work in epistemic ethics of De Bruin (2015), crossing philosophical, psychological and economic knowledge. This approach, which seeks to deconstruct a philosophy of thought and reconstruct it using epistemological tools borrowed from fields of knowledge other than finance and economics, thus makes it possible to question in depth the pertinence of paradigmatic roots and thus to understand whether sustainable buds can grow there.

Living in Anthropocene. Input from the natural sciences (whether physical, life and environmental sciences, geosciences or Earth sciences) is also essential for a good understanding of Earth system issues related to sustainability (Steffen et al., 2015b; Galaz et al., 2018; Nyström et al., 2019). It is impossible to consider financing biodiversity and climate change if we do not master the technical characteristics and a minimum of engineering, but also the meaning and values (Sidiropoulos, 2014). The financier interested in the issue of sustainability must be able to see the world through the eyes of a member of an environmental or social NGO, a renewable energy or agricultural engineer, or a climatologist. This means starting from the definitional basis of what the concepts of biosphere, atmosphere, hydrosphere, geosphere, energy and biomass are, what is meant by the ‘Anthropocene’ and ‘great acceleration’ (Steffen et al., 2015a). Then, the risks of the

¹⁰ Walter (2020:1) supports “*that the main problem with unsustainable neoclassical finance risk modelling is its underlying morphology of randomness that creates a dangerous risk culture*”. The author “*presents Leibniz’s principle of continuity and Quetelet’s theory of average as cornerstones of classical risk culture in finance, acting as a mental model for financial experts and practitioners. It links the notion of sustainability with the morphology of randomness and presents a possible alternative approach to financial risk modelling defined by rough randomness. If morphology of randomness in nature is properly described by fractal and multifractal methods, hence ecological finance theory has to include fractal properties into financial risk models*”.

Anthropocene that emerge from human-driven processes; interact with global social-ecological connectivity; and exhibit complex, cross-scale relationships (Keys et al., 2019), as well as their consequences (global warming, biodiversity loss, deforestation, terraforming, water resource depletion...) must be taught to students in economics and finance, in order to allow a better understanding of the human, economic and social stakes linked to the transformation of our ecosystems.

Energy, Climate and Corporates. In connection with the previous module linked to the Anthropocene, a continuity must be proposed on energy and climate issues and the link they have with the strategic policies of companies. The aim is to clearly define the concept of energy (orders of magnitude, typologies of fossil and renewable energies, carbon-based or decarbon-based energies), its link with indicators such as GDP, what impact anthropogenic energy consumption has had on climate change and what impact the latter has on our societies. This will enable students to better understand the geographical and sectoral challenges of climate change and how companies need to integrate them (carbon accounting, physical and transition risks, opportunities) to become more resilient. It is in this type of module that the issue of physical and transition climate risks for companies, and how these can be integrated and mitigated by investors (Chenet, Ryan-Collins, & van Lerven, 2021), should be addressed in detail. These lessons should mobilise organisations and academic management to understand the logic and the keys of an earth-centric vision that pre-existed the industrial era, the starting point of the Anthropocene (Banerjee & Arjaliès, 2021).

Legal and political aspects of sustainability. Understanding the legal aspects of sustainability and the whole legal arsenal around the shifting principles of regulation, mastering the issues of financial and climate geopolitics, is essential to act within a formal framework allowing the development of ethical and compliant actions. The use of appropriate legal tools, specific knowledge of legal contexts and the exercise of informed judgement would act as proactive shields (Bagley et al., 2020). Students need to understand the regulatory issues in sustainable finance¹¹, international reporting and disclosure standards¹², the legal risks of physical and climate transition risks, governance codes and laws and measures against fraud and corruption, before they can master the financial tools of investment and finance. The history and culture of each economic and social system would allow for a specific regulatory framework that would encourage companies to adopt different environmental and social policies (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 2000). Much research mobilising neo-institutional theories (Matten and Moon, 2008) explains that the choices made by companies in terms of CSR and sustainability are constrained by their institutional and normative environment. Economic and financial actions on climate topics are therefore highly dependent on governmental decisions, but also on geopolitics in climate finance (Gomez-Echeverri, 2013).

Time 2. Talking economics and finance under a sustainable prism

From financial economics to ecological economics. The teaching of economics in master's programmes in finance is often done through the prism of macroeconomics (or Financial

¹¹ For instance, the recent European regulation pack on green and sustainable finance (Sustainable Finance Disclosure Regulation SFDR; Corporate Sustainability Reporting Directive CSRD; European taxonomy for sustainable activities; European climate benchmarks).

¹² Integrated reporting, GRI, Task-Force on Climate-Related Financial Disclosures (TCFD), Carbon Disclosure Project (CDP), Net-zero initiative...

Economics). From learning about business cycles in the 1970s, macroeconomics turned from the 1980s onwards to long-term growth aggregates, justified by the longest period of stock market expansion that markets have ever experienced (Blinder, 2010). The crisis highlighted that economic theory was wrong and that it created a false confidence in economic and financial stability, encouraging politicians to dismantle the institutions that protect this stability (Keen, 2001). Thus, there is a need to rethink the teaching of economic theory and macroeconomics, certainly to bring it closer to development issues (Rajan, 2010) but also to ecological and social emergencies (Svartzman, Dron, & Espagne, 2019). Indeed, the market positioning of macroeconomics from a growth perspective engages a model based on the use of resources and therefore on intensive speculation of the price of these resources, mainly fossil. The objective of the market is to set a price signal that would be the only indicator that governs and paces exchanges, economies, in a self-regulating prophecy because in “capacity to organise the totality of economic life without external help or intervention” (Polanyi, 2001: 87) and requiring trade-offs between interdependent ecosystem services (Muradian and Rival, 2012). The consequence is a destruction of Earth ecosystems by the financial economy, as natural capital is seen by the market as a third factor of production in addition to capital and labour (Svartzman et al., 2019). It is therefore a question of switching from a financial macroeconomy to an ecological macroeconomy (Fontana & Sawyer, 2016), where the monetary objective is focused on the sustainable objective, in a political and public perspective cutting the market as the sole regulator of exchanges and the allocation of financing. In this ecological macroeconomy, monetary theory moves away from the theory of loanable funds to emphasise an endogenous theory of money (Svartzman et al., 2019) - as modern monetary theory can be (Wray, 2012) - where the governance of money is reinscribed

in a vision that materialises the finiteness of biophysical resources but also the immeasurable value of the services they provide (Svartzman et al., 2019).

From financial accounting to ecological accounting. The basis of financial language is accounting language. International accounting provides a common financial language in a globalised economy focused on the fiduciary duty of maximising shareholder value (Bagley et al., 2020) via the cash flows generation and in a fair value vision. In an *IAS/IFRS standards*, discounting makes it possible to reduce the question of climate resilience to a monetary decision at time t (Shrivastava et al., 2019), The standardisation of this language does not allow for the achievement of sustainability since it integrates externalities as additional costs in the sole service of cash flow (thus allowing the pricing of financial securities). In this accounting system, Earth ecosystems and natural resources provide free services, are considered as a stock of natural assets serving economic functions, which do not represent any cost of extraction or use. The economic actor does not pay nature for the services it provides. This system of plundering on an industrial scale continually promotes the perpetuation of a macroeconomic growth model. In this respect, ecological accounting allows for a re-integration that favours environmental and social justice, since it replaces natural capital, considered as an asset in the accounting sense, with an ecological debt, favouring the transition from the *triple bottom line (TBL)* to the *triple depreciation line (TDL)* (Rambaud & Richard, 2015). In a world of mainstream sustainable finance embedded in a neoliberal paradigm, TBL is the rule, notably through integrated reporting, or the *Task Force on Climate-related Financial Disclosures (TCFD)*, and more recently through the *IAS/IFRS standards* to integrate extra-financial issues and attempt to standardise ESG. In a world embedded in a strong sustainability paradigm, the TDL principle would be applied, in particular via its *CARE*

model (Comprehensive Accounting in Respect of Ecology) (Rambaud & Richard, 2015), in a logic in which natural resources are a capital to be preserved and not an asset, but also a loan that the user entity will have to repay (Rambaud & Chenet, 2021). This accounting re-articulation is perfectly in line with the objective of the Paris agreements seeking to preserve global warming at pre-industrial levels, and represents the expected epistemological anchor where sustainability guides financial action.

