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REGULAR ARTICLE

Some elements for a definition of an evolutionary efficiency criterion

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Abstract
Together with the concepts of equilibrium, scarcity, choosing, etc., efficiency is at the core of economics. However, in an evolutionary context, efficiency raises several issues concerning to rationality, the complex evolving nature of the economy, economic change as the fundamental economic problem, and the role of expectations —that link purposeful action to actual action. The main goal of this paper is to provide some necessary elements to accommodate an efficiency criterion within an evolutionary theory of the production of action. In a nutshell, an evolving complex system could be considered as being (or "becoming") efficient if the agents' intentions could "materialize" in actions that would give rise to real states of affairs which, essentially, were compatible (even similar; never identical of course) with what it was expected (ex-ante) when the action "plans" were elaborated and selected. We set out this criterion as a micro-criterion and then we explore an extension of it at a systemic level using the theory of meso-level connections.

Keywords Evolutionary efficiency · Action plans · Reflexivity · Expectations

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At the core of economics is the concept of efficiency.
Leibenstein (1966: 392)

1 Introduction

The need for suitable normative criteria to assess evolving complex systems has been clearly recognized in economics since, at least, Nelson and Winter (1982: 357ff). This

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question is still an open issue in the evolutionary arena, as van Staveren (2012) has pointed out. The traditional Pareto (1909: *Appendice*, §89 and §117) optimality criterion, as has been incorporated in mainstream economics, departs from a set of axiomatic assumptions based on consistent preferences and complete rationality that operates on a set of information that includes all relevant information about the environment together with the assumption that agents know all the consequences of each choice.[1] In this view, agents allocate their resources as efficiently as possible. For choices to be unequivocally judged more efficient requires not only that agents know all the means at their disposal and how these are directed to the objectives (ends) that can be achieved, but also the consequences of each alternative. This is possible only if production and utility functions are given —known a priori. Existence of equilibrium is equivalent to the logical possibility of pre-reconcilable choices (Weintraub 1979). All this reduces economic processes to the study of the static properties of equilibrium states resulting from market exchange. However, Pareto efficiency seems unsuitable for evaluating and judging evolutionary economic processes that include the emergence of novelty.

The interactive deployment of the selected planned courses of action produces the different outcomes of action (goods, services, etc.) registered in statistical and historical records. Broadly speaking, a plan is a sequence of intended actions that are (*ex ante*) linked within a specific internal structure with intended goals —as is the case of consumption or production plans, for instance. The comparison of the expected outcomes with what was achieved by each agent according to their plans leads the agents to evaluate their plans and introduce modifications into the constitution of new plans of action, giving rise to new courses of action and producing new instants of reality, and so on.

Conventional economic theory —in particular, mainstream microeconomics— usually operates under the more or less explicit assumption that the objectives (purposes, ends, goals…) of the agents are given (Robbins 1932; Stigler and Becker 1977) and consistent; thus, an optimum can be achieved, as in the case of (Walrasian) General Equilibrium theory. However, the theory should consider the continuous emergence of new goals of action, the hierarchical reordering of the existing goals, and the elimination (or set up) of inconsistencies among goals of action, etc. (Muñoz and Encinar 2015). These dynamics of objectives involve new means or actions, some of which have to be "invented" to achieve the new goals set up by agents (Cañibano et al. 2006).[2]

In contrast, evolutionary economics considers that the agents have different cognitive abilities, limited information processing capabilities, and imperfect knowledge of the environment and the future conditions of the economic system (Loasby 1991). These limitations are due not only to the failure of factual knowledge and reasoning

[1] Important formal developments are Arrow (1951), Arrow and Debreu (1954) and Debreu (1959). An interesting extension is Allais' principle of *efficacité maximal* (Allais 1989, §114). This principle refers also to the minimization of waste (*perte*)—as in van Staveren (2012: 119)—however, obviously, with reference to the agents' preference indexes, and not to the mere use of resources. Moreover, Allais (1989, §424) also points out that the Pareto criterion incurs at least in a couple of mistakes.

[2] As shown below, in our approach, we analytically separate the allocative operation from the constitution of action plans for the sake of simplicity. This separation is important because the allocative operation itself is not likely to accommodate an explanation of the formation of plans since both means and ends should be analytically given (see Loasby 2003) when the selection of plans takes place.

ability; agents also lack consistent valuation structures, since their decisions usually refer to specific aspects of particular subsets of values, temporarily ignoring others. Evolutionary economics usually assumes that agents have bounded rationality (Simon 1983; Nelson 2008) instead of an Olympic rationality (Fontana 2008). This means that agents act in accordance with standardized procedures such as routines, habits, etc. (Becker 2004; Nelson 2008). These routines tend to be stable, practical and precise, confer meaning and provide answers to a complex changing system. Although they have a rather inertial nature, routines are also open to change through learning in specific contexts. Agents must maintain continuous learning of factual and normative processes to be able to adapt or to creatively respond (Schumpeter 1947a; Antonelli 2017) to an environment that is continuously changing.[3]

Despite recognizing the superiority of the evolutionary approach when addressing dynamic phenomena over the more conventional view, evolutionary economics has not yet fully accommodated the intentional nature of human action.[4] Although intentionality plays an essential role in the explanation of human action,[5] it is at most stated in many evolutionary models.[6] This is a complex issue with many aspects and implications that affect the theoretical meaning of rationality and efficiency.[7] Perhaps one reason is that a full integration of intentionality within an evolutionary explanation challenges concepts such as rationality and efficiency as economists usually understand them. However, we claim that it is necessary to complement the evolutionary approach with a theory that explains economic processes from the perspective of the production of intentional action if evolutionary efficiency is to have any meaning. A theory that does not consider the intentionality of the agents in the production of their action necessarily becomes mechanistic, relegating, for example, the change of routines themselves to some bizarre mechanism such as random mutations, leaving no room for a meaningful efficiency criterion.

An evolutionary theory of the production of action (Muñoz and Encinar 2014a, b) raises several issues concerning rationality (Schütz 1943), well-being and economic policy (Schubert 2012, 2014; Pelikan 2003), the economy as a complex evolving system (Arthur 2015), the emergence of novelty (Witt 2009a, b) and economic change as the fundamental economic problem (Nelson 2017), and the role of expectations (Koppl 2002), which links purposeful action to actual action. In this paper, we focus on defining efficiency in this particular evolutionary context. The main goal of the paper is to provide the necessary elements to accommodate an efficiency criterion within an evolutionary theory of the production of action. Our main claim is that an evolving complex system is efficient if it *produces* the projected goals of action. Adequacy in the connections between actions and goals arises when the agents' intentions (activated and updated as new goals of action are formulated) give rise to actual facts and states of affairs as expected when actions

[3] This may include "preference learning" (Schubert 2013: 246) and "learning to consume" (Witt 2001).

[4] Although authors such as Lane et al. (1996) have recognized the importance of action beyond mere choice to understand economic processes in the evolutionary context, developments in evolutionary economics usually do not go beyond such statements.

[5] See, for example, Ascombe (1957), Searle (1983), Bratman (1987 [1999]), Malle et al. (2001), and, from the point of view of neuroscience, Fuster (2008).

[6] For a discussion, see Vanberg (2014).

[7] For an action to be rational, it must be intentional (Muñoz et al. 2011), i.e.: pursue ends (Nelson 2017).

were projected. In this context, elements such as plans, expectations, intentionality, interaction, feasibility, consistency and reflexivity are crucial for explaining possible (in)efficiencies in the production of agents action.

The concept of evolutionary efficiency here proposed is not even close neither to the idea of "rational expectations" equilibria, nor to the neoclassical typical view of intertemporal optimum paths coordinated in "dynamic general equilibrium" settings, which are amenable to Pareto optimum assessment. Moreover, in our opinion, as we will show below, the criterion also surpasses the Austrian "dynamic efficiency" idea.[8] More precisely, whereas in the Kirznerian idea of equilibrating market processes or in the Hayekian view of spontaneous free-market orders tending to coordinate action, or even in the Popperian vision of "open societies" leading to the increase of useful knowledge, we explain that dynamic efficiency tends to prevail in the long-run. In this paper we show that according to the evolutionary criterion we propose, evolving systems may (easily) become "inefficient", so that emergent paths in an evolving system might lead to ever-increasing dis-coordination and failed intentions, as Lachmann (1971) pointed out. Crucial failures may emerge both at the micro and the systemic levels. Finally, there is also an advantage of the evolutionary criterion here proposed against typical Keynesian rationing outcomes, namely, Keynesian models are usually short-run and even quasi-static, whereas our evolutionary approach is truly dynamic.

The paper is organized as follows. First, in section 2, we depart from a particular analytical framework — the "action plan approach" — that would allow us to show the links between purposeful action (intentionality) to actual action by identifying the constitutive elements of action (action plans, intentions, expectations, interaction, feasibility, consistency, reflexivity, coordination…) when establishing an efficiency criterion in an evolutionary context. From these constitutive elements, section 3 elaborates an evolutionary efficiency criterion that operates at the micro-level and explores the implications of its extension into the meso-level (Dopfer et al. 2004). This criterion should be able to assess the performance of a particular (socio-economic) evolving system in terms of the adequacy of the connections as well as to the alignments of goals, intentions and expectations of the agents interacting within that system. The paper ends with some concluding remarks.

2 Action, coordination and efficiency: an extended analytical framework[9]

2.1 Action plans and interaction

Economic processes are special processes deployed within global human action in historical time. However, although economic processes appear in many different forms (production, consumption, exchange, trade, investment, etc.) it can be said, without loss of generality, that there is a basic (core) economic process that is the fundamental theoretical

[8] Within the Austrian paradigm, a related but more limited concept that is linked to the logic of the entrepreneurial function is *dynamic efficiency* (Huerta de Soto 2012).