Sustainable and ESG Risks Management. Sustainable risk management (or ESG risk management) techniques are now part of a financial toolkit that is often not compatible with long-term sustainability issues. When companies adopt social impact strategies, investors lag behind (Porter, Serafeim & Kramer, 2019), certainly given the market requirements they have to follow and which dictate their actions, such as fiduciary responsibility, and ESG data compatible with financial data and their interests (Kotsantonis and Serafeim, 2019; Slager and Gond, 2022), *i.e.* monetisable and mainly centred on large-cap companies (Drempetic, Klein, & Zwergel, 2020). This vision of the financial materiality of ESG is present in accounting standards such as the *Sustainable Accounting Standards Board (SASB)*, which propose indicators centred at the level of a sector, with the aim of standardisation allowing comparability and benchmarking, and not at the specific level of a company (Porter et al., 2019). Teaching sustainable or ESG risk analysis requires moving away from a logic of ESG performance scores towards impact data derived from a strategic analysis of issuers. ESG risk analysis must be refocused on a “project” or “company” approach, and move away from a standardized score logic via ESG indicators that are commensurable but not always adapted to the company or the sector. Two objectives are essential in the approach to sustainable or ESG risks: the search for double materiality (Gourdel, Monasterolo, Dunz,

Mazzocchetti, & Parisi, 2022) and the temporality of the analysis. Double materiality will require the analyst to consider the impact of economic and financial activity on the environment (social, natural). Temporality will require the analyst to fully re-appropriate risk analysis, to internalise ESG data collection, and to carry out in-depth due diligence without referring exclusively to published public documents. This teaching module is appropriate to implement a case-based pedagogy, in order to understand, for example, the difference between a company's ESG scores and the reality of the risks (for instance the *BP* case in 2010 with the Deepwater explosion; *Volkswagen* in 2015 with Dieselgate; *Lafarge Holcim* in 2016 with suspicion of terrorist financing, or more recently *Orpea* in 2022 for mistreatment in health care homes), or even to reflect on the relevance of the indicators to be taken into account and the methods of ESG risk analysis.

Climate-related financial risks (CRFR) management. Long-term climate issues are now at odds with the immediacy of finance, postponing political decisions in the face of the radical uncertainty of climate risks (Chenet et al., 2021). Financial actors, through their scenario analyses and stress tests used to measure the degree of exposure of their assets to these risks, define short horizons, over periods of one to three years, and using 'business as usual' scenarios versus an adverse scenario (Chenet et al., 2021). Climate risk modelling would involve anticipating future behaviours, in a multitude of scenarios, in order to reduce the climate issue to a single, efficient price today, and then in a discounted valuation model (pricing long-term climate resilience today and thus omitting potential future damages). In other words, the challenge is to understand whether a climate impact that will have an impact in the medium to long term can have an impact on the profitability of projects today. This again reduces climate action or ESG to an adjustment variable for current risks given the financial models used, which are not embedded in a sustainability logic

but are epistemologically modelled on a purely financial language (Walter, 2016). After integrating energy and climate issues into the fundamentals of the curriculum as well as the definition of physical and transition risks, the aim is to propose an understanding of climate risk modelling issues in a long-term vision and in a world where climate policies would be anticipated in a stable framework (Battiston, Mandel, Monasterolo, Schütze, & Visentin, 2017) based on precautionary financial policies including macro-prudential interventions and monetary policies (Chenet et al., 2021). This teaching module is also part of a pedagogy based on cases and real-life situations, in particular through the application of scenarios and stress-tests on asset portfolios.

Sustainable Development Goals (SDGs) Investing. Sustainable investment practices are mainly located in the asset management industry and on listed companies (Drempetic et al., 2020). Asset valuation techniques that integrate ESG risks, or ESG factoring are focused on the search for financial materiality and seek to identify a ‘green alpha’ or ‘green premium’ to the investment (Schramade, 2016; Pastor, Stambaugh, & Taylor, 2021; Zerbib, 2020). Investors or asset managers mostly do not have the time to focus on in-depth fundamental analysis, preferring to rely on liquidity, mass diversification and profitability criteria as well as passive management tools to save time they no longer have, and thus discouraging companies from creating shared value (Porter et al., 2019). In this teaching module, the focus is on the market of listed companies in a case-based pedagogy, focusing on project evaluation via strategic fundamental analysis in relation to the achievement of the SDGs. ESG is no longer seen as a risk adjustment indicator in a macro-universe vision (standardisation of impact indicators) but as a vector of transformation and as an impact definition objective, guiding investment, in a more micro-universe focused vision (uniqueness of impact). The investment strategies determined in the business-cases administered to the students

must integrate the geopolitical and geographical dimension inherent in the SDGs (emerging markets vs. developed markets environment, etc.). The logic of active ownership must also be at the heart of the proposed asset portfolio strategies (Kölbel et al., 2020), as vectors of internal transformation and impact achievement.

Impact Investing. This teaching module focuses on the case of unlisted companies and social entrepreneurship or social impact projects. Each investment project must benefit from a clear vision of impact and *philia*, *i.e.* based on an ethical and unique intentionality to create impact and to measure it (Paranque and Revelli, 2019). The process of creating *philia*, as described in the previous section, is developed throughout the investment and can only be measured if there is a systematic intentionality of impact. The notion of uniqueness of impact is thus closely linked to the requirement of intentionality. Each investment has a specific DNA, depending of the industrial sector of the company, its geographical area, its local context, its stakeholders, its legal market framework, its political risk, etc. In a macro investment logic and with a large volume of assets under management, it is complex to implement “intentionality-uniqueness” impact strategies. In a more micro environment with a longer timeframe, the investor sets impact objectives when he deals with the company. The circularity imposed by resilience in a *Philia-Money-Philia* logic will thus make it possible to demonstrate to investors that the ethical act of creating *philia* generates, over time, a more robust creation of economic value that is beneficial to all of the project's stakeholders, including the investors. The impact chain will ultimately be formalised through the quadriptych “intentionality-uniqueness-commitment-measurement”. This teaching module could be carried out in the form of social impact investment projects to be pitched to a panel of

professionals, and under criteria of innovation, financial feasibility, replicability and significant and measurable impact.

Figure 2 presents our puzzle-solving in a sustainable ontology and mobilizing our metaphors (complex thinking, transdisciplinarity, hierarchy and resilience, *philia/impact*). Table 3 presents this curriculum in a comparative perspective with existing curricula in finance and economics integrating sustainable courses, or in sustainable finance with interdisciplinary courses.

Insert figure 2 about here

Insert table 3 about here

DISCUSSION & CONCLUSION

Gladwin et al (1995) proposed a paradigmatic view of sustainability issues. Since then, many contributions have focused on the integration of these issues into management education or on the importance of integrating ethical and responsible values into educational programmes in business schools and universities (Alcaraz & Thiruvattal, 2010; Aragon-Correa et al., 2017; Audebrand, 2010; Bagley, Sulkowski, Nelson, Waddock, & Shrivastava, 2020; Moosmayer, 2012; Rusinko, 2010; Snelson-Powell, Grosvold, & Millington, 2016; Starik et al, 2010; Stead & Stead, 2010). Other research has addressed the themes of value and sense, the financial crisis and the importance of ethics in overcoming this paradigmatic and legitimacy crisis (Fotaki & Prasad, 2015; Giacalone & Promislo, 2013; Giacalone & Wargo, 2009; Harley, 2019; Henisz, 2011; Holt, 2020; Sidiropoulos, 2014; Tourish, 2020; Vos & Page, 2020; Wang et al., 2011). Recently, the academic debate has also focused on the challenges of education, in a broad sense, and on the specific case of management, in the Anthropocene era (Gasparin et al. 2020; Gilbert, 2016; Hadengue &

Guntzburger, 2021), to underline the urgent need to move practices towards a sustainable ontology. Our research proposes to specifically address the theme of education in sustainable finance and economics by integrating all the perspectives already addressed by the literature, but often separately. We thus start from the paradigmatic vision necessary to teach these themes, through the critical approach of existing practices and the importance of values in the question of teaching and learning, while aligning this vision with the challenges of the Anthropocene, which has never been done to date to our knowledge. Our paper thus proposes a holistic vision, starting from the ontological and epistemological question, rewriting the metaphors necessary to propose a practical pedagogical vision embedded in the issues of transdisciplinarity, complex thinking, resilience and impact. We identify three main propositions of this vision, which we discuss below.