[9] We summarize and build on Rubio de Urquía (2005) and Muñoz and Encinar (2014a).

object of modern economic theory: the so-called allocative process. An allocative process consists of the selection and adoption of action plans by agents (individuals or organizations), along with the outcomes (products) and properties resulting from the interactive deployment of agents action according to their plans. Plans are formed by agents and imply, among other things, the allocation of scarce resources.

Thus, at each instant of analytical time t and for each agent, we can consider the following sequence of *four* analytical stages: (1) the *constitution* ("design" or formation) of bundles of alternative action plans by the agents within the system —these bundles include courses of action imagined and deemed possible (Shackle 1979: 26) by agents; (2) *selection*, within the bundle, of the action plan that the agent wants to make effective[10]; (3) (attempt of) *interactive deployment* of the selected plans within the (external) physical and social environment; and (4) *evaluation* and (eventually) revision of plans as a consequence of the comparison between the observed outcomes of action and what was initially planned by agents. Finally, evaluation and revision would have implications for the next bundle of plans set up for the following analytical moment $t + 1$.

At the first analytical stage (the constitution of bundles of action plans), each agent, departing from his intentional state (Searle 1983), determines what he wishes to do, what he believes he can do, and how to proceed. As shown below, this is a fundamental analytical stage in the explanation of the production of interactive human action, although from a strictly economic point of view it is a *pre-analytical* stage. Economics actually begins at the moment at which agents, based on a given set of courses of action (plans of production, consumption, investment, etc.), choose the action plan that will unfold — attempt to deploy — because they somehow consider them the most preferable (the "best") from their own points of view.[11] At this stage, when the agent selects the action plan he considers the best, the principle of economic behavior is operating.

Once a decision is made, the agent undertakes the external actions according to the selected course of action to reach or to produce the pursued goals. The agent interactively deploys the plan previously formed and selected in the external (physical and social) reality in which the agent lives to transform that reality according to his intended goals—i.e. his intentionality. Finally, the agent evaluates what is being produced (reached) according to the sequence of his/her planned goals, which will transform both the external and internal reality of the agent. As far as what is being executed and achieved conforming to what was previously planned, it can be said that the action is

[10] For simplicity, we assume here that agents select only one plan at each instant of time. Obviously, this is only true in the case of alternative and exclusive plans: I cannot be in Paris and Melbourne at the same time. However, in general, it is possible to deploy two or more plans at the same time: I can run and listen to music if I have an iPod.

[11] The "design" or formation of each personal action plan depends on the personal characteristics of the person: his internal structure of beliefs, attitudes, values and its representations of reality that constitute a set of elements that define what a person perceives as existing, based on what he knows, feels and wants. Rubio de Urquía (2005) has referred to this structure as the *personal ensemble*. The personal ensemble is a fundamental element for the formation of the bundle of action plans, although it does not fully determine it. The personal ensemble is caused by the dynamics of deployment of the person (his "biography"), especially his ethical and cognitive (both personal) dynamics and the cultural dynamics in which the person develops his existence. Similar notions are *mental models* (Denzau and North 1994), *space of representations* (Loasby 1999), *theories* (Schütz 1951), etc.

efficient. Deviations from planned sequences of actions and from the outcome in terms of the pursued goals eventually determine more or less radical adjustments (even the total removal) of the action plans, giving rise, eventually, to the generation of new bundles of action plans.

2.1.1 Feasibility and consistency

Two outstanding properties of action plans with strong implications for the evolutionary efficiency criterion are feasibility and consistency. From a general point of view, action plans can be feasible or unfeasible a priori. Feasibility refers to the possibility of the effective realization of a plan: the sequence of actions and objectives of the plan can be effectively carried out and reached, respectively.[12] However, in practice, plans are more complex than what is possible or impossible: thus feasibility refers to the *degree* to which the sequence of actions facilitates achievement of the goals in the plan. Provided that the feasibility of the plan is not complete, the most likely scenario, unfeasibility, is understood rationed action: the intended objectives are accomplished in some way, to some extent, but not completely. Technically speaking, we should distinguish *ex ante* feasibility —from a logical and material point of view — and *ex post* feasibility — the possibility of a plan to succeed when interacting with the plans of other agents within the social milieu. We denote these types of feasibility as $F1$ and $F2$, respectively.

Additionally, an action plan is consistent if it does not present any source of unfeasibility. Consistency of action can be also of two types: the first one, $C1$, refers to the adequacy of means in relation to the goals of action; and the second to the compatibility of goals, or $C2$, that is, the agent does not incur in paradoxes of objectives. As in the case of feasibility, the consistency of the plans is usually partial. From a negative point of view, we can identify different sources of unfeasibility. A plan is (partially) unfeasible if it violates physical and/or logical laws or because of the presence of the inconsistency of goals — for example, the pursuit of mutually exclusive or contradictory goals. Consequently, the feasibility of an action plan is linked to the presence and degree of consistency that exists in such a plan.[13]

2.1.2 Coordination

Social reality emerges when agents interactively deploy their actions (Searle 1995). Moreover, it is in the process of the interactive deployment of action when the system reveals the extent to which agents *ex post* achieve (produce) their intended goals of action as well as the degree of consistency and feasibility of the plans of each agent. Thus, interaction and consistency are bound through the concept of *coordination* of plans. As has been said, the degree of fulfilment of a plan depends on the condition of consistency when the plan is formed; however, consistency only manifests through

[12] Schütz (1951: 166-169) speaks of practicability. In what follows, it is important to point out that projecting — and selecting — a course of action is different from mere fancying. "Projecting of performances (…) is a motivated phantasying, motivated namely by the anticipated supervening intention to carry out the project." (Ibid. p. 165).

[13] Consistency is a necessary condition for the feasibility of the plans because consistency enables effective feasibility *ex post*. For a formal proof, see Encinar (2002).

feasibility — when the agent effectively deploys the plan.[14] In this sense, feasibility is the observable expression of consistency. Feasibility and consistency are not simultaneous but co-implied and successive properties. A course of action that is consistent a priori would guarantee the possibility of *ex ante* feasibility of the plan (i.e., $F1$). However, feasibility does not effectively occur until plans unfold in interaction: *ex post* feasibility involves the coordination of plans of different agents interacting within a system.[15] Property $F2$ is not guaranteed a priori because a plan verifies $C1$ and $C2$ at the stage of its constitution. It is also necessary for the interaction of plans to be of a special type to produce $F1$. That is, $C1$ and $C2$ are necessary, but not sufficient, conditions for plans to be $F1$. In addition, $F2$ requires the necessary but not sufficient condition that plans verify $F1$. Increasing coordination of action plans implies a *gain of feasibility*.[16]

It is important to note that $F1$ is a type of feasibility that corresponds to the individual evaluation of the action plans of the agent, which depends on the (in)consistency of his action, while $F2$ corresponds to an evaluation of the feasibility resulting from the interaction of the deployed courses of action (based on plans) by agents within the system. Because of interaction, when the agent does not observe $F1$ he redirects his attention simultaneously towards $C1$ and $C2$ as well as towards $F2$. That is, the agent examines the inward (constitution and selection) and outward (the outcome of interaction) properties of the deployed action plan. It is at this analytical stage that the agent evaluates the plan, focusing on the achievement of his intentional goals in terms of $F1$. The *balance of feasibility* (degree of achievement) reverts in the way in which the agent forms his plans, which may imply a more or less substantive revision of his bundles of action plans in the following analytical moment. Thus, both the agent's individual and social dynamics as a whole is a process where the external is caused by and causes the internal

[14] It could be the case that compensating errors may lead to plan completion even though it is based on false assumptions. However, completion of everyone's plans is not evidence of Pareto efficiency. For example Rizzo (1990) explains how, for Hayek, agents could be in individual equilibria because they do not discover any evidence that would cause them to change their plans, even though those plans are not optimal. They can be in equilibria even though there are unexploited gains from trade that are ignored. Kirzner (1973: 215-218) proposes an example in which buyers in one part of the market are ignorant of sellers in another part of the market who would sell at lower prices. The buyers buy at high prices (their expectations are met) but they would clearly regret those transactions if they knew about the other sellers who sell at lower prices. There might be nothing in the course of events that would cause them to discover what they are ignorant of and their projected goals of action are realized even though the system is not "efficient" in a Pareto sense. That is, Kirzner equates full coordination with Pareto efficiency; however, Hayek allows for agents and the system to settle into an equilibrium that is not Pareto optimal. Additionally, for Hayek, to talk about equilibrium requires the passage of time and human action — it is not static and atemporal.

[15] Unlike the neoclassical version, our approach does not take action as an isolated unit: each agent knows that his fellow social actors are guided by anonymous typifications of other actors –a knowledge that gives each agent an incentive to fit his own actions into the stereotyped patterns expected by others — and other agents must understand the agent if his/her actions are to succeed or have, at least, an objective probability of success (Koppl 2002, p.113). Additionally, our approach allows conflict to play a role. Conflicts of goals and/or actions are a source of unfeasibility with which agents have to deal. This is a very important issue that we cannot elaborate here due to lack of space.

[16] Defined in a negative sense as a decrease in the degree of the unfeasibility of agents' action plans. Hayek (1978) stressed the importance of coordination in his discussion on the empirical tendencies toward equilibrium: he characterized it "by a maximum compatibility of plans and dissemination of knowledge, subject to the adaptation to constant change in system's external data" (Rizzo 1990: 16).

process of constitution and interactive deployment of agents' action, a process that transforms both the internal and external reality of the agent. The "mechanism" that binds the outcome (products) of action with the establishment of new plans is *reflexivity* (symbolized *R*). In order to gain efficiency, the main task of the agent now consists of removing the sources of infeasibility of his action.