Why sustainable finance curricula are not democratized? From sustainable finance to the sustainability of finance

Although the issue of sustainability in education has been raised for many years and is now democratized, the teaching of finance and sustainable economics is still emerging in the curricula of business schools and universities (Belinga & Morsing, 2020). The question is: why? The answer certainly lies in the very definition of what is currently the dominant economic paradigm in finance and economics education in undergraduate and postgraduate programmes. Neoclassical theory has established itself as the dominant, if not the only, paradigm in educational content (Fotaki & Prasad, 2015; Fourcade & Khurana, 2013; Wang et al., 2011). Although practices are evolving, the lens through which sustainability is taught in academia and in finance courses remains that of neoliberal theory (Hursch, 2005). However, understanding the challenges of the Anthropocene certainly requires a paradigm shift. The ecological and social reconstruction of our societies cannot

be imposed under the neoliberal paradigm, which imposes a search for infinite growth and is based on metatheoretical assumptions advocating the search for constant profitability and the maximisation of shareholder value (Lagoarde-Segot & Martinez, 2021), in order to aim for collective well-being (Jensen, 2001). However, these objectives are decoupled from those of the Anthropocene, which consist in putting natural and living issues back at the centre, in a very long-time frame, and where natural capital can no longer be seen as an asset in the service of the search for cash flows. ESG criteria cannot only be part of a logic of *alpha* research, financial risk adjustment and cash flow optimisation (Leins, 2020). The concern is not to define the best way to integrate sustainability into financial practices, in a quest for materiality (Crona et al., 2021), but certainly to rethink the entire toolbox that will make it possible to deal with climate, natural and social issues (Keys et al., 2019), *i.e.* to engage in a profound paradigmatic reform of the mission of finance (Shrivastava et al., 2019).

It is about thinking about the sustainability of finance before thinking about sustainable finance. The sustainability of finance will engage this deep theoretical grounding, which will seek to understand what the purpose of finance is in the face of contemporary challenges, from an anthropological perspective. At the level of teaching practices, this will involve sustainability being seen as the cross-cutting purpose (Revelli, 2016), and finance transforming its tools in the face of Anthropocene challenges (Crona et al., 2021; Keys et al., 2019). In this, the danger would be to tip sustainability issues into a mainstream vision of business as usual (Revelli, 2017), in a utilitarian perspective of managing the reputation effect and the sheep effect (following the trend) via greenwashed practices (Yu, Van Luu, & Chen, 2020). One of the keys will certainly be to push the reflections further, to strictly remove from the curricula the schizophrenic content between philosophy and business ethics on the one hand and neo-liberal financial and economic theories

on the other, giving neither meaning nor solution to the societal challenges to be embraced, reducing green-sustainable finance to green-sustainable neo-liberal finance (Dwizok & Jäger, 2021; Leins, 2020; Magalhães, 2021). Thinking outside the box will therefore require transdisciplinarity and complex thinking.

How to well democratize sustainable finance education? Creating a moving and adaptable theoretical corpus with transdisciplinary and sustainable-integrated courses

The ‘how’ question usually follows the ‘why’ question. Understanding how to move sustainable finance to a global stage while anchoring sustainability and the challenges of the Anthropocene at its core requires a new methodology and a departure from a mainstream view of finance. Mobilising complex thinking and transdisciplinarity will certainly be the keystone of this transformation. In a cybernetic logic (Ross Ashby, 1947; Simon, 1962), hierarchy and self-organisation place natural complex systems above economic and financial complex systems. Following this organisational logic in finance courses requires an ontological break. This evolution is possible if complex thinking in the sense of Morin (1990) is considered, allowing bridges and linkages between disciplines. In a metaphorical sense, complex thinking requires imagining how to fit a circle into a square, to innovate in order to find new opportunities, sometimes still unknown, and which go beyond rational and normative thinking such as neoliberal finance can impose in everyday life (van der Zwan, 2014), in a structured discourse (Walter, 2016), in marketed logics (Vos & Page, 2020 ; Willmott, 2010) and where theories are embedded in social reality in a performative way (Marti & Gond, 2018). Neoliberal finance reduces the complexity of sustainability to a simplified binary (true, false) language (Redman, 2013), which is deductive and whose truth has already been demonstrated. Decompartmentalising therefore requires opening up

knowledge to all disciplines. Understanding how the economy and finance will be able to resolve the Anthropocene therefore requires interweaving knowledge of the physical sciences (understanding energy issues), the geosciences (understanding biological and geological issues), the biosciences (understanding issues relating to living organisms), the social sciences (understanding society and human issues in its environment), philosophy (understanding science, the world, history, ethics), political and geopolitical sciences, psychology... Human beings are facing a new challenge, never experienced before, which will require them to innovate and leave the theoretical framework that has brought them to this ultimate point, by entering a noological perspective that cements the set of concepts and the parts of the whole (Morin, 1990), which makes it possible to organise ideas. The theoretical corpus needed to analyse the challenges of the Anthropocene must be moving, non-deterministic, not fixing a single reality (the agency relationship, the market efficiency, the price signal, etc.) but knowing how to use all the scientific corpus that could be useful in determining a solution at a given moment. The challenge is to solve a long-term problem with economic and financial tools and indicators that do not yet exist or that are not adapted. It is therefore a question of pulling out all the drawers of science to bring together the ingredients that we do not yet suspect could be perfectly aligned in a common cause. We need to look the problem in the face in order to understand and solve it, and not to circumvent it by using inappropriate language. In this, we believe that our curriculum proposal engages this adaptability of science to solve complex problems in the sense of Morin and Serres and pushes the cursor of sustainable finance further than the environmentalist vision (Shrivastava, 1994).

The transdisciplinary approach, through its innovation in relation to the challenges of the coming century, should encourage a pedagogy of impact and a call to action from teachers, to respond to the student community's quest for meaning (Fabbrizzi, Maggino, Marinelli, Menghini,

& Ricci, 2016; Ng, Schweitzer, & Lyons, 2010; Shrivastava, 2010). To do this, the theories and tools mobilized must be adapted in a critical or transformative perspective, helping students to understand complexity and paradoxes (Dehler, Welsh, & Lewis, 2001).

Who can do it? The individual responsibility of academics in the Anthropocene era

Shrivastava (2010: 443) proposes a pedagogy of passion for sustainability: “*our current practices in teaching sustainable management are replete with scientific facts, analytical tools, optimization models, and management techniques. The key pedagogical goal is to help students intellectually understand and solve problems. I argue for a different focus for teaching sustainability. Managing sustainably requires students to develop passion for sustainability*”. We are fully aligned with the fact that 1) the pedagogical question must be at the centre, 2) that sustainability is a question of commitment and passion, which must be transmitted to the students. In order to do this, teaching methods are important, but also the individual responsibility of the teacher. The first question an economics and finance teacher should ask himself or herself is: “What is my role in relation to societal issues, what should I convey and how?” Sustainable finance requires a specific pedagogy, because it mixes two themes that can sometimes seem antinomic: finance and sustainability. To convince people that sustainable finance is not an oxymoron, it is therefore necessary to engage a vision of conviction and passion, even provocation (Kurucz, Colbert, & Marcus, 2014) or rebellion (Akrivou & Bradbury-Huang, 2015), perfectly aligned with ethical and sustainability values, to get across a message that is far from being understood or acquired. Issues of the Anthropocene or the financing of biodiversity cannot be taught in the same way as teaching in computer programming language and financial modelling... The solemnity of the issues and their seriousness

must make it possible to generate a passion-emotion-consciousness that must be supported by the knowledge and relevance of the educational content.

Today, there is a crisis of confidence in management teaching and research which is expressed by concern about the nature of the teaching given in business schools, which is sometimes contradictory to the ethical values held by individuals, but it is up to the teachers themselves to set an example and to face it despite the institutional and societal difficulty (Harley, 2019). It is about restoring meaning and mystery and moving away from the codes of conduct transmitted by neoliberal economic and financial theories, as this cuts off students' ability to think by instilling habits and constructs, keeping the world in the same place (Holt, 2020). These habits are often those of teachers, who do not wish to leave their comfort zone and do not question their method of learning and knowledge, yet challenge and questioning are inherent to the profession of teacher and researcher. This means switching from a teacher-centered to a student-centered approach (Mesny, Pastoriza Rivas, & Poisson-de Haro, 2021), in a search for caring (Heath, O'Malley, & Tynan, 2019) and listening to the expectations of our main stakeholders (Mayseless, 2015).