2.1.3 Reflexivity

Reflexivity, the "feedback effects on some process that influences its performance" (Davis 2017a: 6), establishes a bi-directional connection between the constitution of plans and the evaluation of the outcome in terms of the achievement of objectives after the interactive deployment of action by agents.[17] At every moment in time, each agent decides upon and executes actions that affect him and other agents that interact with him. To the extent that this interactive process shapes social reality (external/social domain of action) and produces a balance in terms of the achievement of goals of action, social reality reverts to the configuration of the plans of the agents (internal/individual domain of action), who redefine (or create *ex novo*) action plans that consider that balance. Reflexivity is the *dynamic nexus* between individual and social reality; it introduces a fundamental dynamic (evolving) element that can be perfectly appreciated in the case of analytical processes in which this property is absent –as in Walrasian General Equilibrium theory. Obviously, learning processes and the formation of expectations are linked to *R*.

Figure 1 summarizes the relationships between all these elements.

According to our argument, there are at least two sources of gains in feasibility. The first one is the partial (re-) constitution of action plans, in which the links of actions/means to goals and among goals are such that inconsistencies (both *C*1 and *C*2) disappear or are at least reduced. The second source is the full (re-)constitution of action plans so that the new plans consider the imbalances of feasibility that agents have observed when they have previously interactively deployed their action plans. The former source of gains in feasibility refers to the intrinsic (*ex ante*) feasibility of agents' actions or gains in *F*1, while the latter refers to extrinsic (*ex post*) feasibility, *F*2. In both cases, the coordination of action involves reflexivity.

Reflexivity, which can manifest in different ways depending on the nature of the feedback mechanisms that individuals use, activates the revision of plans at the constitution stage. However, it is important to note that *R* does not imply increasing coordination in itself; on the contrary, it is perfectly possible to have a type of revision of plans that involves greater discoordination of the individual and social process because reflexivity can introduce or strengthen specific bias in action.

[17] Soros (2013) proposes a concept of reflexivity-related uncertainty principle. His concept is linked, on the one hand, to what he meant by cognitive function (understanding the world in which the agent lives) and, on the other, to what is called the manipulative function (which concerns the action of the agent with reality and therefore is linked to intent, according to the author). The two functions connect the subjective reality perceived (or designed) with the real state of things or objective reality. Both functions are fallible (in the sense that the calculations/perceptions of the agent who makes them can fail). According to Soros, the set of roles indicated along with fallibility and intentionality form a reflective system. An extension is Beinhocker (2013).

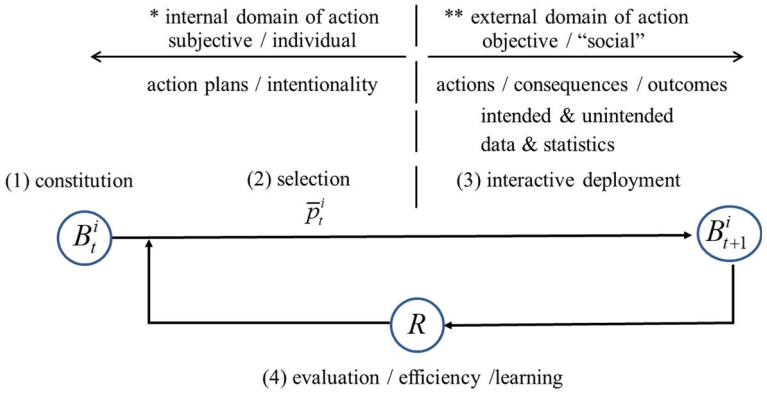

Fig. 1 Internal and external domains of action and efficiency (based on Muñoz and Encinar (2014a: 327)). A rather similar figure can be found in Shiozawa (2018). Note: B_t^i refers to a bundle of action plans for agent i at time t, and $\overline{p}_{it}$ represents a selected action plan from the bundle B_t^i

2.2 Knowledge and uncertainty: the role of expectations

Agents plan and act using knowledge to coordinate their activities with other agents (Hayek 1937, 1945). The dynamics of the generation, dissemination and organization of knowledge is a central to economics (Loasby 1999), but it is by no means the sole element in the explanation of the processes of economic change. First, the interactive deployment of action that produces instants of reality that include all types of emerging properties such as innovation, development, etc. depends on agents' thoughts about the future, that is, the form and content of their expectations. In a dynamic and non-ergodic process that runs in historical time, expectations are at the base of radical (Knightian) uncertainty. Agents use (develop and adapt) conventions (Keynes 1936, esp. Chap. XII), institutions and technologies to manage uncertainty (North 2005; Loasby 1999).[18] However, other elements concur in the explanation of economic change that can also be addressed from the perspective of a theory of knowledge. For instance, the dynamics of goal setting, the hierarchical re-arrangement and the eventual removal of goals of action, and especially the intentionality of the agents (Muñoz and Encinar (2014a, b) and Muñoz et al. (2011)).