This means teaching as if sustainability issues matter (Marshall et al., 2010), adopting a questioning attitude. In a world governed by a Pavlovian positivist reflex, the energy required to convey topics that are counter-systemic is even greater. The question of how we teach is therefore central (Marshall et al., 2010). Laying the foundations for a transformative pedagogy by starting from learners' prior beliefs and offering a critical pedagogy overcomes and eliminates the paradox, thus helping societies to develop (Seatter & Ceulemans, 2017). The final question and the main act of transformation will therefore certainly remain the way one observes and defines the object of study, from an ontological point of view. Without this questioning of the nature of the object,

without this mixing of knowledge, this will to have a profound impact on current and future generations, sustainable finance will remain a market trend but not a groundswell with transformative power.

REFERENCES

- Akrivou, K. & Bradbury-Huang, H. 2015. Educating integrated catalysts: Transforming business Schools toward ethics and sustainability. *Academy of Management Learning & Education*, 14(2): 222-240.
- Alcaraz, J.M., & Thiruvattal, E. 2010. An interview with Manuel Escudero. The United Nations' principles for responsible management education: A global call for sustainability. *Academy of Management Learning & Education*, 9(3): 542-550.
- Alvesson, M., & Willmott, H. (Eds.). 2003. *Studying management critically*. London: Sage.
- Aragon-Correa, J. A., Marcus, A. A., Rivera, J. E., & Kenworthy, A. L. 2017. Sustainability management teaching resources and the challenge of balancing planet, people, and profits. *Academy of Management Learning & Education*, 16(3): 469-483.
- Arvidsson, A. 2009. The ethical economy: Towards a post-capitalist theory of value. *Capital Class*, 33(1): 13–29.
- Audebrand, L. K. 2010. Sustainability in strategic management education: The question for new root metaphors. *Academy of Management Learning & Education*, 9(3): 413-428.
- Bagley, C. E., Sulkowski, A., Nelson, J. S., Waddock, S., & Shrivastava, P. 2020. A path to developing more insightful business school graduates: A system-based, experimental approach to integrating law, strategy, and sustainability. *Academy of Management Learning & Education*, 19(4):541-568.
- Banerjee, S. B. 2008. Corporate social responsibility: The good, the bad and the ugly. *Critical Sociology*, 34(1): 51-79.
- Banerjee, S. B., & Arjaliès, D-L. 2021. Celebrating the end of enlightenment: Organization theory in the age of the Anthropocene and Gaia (and why neither is the solution to our ecological crisis). *Organization Theory*, 2: 1-24.
- Battiston, S., Mandel, A., Monasterolo, I., Schütze, F., & Visentin, G. 2017. A climate stress-test of the financial system. *Nature Climate Change*, 7: 283-288.
- Belinga, R., & Morsing, M. 2020. Teaching sustainable finance. Available on https://www.hhs.se/contentassets/0442e753dd9e45f6b3e0aa79c24b1126/teaching-sustainable-finance-2020_misum_rachelle-belinga_final2.pdf

- Black, F., & Scholes, M. 1973. The pricing of options and corporate liabilities. *Journal of Political Economy*, 81: 637–654.
- Blinder, A. (2010). Teaching macro principles after the financial crisis. *The Journal of Economic Education*, 4(4): 385-390.
- Callon, M. 1998. *The laws of the markets*. Oxford: Blackwell.
- CDP (Carbon Disclosure Project) 2021. Under 1% of \$27 trillion global fund assets are Paris-aligned. Available on <https://www.cdp.net/en/articles/investor/under-1-of-27-trillion-global-fund-assets-are-paris-aligned> (October).
- Carney, M., 2015. Breaking the tragedy of the horizon - climate change and financial stability. In: Speech by Mr Mark Carney, Governor of the Bank of England and Chairman of the Financial Stability Board, at Lloyd’s of London. Available at: <https://www.bis.org/review/r151009a.pdf> (September).
- Chambost, I., Lenglet, M., & Tadjeddine, Y. (Eds.). 2019. *The making of finance: Perspectives from the social sciences*. Oxon: Routledge.
- Chenet, H., Ryan-Collins, J., & van Lerven, F. 2021. Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy. *Ecological Economics*, 183.
- Chiapello, E., & Walter, C. 2016. The three ages of financial quantification: A conventionalist approach to the financiers' metrology. *Historical Social Research*, 41(2): 155-177.
- Christophers, B. 2015. The limits to financialization. *Dialogues in Human Geography*, 5(2): 183-200.
- Cowie, R. H., Bouchet, P., & Fontaine, B. 2022. The Sixth Mass Extinction: fact, fiction or speculation? *Biological Review*, 97: 640-663.
- Crona, B., Folke, C., & Galaz, V. 2021. The Anthropocene reality of financial risk. *One Earth*, 4: 618-628.
- Crutzen, P.J. (2006). The “Anthropocene”. In E. Ehlers & T. Krafft (Eds.), *Earth System Science in the Anthropocene*, Berlin: Springer.
- Daly, H. E. 1999. *Ecological economics and the ecology of economics: Essays in Criticism*. Cheltenham: Edward Elgar.
- Davis, G. F., & Kim, S. 2015. Financialization of the economy. *Annual Review of Sociology*, 41: 203-221.
- De Bruin, B. 2015. *Ethics and the global financial crisis: Why incompetence is worse than greed*. Cambridge, UK: Cambridge University Press.
- Dehler, G.E, Welsh, M.A. & Lewis, M.W. 2001. Critical pedagogy in the “new paradigm”. *Management Learning*, 32(4): 493-511.

- Descola, P. (2005). *Par-delà nature et culture*. Paris: Gallimard.
- Drempetic, S., Klein, C., & Zwergel, B. 2020. The influence of firm size on the ESG score: Corporate sustainability ratings under review. *Journal of Business Ethics*, 167: 333-360.
- Dron, D. 2015. Pour une régulation écosystémique de la finance. *Annales des Mines – Réalités industrielles*, 1: 36-42.
- Dwizok, E., & Jäger, J. 2021. Classification of different approaches to green finance and green monetary policy. *Sustainability*, 13: 11902.
- Fabbrizzi, S., Maggino, F., Marinelli, N., Menghini, S., & Ricci, C. 2016. Sustainability and well-being: The Perception of younger generations and their expectations. *Agriculture and Agricultural Science Procedia*, 8: 592 – 601
- Fama, E. F. 1970. Efficient capital markets: A review of theory and empirical work. *Journal of Finance*, 25(2): 383-417.
- Friedman, M. 1953. The methodology of positive economics. In *Essays in Positive Economics*: 153–184. Chicago, IL: Chicago University Press.
- Fontana, G., & Sawyer, M. 2016. Towards post-Keynesian ecological macroeconomics. *Ecological Economics*, 121: 186-195.
- Fotaki, M, & Prasad, A. (2015). Questioning neoliberal capitalism and economic inequality in business schools. *Academy of Management Learning & Education*, 14(4): 556-575.
- Fourcade, M., & Khurana, R. 2013. From social control to financial economics: The linked ecologies of economics and business in twentieth century America. *Theory and Society*, 42(2): 121-159.
- Galaz, V., Crona, B. Dauriach, A., Scholtens B., Steffen, W. (2018). Finance and the Earth system – Exploring the links between financial actors and non-linear changes in the climate system. *Global Environment Change*, 53: 296-302.
- Gasparin, M., Brown, S. D., Green, W., Hugill, A., Lilley, S., Quinn, M., Schinckus, C., Williams, M., & Zalasiewicz, J. 2020. The business school in the Anthropocene: Parasite logic and pataphysical reasoning for a working Earth. *Academy of Management Learning & Education*, 19(3): 385-405.
- Georgescu-Roegen, N. 1971. *The Entropy Law and the Economic Process*. Cambridge, MA: Harvard University Press.
- Ghoshal, S. 2005. Bad management theories are destroying good management practices. *Academy of Management Learning & Education*, 4(1): 75–91.
- Giacalone, R. A., & Promislo, M. D. 2013. Broken when entering: The stigmatization of goodness and business ethics education. *Academy of Management Learning & Education*, 12(1): 86-101.

Giacalone, R. A., & Thompson, K. R. 2006. Business ethics and social responsibility education: Shifting the worldview. *Academy of Management Learning & Education*, 5(3), 266-277.