As far as expectations integrate into the action plans of agents,[19] setting and shaping the goals of action as desired future states of the system, they manifest in

[18] Koppl (2002: 107) points out that ignorance of the future discourages agents' action aimed at the future. Thus, agents plan only where the inner zones of relevancy — that is, the field of action or part of the world the agents think they can control at least in some degree, and the milieu of action or other fields of action not open to agents' immediate domination but mediately connected with the field of action (Schütz, 1946: 124–125) — give them enough subjective predictability to expect the desired result with the required degree of confidence. On the other hand, agents plan for the foreseeable future, and the very concept of expectations contains within it the notion of the predictability of the future. This notion of predictability is a pragmatic and subjective one (not a philosophical one) and pragmatic judgment may be mistaken. Koppl (2002) has also noted a similarity between Keynes (1936) and Schütz's (1951) discussions of conventions. Davis (2017b), also on Keynes' philosophical thinking, connects reflexivity, complexity and uncertainty. On the role of expectations in a radical uncertainty environment, see Shackle (1955), esp. Part I, and Shackle (1972).

[19] "[O]ur expectations about events we do control (…) is our knowledge of the field of action. This knowledge exists in the form of plans we might carry out. The field of action is filled, therefore, with hypothetical propositions. 'If I do this, that follows.' The point of our plans is precisely to change events, to move them from the path they would otherwise take." (Koppl 2002: 107)

the interactive action of agents, thus giving rise to the products of action. A possible outcome is the full coordination of action. However, a gradation usually occurs in the coordination as a result of interaction: the system may present novelties[20] or some type of blockage provoking agents to not satisfy their aspirations or expectations, producing rationed action. On many occasions, rationing (its sources) is relieved or even completely removed if agents conveniently adapt their expectations and plans. If they do not adapt their expectations and actions enough in a situation perceived as rationed action, the system may be locked in a given state; it falls into an *evolutionary trap* (Muñoz et al. 2015).

As mentioned above, reflexivity accommodates the feedback and the (eventual) judgment on the achievement of the goals included in the selected and interactively deployed action plans. Based on the evaluation of the outcome of the deployment of interactive action, it is possible to analyze the efficiency of action, which consists of determining the extent to which the selected plan *is becoming* effective.

3 An evolutionary efficiency criterion: a proposal

In this section, we show that an evolving complex system could be considered as being (or "becoming") efficient if the agents' intentions could "materialize" in actions that would give rise to real states of affairs which, essentially, were compatible (even similar; never identical of course) with what was expected (ex-ante) when the action "plans" were elaborated and selected. First, in 3.1 we introduce the (necessary) elements to set out this criterion as a micro-criterion; secondly, in 3.2, we explore and propose an extension of the micro-level criterion at a systemic level using the theory of meso-level connections.

3.1 Elements for an evolutionary efficiency criterion at the micro level

The dynamic process of building connections (Potts 2000; Loasby 2001; Foster 2005) between actions and goals established by the agents that interact within an economic system can be judged in terms of the appropriateness or adequacy of the connections between actions and goals and among goals. The interactive deployment of agents' planned action is at the base of the emergence of complexity in an evolutionary socio-economic system (Muñoz and Encinar 2014a). Adequacy in the connections between actions and goals arises when the agents' intentions (activated and updated as new goals of action are formulated) give rise to actual facts and states of affairs as expected when actions were projected. Although efficiency of action is a systemic property, it also can be stated of individual action. Thus, there is *evolutionary efficiency at the micro-level* when the intention of an agent is updated through actions that are deployed in an interaction: *updated intentions produce the projected goals*.

The state of the system within which agents interact is not independent of their actions but the outcome of those actions through a complex system of interactions.

[20] The emergence of novelties produce disequilibrium. As we have shown elsewhere, novelty depends on the intentionality of agents. The very fact that an unexpected event arises from the interaction of intentional dynamics does not eliminate the fact that its origin is intentional (Muñoz and Encinar 2014a: 332).

Economic processes are dynamic processes in historical time that involve radical uncertainty. Individual and collective intentionality of action (Tomasello et al. 2005), which is the determinant of evolution (Loasby 2012), is linked to expectations. In this sense, the very concept of expectations binds the theory of action to efficiency. Efficiency of action — at the micro level — should be judged in terms of a more or less permanent/recurrent mismatch between what agents intentionally pursue and what they reach as a result of the interactive deployment of their action, that is, the mismatch between planned and actual action.[21] To accommodate efficiency in our approach, we depart from the difference between the expected (and judged possible) outcome[22] and the effective outcome,[23] the result of the interaction of agents action plans.

At each instant of time t, we define the effective future of the system as the state the system will reach at $t+1$. At the level of the agents, their state of the system does not refer to a mere external reality, something that is "out there" that is met[24] as a result of the evolution of things or even as a result of an intentional pursuit of that state. Thus, for each agent, his state is not only the consequence of a process of the search for knowledge. The state of each agent is the outcome of the dynamics of the general interaction of the system within which each agent operates, which involves the interaction of agents' plans as well as the internal properties of the plans.