Giacalone, R. A., & Wargo, D. T. 2009. The roots of the global financial crisis are in our business schools. *Journal of Business Ethics Education*, 6: 147–168.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzmann, S., Scott, P., & Trow, M. 1984. *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.

Gilbert, J. 2016. Transforming science education for the Anthropocene—Is it possible? *Research in Science Education*, 46: 187-201.

Gladwin, T. N., Kennelly, J. J., & Krause, T-S. 1995. Shifting paradigms for sustainable development: Management theory and research. *Academy of Management Review*, 20(4): 874-907.

GSIA (Global Sustainable Investment Alliance) 2020. Global sustainable investment review 2020. Available on <http://www.gsi-alliance.org/wp-content/uploads/2021/08/GSIR-20201.pdf>

Gomez-Echeverri, L. 2013. The changing geopolitics of climate change finance. *Climate Policy*, 13(5): 632-648.

Gourdel, R., Monasterolo, I., Dunz, N., Mazzocchetti A., & Parisi, L. 2022. Assessing the double materiality of climate-financial risks in the euro area economy and banking sector. Available on https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3939895

Gramsci, A. 1948–1951. *Quaderni del Carcere*, Torino: Giulio Einaudi Editore. English translation by Buttigieg, J. A. (Ed). 2011. *Prison Notebooks (Vol II)*, New York: Columbia University Press.

Hadengue, M., & Guntzburger, Y. 2021. Reshaping management education at the time of the Anthropocene: A proposal. *Academy of Management Proceedings*, <https://doi.org/10.5465/AMBPP.2021.14939abstract> (July)

Harley, B. 2019. Confronting the crisis of confidence in management studies: Why senior scholars need to stop setting a bad example. *Academy of Management Learning & Education*, 18(2): 286-297.

Henisz, W. J. 2011. Leveraging the financial crisis to fulfil the promise of progressive management. *Academy of Management & Learning Education*, 10(2): 298-321.

Holt, R. 2020. Hannah Arendt and the raising of conscience in business schools. *Academy of Management Learning & Education*, 19(4): 584-599.

Hursch, D. 2005. Neo-liberalism, markets and accountability: Transforming education and undermining democracy in the United States and England. *Policy Futures in Education*, 3(1): 3-15.

Ingold, T. 2018. *Anthropology, why it matters*. Cambridge: Polity Press.

IPCC (Intergovernmental Panel on Climate Change) 2022. IPCC Sixth Assessment Report, Climate Change 2022: Impacts, Adaptation and Vulnerability. Available on <https://www.ipcc.ch/report/ar6/wg2/>

Jensen, M. C., & Meckling, W. 1976. Theory of the firm: Managerial behavior agency costs, and capital structure. *Journal of Financial Economics*, 3: 305–360.

Jensen, M. C., 2001. Value maximization, stakeholder theory, and the corporate objective function. *Journal of Applied Corporate Finance*, 14(3): 8–21.

Keen, S. 2001. *Debunking economics. The naked emperor dethroned?* London: Zed Books Ltd.

Keys, P. W., Galaz, V., Dyer, M., Matthews, N., Folke, C., Nyström, M., & Cornell, S. E. 2019. Anthropocene risk. *Nature Sustainability*, 2: 667-673.

Knights, D. 2008. Myopic rhetorics: Reflecting epistemologically and ethically on the demand for relevance in organizational and management research. *Academy of Management Learning & Education*, 7(4): 537-552.

Knights, D., & Willmott, H. 1997. The hype and hope of interdisciplinary management studies. In J. Burgoyne, D. Knights, & H. Willmott, Guest Editors Special Issue on Interdisciplinary Studies in Management: *British Journal of Management*, 8(1): 9–22.

Kolbert, E. 2014. *The sixth extinction: An unnatural history*. London: Bloomsbury.

Kölbel, J., Heeb, F., Paetzold, F., Busch, T. 2020. Can sustainable investing save the world? Reviewing the mechanisms of investor impact. *Organization & Environment*, 33(4): 554-574.

Kotsantonis, S., & Serafeim, G. 2019. Four things no one will tell you about ESG data. *Journal of Applied Corporate Finance*, 31(2): 50-58.

Kuhn, T. 1962. *The structure of scientific revolutions*. University of Chicago Press.

Kurucz, E., Colbert, B.A. & Marcus, J. 2014. Sustainability as a provocation to rethink management education: Building a progressive educative practice. *Management Learning*, 45(4): 437-457.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. 2000. Investor protection and corporate governance. *Journal of Financial Economics*, 58: 3–27

Laasch, O., Moosmayer, D., Antonacopoulou, E., & Schlattegger, S. 2020. Constellations of transdisciplinary practices: A map and research agenda for the responsible management learning field. *Journal of Business Ethics*, 162: 735-757.

Lagoarde-Segot, T. 2015. Diversifying financial research: From financialization to sustainability. *International Review of Financial Analysis*, 39: 1–6.

Lagoarde-Segot, T., & Martinez, E. 2021. Ecological finance theory: New foundations. *International Review of Financial Analysis*, 75.

- Lawson, T. 1997. *Economics and reality*. Oxon: Routledge.
- Lawson, T. 2006. The nature of heterodox economics. *Cambridge Journal of Economics*, 30: 483–505
- Leins, S. 2020. ‘Responsible investment’: ESG and the post-crisis ethical order. *Economy and Society*, 49(1): 71-91.
- Levi-Strauss, C. 1958. *Anthropologie structurale*. Paris: Plon.
- Levinas, E., 1969. *Totality and infinity: An essay on exteriority*. Pittsburgh: Duquesne University Press.
- Lintner, J. 1965. Security prices, risk, and maximal gains from diversification. *Journal of Finance*, 20(4), 587-615.
- MacKenzie, D. 2006. Is economics performative? Option theory and the construction of derivatives markets. *Journal of the History of Economic Thought*, 28(1): 29–55.
- MacKenzie, D., & Millo, Y. 2003. Constructing a market, performing theory: The historical sociology of a financial derivatives exchange. *American Journal of Sociology*, 109(1): 107–145.
- MacKenzie, D., & Spears, T., 2012. ‘The formula that killed Wall Street’? The gaussian copula and the material cultures of modelling. Available on <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.296.8633&rep=rep1&type=pdf>.
- Magalhães, N. 2021. The green investment paradigm: Another headlong rush. *Ecological Economics*, 190.
- Markowitz, H. 1952. Portfolio selection. *Journal of Finance*, 7(1): 77–99.
- Marshall, S., Vaiman, V., Napier, N., Taylor, S., Haslberger, A., & Andersen T. 2010. The end of a “period”: Sustainability and the questioning attitude. *Academy of Management Learning & Education*, 9(3): 477-487.
- Marti, E., & Gond, J. P. 2018. When do theories become self-fulfilling? Exploring the boundary conditions of performativity. *Academy of Management Review*, 43(3): 487– 508.
- Marti, E., & Scherer, A. G. 2016. Financial regulation and social welfare: The critical contribution of management theory. *Academy of Management Review*, 41(2): 298–323.
- Matten, D., & Moon, J. 2008. ‘Implicit’ and ‘explicit’ CSR: a conceptual framework for a comparative understanding of corporate social responsibility. *Academy of Management Review*, 33: 404–424.
- Mayseless, O. 2015. *The caring motivation: An integrated theory*. Oxford: Oxford University Press.

- Mesny, A., Pastoriza Rivas, D., & Poisson-de Haro, S. 2021. Business school professors' teaching approaches and how they change. *Academy of Management Learning & Education*, 20(1): 50-72.
- Moosmayer, D. 2012. A model of management academics' intentions to influence values. *Academy of Management Learning & Education*, 11(2): 155-173.
- Morgan, G. 1980. Paradigm, metaphors, and puzzle solving in organization theory. *Administrative Science Quarterly*, 25: 605–622.
- Morin, E. 1977. *La Méthode 1. La nature de la nature*. Paris: Le Seuil.
- Morin, E. 1982. *Sciences avec conscience*. Paris: Fayard.
- Morin, E. 1990. *Introduction à la pensée complexe*. Paris: ESF Editeur.
- Morin, E. 1991. *La Méthode 4. Les Idées*. Paris: Le Seuil.
- Morin, E. 1994. Interdisciplinarité et transdisciplinarité. *Transversales, Science, Culture*, 29: 4-8.
- Morin, E. 2008. *Mon chemin* (entretien avec Djénane Kareh Tager), Paris: Fayard.
- Morin, E. 2014. *Enseigner à vivre. Manifeste pour changer l'éducation*, Paris: Actes Sud – Play Bac Éditions.
- Muradian; R., & Rival, L. 2012. Between markets and hierarchies: The challenge of governing ecosystem services. *Ecosystem Services*, 1(1): 93-100.
- Nagrawala, F., & Springer, K. 2020. Point of no returns: A ranking of 75 of the world's asset managers approaches to responsible investment. Available on <https://api.shareaction.org/resources/reports/Point-of-no>Returns.pdf> (March).
- Ng, E. S. W., Schweitzer, L., & Lyons, S. T. 2010. New generation, great expectations: A field study of the millennial generation. *Journal of Business and Psychology*, 25: 281-292.
- Nyström, J. B., Jouffray, A., Norström, V., Crona, B., Søgaard-Jørgensen, P., Carpenter, S. R., & Folke, C. 2019. Anatomy and resilience of the global production ecosystem. *Nature*, 575: 98-108.
- Paranque, B., & Revelli, C. 2019. Ethico-economic analysis of impact finance: The case of green bonds. *Research in International Business and Finance*, 47: 57-66.
- Parker, M. 2003. Business, ethics and business ethics: Critical theory and negative dialectics. In M. Alvesson & H. Willmott (Eds.), *Studying management critically*: 197-219. London: Sage.
- Pastor, L., Stambaugh, R. F., & Taylor, L. A., 2020. Sustainable investing in equilibrium. *Journal of Financial Economics*, 142(2): 550-571.
- Polanyi, K., 1944. *The great transformation*. New York: Farrar and Rinehart.

- Polanyi, K. 2001. *The great transformation: The political and economic origins of our time* (2nd ed). Boston: Beacon Press.
- Popper, K. 1972. *Objective knowledge: An evolutionary approach*. Oxford: Oxford University Press.
- Porter, M. E., Serafeim, G., & Kramer, M. 2019. When ESG fails. *Institutional Investors*, available on <https://sharedvalue.org.au/wp-content/uploads/2019/11/Where-ESG-Fails--Institutional-Investor.pdf> (October 16, 2019).
- Quine, W. V. 1961. *From a logical point of view: 9 logico-philosophical essays*. New York: Harper and Row.
- Rajan, R. 2010. The financial crisis and the death (or hegemony) of development economics. *The Journal of Economic and Education*, 41(4), 398-402.
- Rambaud, A., & Chenet, H. 2021. How to re-conceptualise and re-integrate climate-related finance into society through ecological accounting? *Bankers, Markets & Investors*, 166: 20-43.
- Rambaud, A., & Richard, J. 2015. The “triple depreciation line” instead of the “triple bottom line”: Towards a genuine integrated reporting. *Critical Perspectives on Accounting*, 33: 92-116.
- Redman, E. 2013. Advancing educational pedagogy for sustainability: Developing and implementing programs to transform behaviors. *International Journal of Environmental & Science Education*, 8(1): 1-34.
- Revelli, C. 2016. Re-embedding financial stakes within ethical and social values in socially responsible investing (SRI). *Research in International Business and Finance*, 38: 1–5.
- Revelli, C. 2017. Socially responsible investing: From mainstream to margin? *Research in International Business and Finance*, 39: 711-717.
- Ross Ashby, W. 1947. Principles of the self-organizing dynamic system. *Journal of General Psychology*, 37: 125-128.
- Rusinko, C. A. 2010. Integrating sustainability in management and business education: A matrix approach. *Academy of Management Learning & Education*, 9(3): 507-519.
- Sawyer, M. 2013. What Is Financialization? *International Journal of Political Economy*, 42(4): 5-18.
- Seatter, C. S., & Ceulemans, K. 2017. Teaching sustainability in higher education: Pedagogical styles that make a difference. *Canadian Journal of Higher Education*, 47(2): 47-70.
- Serres, M. 1972 : *Hermès II, l'interférence*. Paris: Éditions de Minuit.
- Serres, M. 1980 : *Hermès V, le passage du Nord-ouest*. Paris: Éditions de Minuit.
- Serres, M., Harari, J. V. (Ed), & Bell, D. F. (Ed). 1982. *Hermes: Literature, science and philosophy*. Baltimore: The Johns Hopkins University Press.

- Schinckus, C. 2008. The financial simulacrum: The consequences of the symbolization and the computerization of the financial market. *Journal of Socio-Economics*, 37(3): 1076-1089.
- Scholten, B. 2006. Finance as a driver of corporate social responsibility. *Journal of Business Ethics*, 68: 19-33.
- Schramade, W. 2016. Integrating ESG into valuation models and investment decisions: the value-driver adjustment approach. *Journal of Sustainable Finance & Investment*, 6(2), 95-111.
- Sharpe, W. F. 1964. Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance*, 19(3): 425-442.
- Shrivastava, P. 1994. Castrated environment: Greening organizational studies. *Organization Studies*, 15(5): 705-726.
- Shrivastava, P. 2010. Pedagogy of passion for sustainability. *Academy of Management Learning & Education*, 9(3): 443-455.
- Shrivastava, P., Zsolnai, L., Wasieleski, D., Stafford-Smith, M., Walker, T., Weber, O., Krosinsky, C., & Oram, D. 2019. Finance and management for the Anthropocene. *Organization & Environment*, 32(1): 26-40.
- Sidiropoulos, E. 2014. Education for sustainability in business education programs: A question of value. *Journal of Cleaner Production*, 85: 472-487.
- Simon, H. 1962. The architecture of complexity. *Proceedings of the American Philosophical Society*, 106(6): 467-482.
- Simon, H. 1986. The failure of armchair economics. *Challenge*, 29(5): 18-25.
- Slager, R., & Gond, J-P 2022. The politics of reactivity: Ambivalence in corporate responses to corporate social responsibility ratings. *Organization Studies*, 43(1): 59-80.
- Snelson-Powell, A. Grosvold, J., & Millington, A. 2016. Business school legitimacy and the challenge of sustainability: A fuzzy set analysis of institutional decoupling. *Academy of Management Learning & Education*, 15(4): 703-723.
- Starik, M., Rands, G., Marcus, A. A., & Clark, T. S. 2010. From the guest editors: In search of sustainability in management education. *Academy of Management Learning & Education*, 9(3): 377-383.
- Stead, J. G., & Stead, W. E. 2010. Sustainability comes to management education and research: A story of coevolution. *Academy of Management Learning & Education*, 9(3): 488-498.
- Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. 2015a. The trajectory of the Anthropocene: The great acceleration. *The Anthropocene Review*, 2(1): 81-98.
- Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M.,

- Persson, L. M., Ramanathan, V., Reyers, B., & Sörlin, S. 2015b. Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223).
- Stigler, G. J. 1984. Economics – The imperial science? *The Scandinavian Journal of Economics*, 86(3): 301-313.
- Svartzmann, R., Dron, D., & Espagne, E. 2019. From ecological macroeconomics to a theory of endogenous money for a finite planet. *Ecological Economics*, 162.
- Tourish, D. 2020. The triumph of nonsense in management studies. *Academy of Management Learning & Education*, 19(1): 99-109.
- Ulanowicz, R. E. 2009. The dual nature of ecosystems dynamics. *Ecological Modelling*, 220: 1886-1892.
- van der Zwan, N. 2014. State of the art. Making sense of financialization. *Socio-Economic Review*, 12: 99–129.
- Vos, L., & Page, S. J. 2020. Marketization, performative environments, and the impact of organization climate on teaching practice in business school. *Academy of Management Learning & Education*, 19(1): 59-80.
- Walter, C. 2016. The financial logos: The framing of financial decision-making by mathematical modelling. *Research in International Business and Finance*, 37, 597–604.
- Walter, C. 2020. Sustainable financial risk modelling fitting the SDGs: Some reflections. *Sustainability*, 12(18): 7789.
- Wang, L., Malhotra, D., & Murnighan, J. K. 2011. Economics education and greed. *Academy of Management Learning & Education*, 10(4): 643-660.
- Willmott, H. 2010. Creating ‘value’ beyond the point of production: Branding, financialization and market capitalization. *Organization*, 17(5): 517–542.
- Wray R. (2012), *Modern money theory. A primer on macroeconomics for sovereign monetary systems*. London: Palgrave-Macmillan.
- Yu, E. P., Van Luu, B., & Chen, C. H. 2020. Greenwashing in environmental, social and governance disclosures. *Research in International Business and Finance*, 52.
- Zerbib, O. D. 2020. A sustainable capital asset pricing model (S-CAPM): Evidence from green investing and sin stock exclusion. Available at SSRN <https://ssrn.com/abstract=3455090>.