Additionally, the "global" state of the system (the economy) is also the outcome of the intentional action loaded with the expectations of the agents. This state is something that agents are producing and, for this reason, it is not a mere "external" or "objective" reality, but the effective reality that agents are producing from their subjectivity (Muñoz and Encinar 2014b).

The expectation of agent i about his state of the system at $t+1$ — his "state of expectations" — expresses a desire: what is expected and, in some sense, what the agent wants to reach. Thus, expectation incorporates the intentionality of the agent.[25] At each instant of time each agent forms a bundle of (alternative) courses of action —planned action— based on his expectations. From this bundle (B_t^i) the agent selects the action plan he wants to carry out. As he deploys interactively his planned action, actual action, the consequence of (the attempt of) executing actions included in the selected action plan, is being produced, as well as the general (social) dynamics of interaction of agents within the system. Agents expectations exist prior to the actual state of the system (both at the individual and social levels). Moreover, expectations as such, along with the ethical, cognitive and cultural dynamics of the agents exist, from a logical point of view, prior to the interactive deployment of action by agents,[26] and thus, they produce instants of reality (individual states) for each agent through the general dynamics of social interaction. In this sense, the sequence of states of the

[21] Divergence between the expected and that that is actually obtained, on the other hand, is the result that is expected more frequently in genuine dynamic processes. See Antonelli (2011) on "out-of-equilibrium dynamics".

[22] Expectations are conjectures about the future. An action plan is, in fact, an expectation, a genuine conjecture (an experiment) in a Popperian sense.

[23] How effective is not real in the sense of *the external*, something that is there, if that is not what the agent perceives as real as a result of its plan of action in interaction.

[24] As if it were a search process in the sense of Kirzner (1992).

[25] For this expectation to generate action, it must not be a mere mental state (a pure expression of desire) but should articulate and make sense of the projective space of action.

[26] Expectations affect the constitution of spaces of action of the agents.

system that he encounters are not possibilities and realities that are completely external to the agent: *reality is not independent of his deployment of intentionality.*

Finally, to compare the expected — based on stages (1) and (2) of the domain of action (see Fig. 1) — with the effective —result of stage (3), the external domain —, agents use their own "norms" at stage (4). At each instant of time, an action plan included in a bundle of plans connects something that the agent wants to achieve with the actions and means that the agent knows or perceives that would produce the pursued state of affairs (his goals of action). At this micro level, the evolutionary efficiency criterion refers to the degree to which the selected plan of action, and the actions consequently executed — interactive deployment of actual action — leads to what was planned according his expectations and therefore *produces* (totally, partially or not at all) the goals included in the selected plan.

Thus, if according to his norm, the difference between that observed by an agent and the expected is considered significant in some sense by the agent himself, the agent will trigger processes of learning. The agent will attempt to remove or reduce the sources of his rationed action: he will seek and identify the source and nature of the obstacles that prevent the agent from successfully achieving his desired states (goals of action). These obstacles can be found in different states of action referred above. The agent might be able to identify obstacles in the social environment of interaction (external/social domain of action; that is, stages (3) and (4)) — for example, the existence of conflicting goals — or within his own dynamics of generation of intentional action (internal/individual domain — stages (1) and (2)). We say the agent "might be able" because a priori there is no guarantee that the agent will be able to do so. In a negative sense, the (degree of) failure to fulfil the plans is a measure of the inefficiency of his action.[27] Through the mechanism of reflexivity, the agent will review parts or the whole of the plans (to discard or replace them completely or only partially) if he judges that his plans are not effective enough. Accordingly, agents can establish new connections between the previous elements (actions) or explore completely new connections, which will trigger processes of learning and experimentation as they explore adjacent states (Potts 2000) within the system in which they interact.[28]

The differences between the desired and pursued state and what was achieved by the agent according to the norm of comparison, determine a (approximate) measure of inefficiency of his action — negative criterion.[29] To increase the efficiency of action, agents should look for the causes of those differences in the different stages of his/her deployment of action. Thus:

– Expectations are poorly formed, because lack of knowledge (Hayek 1937; Kirzner 1992; Loasby 1999; Simon 1983; etc.); the presence of inconsistencies in

[27] We are assuming that, to some extent, agents can interpret and find out why their plans failed. However, we are aware that the Duhem-Quine thesis would suggest that it can be very hard to know why a plan failed within a complex system − because of the initial conditions versus the general hypothesis vs the implementation of the plan or market test or even measurement errors.

[28] New connections or new combinations that are at the basis of entrepreneurship (Earl 2003).

[29] An interesting example is Sarewitz and Nelson (2008), who propose the so-called "Sarewitz-Nelson rules", a certain dynamic negative efficiency criterion applied to the selection of technological trajectories (in particular, three rules to rule out, a priori, the lack of promising technological paths). Almudi et al. (2016) criticize, formalize and extend these types of rules.

objectives (Sen 1993); the absence of mechanisms of learning — and even negative learning (Almudi et al. 2016)[30]; etc.
- In the process of deployment of actual action, elements of "irrationality" may appear linked, for example, to states of mood, physical and psychological factors, emotions, luck, blows of fate, etc. Although important from a practical point of view, for the purpose of the main argument, these sources of inefficiency may be considered analytically residual.
- Social dynamics of interaction can promote, ration, limit or even cancel specific courses of action that *ex ante* would appear perfectly feasible and consistent that, when deployed, may collide with the action deployed by other agents, returning (*ex post*) rationed action. Conflict plays here an important role.