TABLE 1

Paradigmatic presuppositions of Neoclassical Finance vs. Ecological Finance Theory (EFT)

Neoclassical presuppositions and arguments	EFT presuppositions and arguments
<p>Objectivism</p> <p><i>“So economics is an imperial science: it has been aggressive in addressing central problems in a considerable number of neighboring social disciplines, and without any invitations”</i> (Stigler, 1984: 311).</p>	<p>Embedding</p> <p><i>“The financial sector, which handles the monetary symbols related to economic activity, can only exist insofar as it is supported by its underpinnings; it is therefore the most restricted and objectively the most dependent of the other subsystems (market exploitation of physical, biological and social resources; culture and organisation of societies; physical and biological world)”</i> Dron (2015: 4)</p> <p><i>“Although the institution of the market has been quite common since the end of the Stone Age, its role has never been more than secondary in economic life”</i> (Polanyi, 2001)</p>
<p>"Instrumentalism</p> <p><i>“The proper test of a theory is not the realism of its assumptions but the acceptability of its implications”</i> Sharpe (1964: 434)</p>	<p>Realisticness</p> <p><i>“When abstraction loses touch with reality, science becomes dogmatism”</i> Georgescu-Roegen (1971: 319)</p>
<p>Reductionism</p> <p><i>“The firm is (...) a legal fiction which serves as a focus for a complex process in which conflicting objectives of individuals are brought into equilibrium within a framework of contractual relations”.</i> Jensen and Meckling (1976: 311)</p>	<p>Holism</p> <p><i>“(..) macroscopic properties emerge from local actions that spread to higher scales due to agents’ collective behavior; these properties then feedback, influencing individuals’ options and behaviors”</i> Levin et.al, (2012, p.113)</p>

Source: adapted from Lagoarde-Segot & Martinez (2021)

TABLE 2

Metaphors of Neoclassical Finance vs. Ecological Finance Theory (EFT)

Metaphors related to neoclassical finance paradigm	Metaphors related to EFT
Simple thinking by technical and technological complexity	Complex thinking
Pluridisciplinarity (with financial ontology)	Transdisciplinarity (with sustainable ontology)
Libertarianism and desembedding	Hierarchy and resilience
Infinite growth by use of needs/resources	<i>Philia</i> and impact (redistribution, circularity)

TABLE 3

Modeling curriculum – From financial ontology to sustainable ontology

	Curriculum 1	Curriculum 2	Curriculum 3	Curriculum 4
Nature of programme^a	Master in finance and economics ^b	Sustainable finance track in Master of finance and economics	Sustainable finance master (fully dedicated)	Sustainable Finance Master (fully dedicated)
Level	M2	M2	M2	M2
Year	2021-2022	2021-2022	2021-2022	New curriculum proposal
Ontology	Financial	Financial	Financial	Sustainable
Paradigm	Neoclassical	Neoclassical	Neoclassical	Ecological finance and economics (new framework; with no mention of neoclassical theories and skills)
Fields and disciplines (core courses)	<ul style="list-style-type: none"> ➤ Finance ➤ Economics ➤ Mathematics ➤ Accounting ➤ Philosophy (Ethics) ➤ Psychology 	<ul style="list-style-type: none"> ➤ Finance ➤ Economics ➤ Mathematics ➤ Accounting ➤ Sustainability 	<ul style="list-style-type: none"> ➤ Finance ➤ Economics ➤ Mathematics ➤ Accounting ➤ Sustainability ➤ Digital and numeric ➤ Governance ➤ Philosophy (Ethics) ➤ Law and legal sciences 	<ul style="list-style-type: none"> ➤ Finance ➤ Economics ➤ Mathematics ➤ Accounting ➤ Sustainability ➤ Anthropology ➤ History ➤ Epistemology ➤ Philosophy (including Ethics) ➤ Psychology ➤ Geosciences ➤ Biosciences ➤ Physics ➤ Strategy ➤ Law and legal sciences ➤ Governance ➤ Ethics ➤ Political sciences
Integration of disciplines	➤ Interdisciplinarity	➤ Interdisciplinarity	➤ Interdisciplinarity	➤ Transdisciplinarity

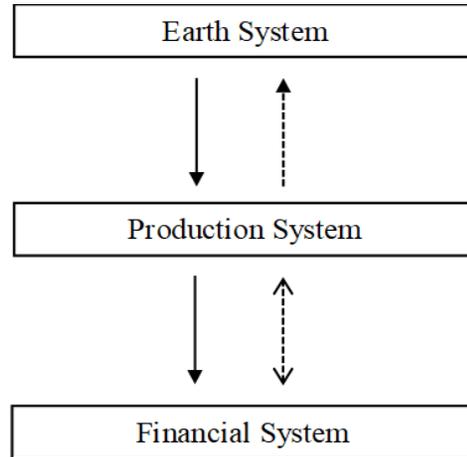
<p>Core courses in finance and economics</p>	<ul style="list-style-type: none"> ➤ Probability and statistics ➤ Behavioral Finance ➤ Corporate valuation ➤ Securities markets ➤ Financial statement analysis ➤ Introduction to finance ➤ Corporate finance ➤ Financial accounting and reporting ➤ International macroeconomics ➤ Empirical Methods in Finance ➤ Asset management ➤ Financial regulation ➤ Fixed income and MM ➤ Securities markets ➤ International finance ➤ Financial engineering ➤ Quantitative asset management ➤ Corporate restructuring ➤ Derivatives 	<ul style="list-style-type: none"> ➤ Mathematics ➤ Statistics ➤ Econometrics (R) ➤ Econometrics (Stata) ➤ Financial markets and institutions ➤ Financial accounting and reporting ➤ Fixed income analysis ➤ Modern portfolio theory ➤ Microeconomics, risk and information ➤ Financial analysis and valuation ➤ Corporate finance ➤ Derivatives ➤ Financial stability ➤ International monetary economics ➤ Monetary policy ➤ Contemporary issues in public Finance ➤ Asset pricing theory ➤ Macroeconomics and international finance 	<ul style="list-style-type: none"> ➤ Big data and artificial intelligence ➤ Financial inclusion and digitalisation ➤ Fintech seminar ➤ Programming with Python Financial modelling (machine learning and statistics) ➤ Venture capital & values creation ➤ Digitalisation, M&A and corporate restructuring strategy ➤ Digital financial regulation ➤ Blockchain and crypto assets ➤ Financial modelling (Excel + VBA) 	
<p>Core courses in sustainable finance and economics</p>	<ul style="list-style-type: none"> ➤ Ethics seminar 	<ul style="list-style-type: none"> ➤ Principles of sustainable finance ➤ Framework and tools ➤ Investment strategy, implementation and risk management ➤ Sustainable corporate strategy, creating out-performance ➤ Economics of natural hazard 	<ul style="list-style-type: none"> ➤ Sustainable finance, CSR risk ➤ Integrated thinking & impact investment ➤ Sustainable banks and neobanking ➤ CSR & green business ➤ Corporate integrated reporting ➤ Asset management, green bonds & ESG integration ➤ Extra financial performance & Refinitiv ESG database Governance, regulation & Ethics 	<ul style="list-style-type: none"> ➤ Anthropology of finance ➤ Epistemology and philosophy of financial models ➤ Living in Anthropocene ➤ Energy, Climate and Corporates ➤ Legal and political aspects of sustainable finance ➤ Ecological economics ➤ Ecological accountability ➤ Sustainable and ESG Risks Management. ➤ Climate-related financial risks management ➤ SDGs investing ➤ Impact investing

^a Curriculum 1,2 and 3 are existing but are anonymized for the study. All information is extracted from websites of business schools or universities. Sources are available upon request. Curriculum 4 is a puzzle-solving curriculum and proposal designed according to our paradigmatic and metaphoric thinking.

^b Master ranked among the top5-ranked master programs by Financial Times 2021 ranking

FIGURE 1

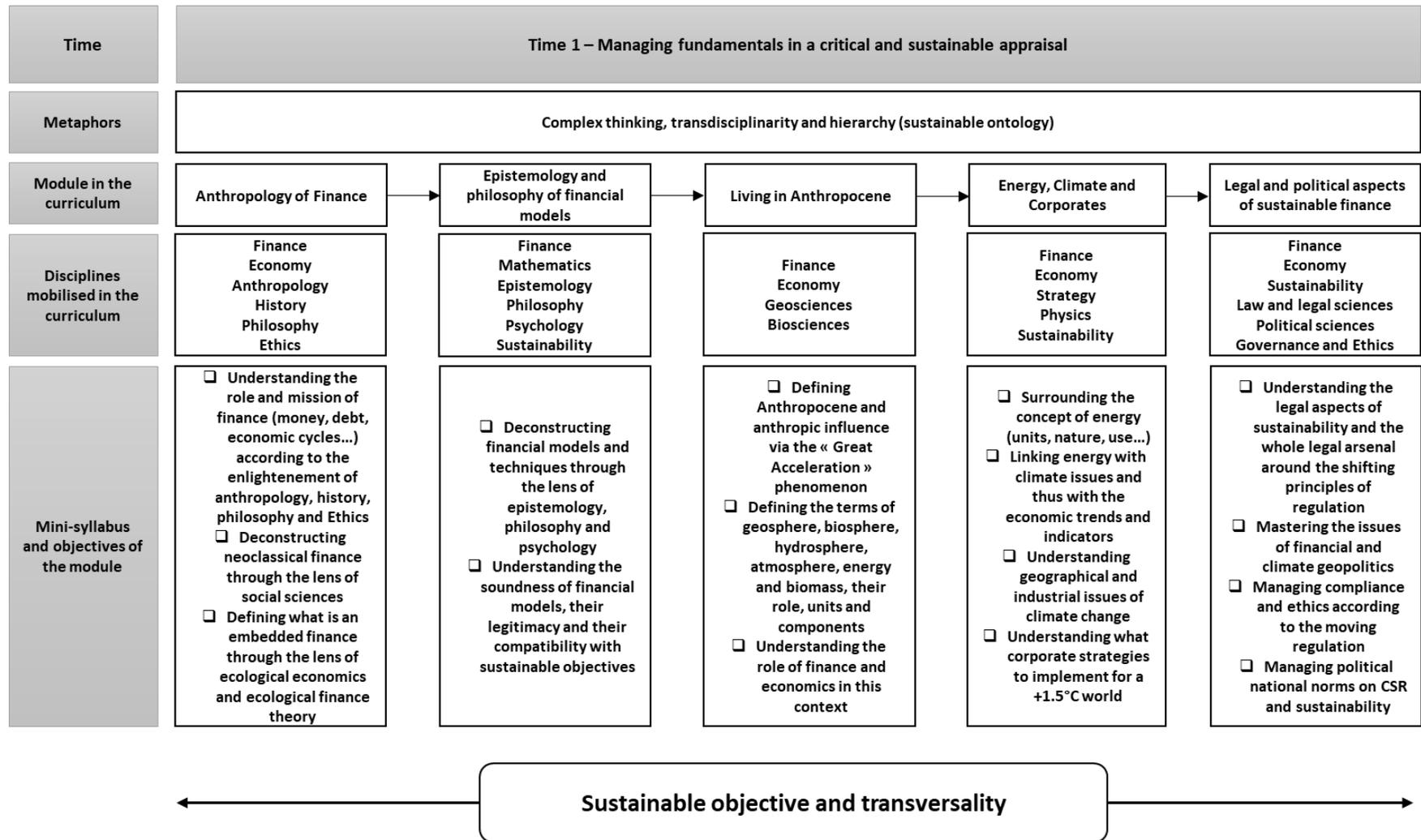
A new ecological ontology for financial theory

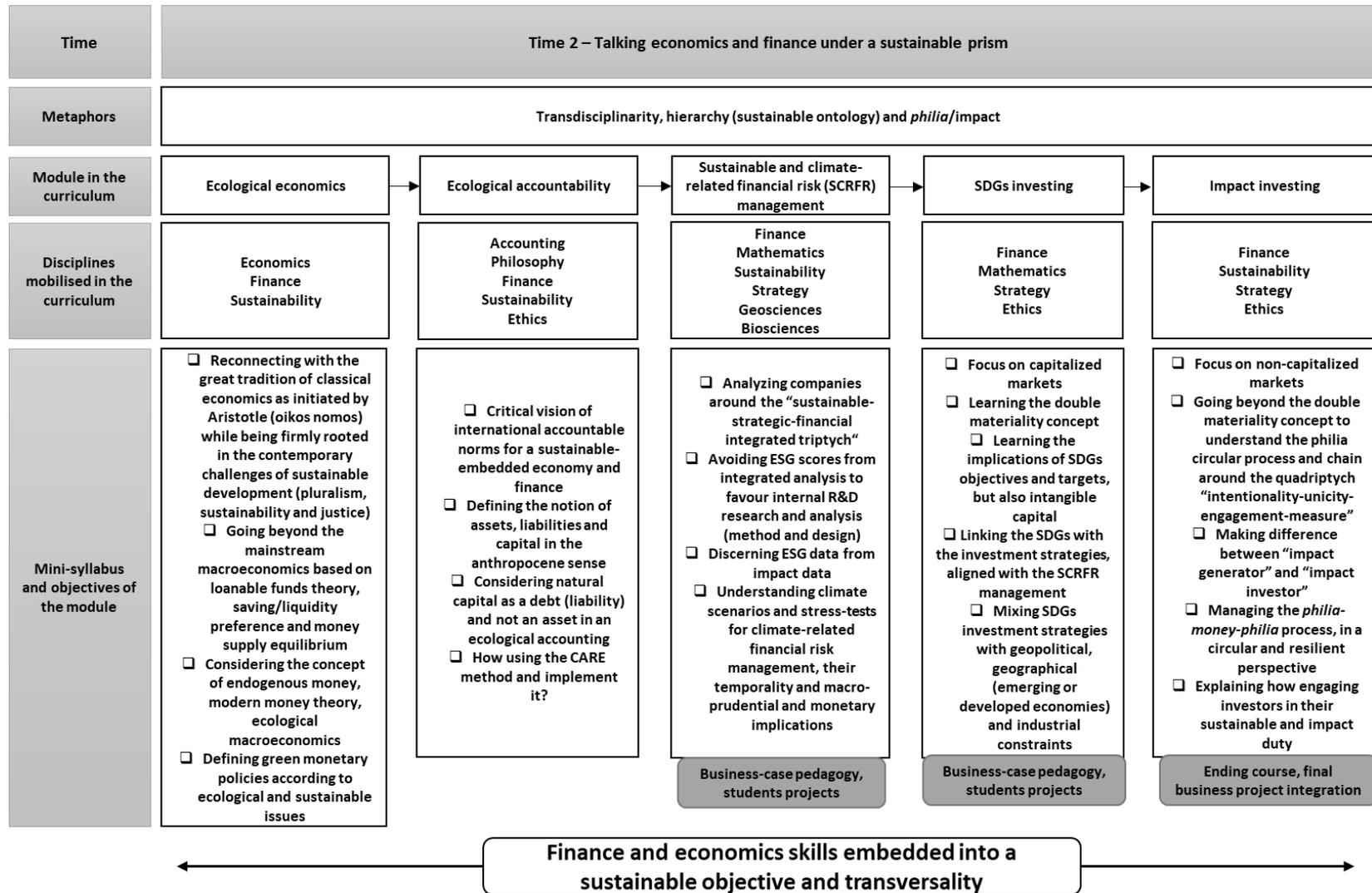


Source: Lagoarde-Segot & Martinez (2021)

FIGURE 2

A new sustainable embedded curriculum for master's degree in finance and economics





Note: All courses are proposed one after the other, without collision, on a separate period (10 courses between 30-40h with assessments). The pedagogical vision engages that students must receive all the courses in a logical sequence. All pedagogical contents are useful to understand and manage the concept of the next one. For example, the course *Anthropology of Finance* serves the *Sustainable & ESG Risks management & CRFR management*, *SDGs investing* and *Impact Investing courses* to define what kind of finance we use, what mission, what models and if it is aligned with Anthropocene issues. It allows to leave from the neoclassical mainstream paradigm and propose new transdisciplinary topics. Finally, sustainability is the ontological vision, anchored in our metaphors (complex thinking, transdisciplinarity, hierarchy and resilience, *philia* and impact), and is transversal along the curriculum. It acts as the hierarchic finality and the transformation vector of all contents.