3.2 Towards an evolutionary efficiency criterion at the meso level

In this subsection, we explore how to transcend the previous micro-level analysis into the next (higher) level of interaction: the meso level.[31] As has been said, it is only possible to establish full judgment on the evolutionary efficiency of action at the level of interaction. The above micro-level evolutionary efficiency criterion enables a dimension that goes beyond the individual; this feature should allow us to judge the performance of a system at a level of interaction, where actions and their consequences objectify (external domain in Fig. 1). Analytically, it consists of applying the efficiency criterion to both the analysis of the adequacy of the connections as well as to the alignments of goals, intentions and expectations of the agents interacting within a particular (socio-economic) system.[32] The proposal is consistent with a criterion rooted at the micro level but the effects of which are *observable* at the meso level (Dopfer et al. 2004; Dopfer and Potts 2009). In terms of this criterion, the performance of a system is[33]:

- *high* if the connections within that system are *suitable* — that is, where the special alignment of the goals and actions of the agents "causes" the achievement of pursued goals by agents interacting at the system level. If this is the case, it can be said that the *system* is *evolutionary efficient*.[34]

[30] The formal proposal in Almudi et al. (2016) makes it possible to detect blockages and barriers that may stop (or at least slow-down to the limit) the learning co-evolutionary processes taking place between "practice" and "understanding". This blockage of co-evolution may eliminate domain-specific possibilities for learning, which might erode (e.g.) technological advance. Accordingly, this would be the case if the "enlightening testability rule" were not verified at a sufficiently high level in certain cases; or even if the "standardized technical core rule" were not verified in certain domains.

[31] See Dopfer (2012) for a discussion of the concept of meso.

[32] An organization, company, industry, economic sector and, ultimately, the entire economy.

[33] At this point we make abstraction of the institutional setting. Of course, different social arrangements have consequences in terms of coordination −to the extent that a social arrangement can be judged economically better than another if it generates faster mutual discovery processes and more extensive meshing of plans (Harper 2013: 63). In particular, revisiting Kirzner's work, Harper (2013) stresses the role of the system of property rights of a society to have a better understanding of the logic of economic coordination.

[34] A limit case, however in a static or atemporal context!, is the Walrasian GE, where all plans (of consumption and production) are mutually compatible a priori. However, in true dynamic processes, the common situation is the presence of goal conflicts. Muñoz and Encinar (2014b) and Kallerud (2011) provide some examples.

– *low* if the performance results in *inadequate* connections in the sense that deployed action does not proceed as planned or does not lead to the achievement of the pursued objectives of action.

The latter is the case of an evolutionary inefficient system (Encinar 2016): the system may allow the fulfilment of the objectives of some agents but block, limit or ration other agents' goals. Another possibility is that the goal of an agent (or of several agents) blocks the development of the system (as in the case of an evolutionary trap). There could also be inconsistencies in objectives, i.e., that the goals of the agents themselves were inconsistent (and therefore unfeasible), etc. Internal inconsistencies of action plans (at the micro level) produce rationing on goal satisfaction, generating a deterioration in the efficiency of the actions of the agents at the system (meso) level. Thus, the system as a whole can result in lower performance and rationing in terms of objectives (Geels 2004).

If we consider the *social balance* resulting from the concurrence of all agents represented by their individual dynamics, at least two alternative scenarios emerge:

A. All agents individually generate feasible action plans ($F1$), so that for every agent and their respective selected plans of action, the interactive deployment of individual actual action effectively results in what was planned by each agent. Therefore, they all have effectively *produced* the desired goals included in their plans. In this case, there is efficiency at the meso level since all plans are simultaneously possible and all connections for all agents are *suitable*.
B. Agents —all or some of them— design plans that, when individually considered, *do not* fully produce the desired effects. These plans are inefficient because selected and interactively deployed action plans do not effectively produce what was planned and, therefore, do not effectively lead to the objectives included in the plans for any agent. This inefficiency generates rationed action: effective future individual states are different and "worse" — or not so good — than expected.

To explain these results in meso level, we have to consider the analysis of the properties that specific individual dynamics have at the micro level (stages (1) and (2) in Fig. 1). For example, in case (A) above, it could happen that, in terms of the feasibility of individual plans, these would be both $C1$ as $C2$ a priori — and then necessarily $F1$. Given this, full feasibility ($F2$) would emerge at the level of interaction. One example is that in which, in the dimension of interaction (stages (3) and (4)), a type of reflexivity R unfolds that operates, when action plans deploy and interact in such a way that agents do not generate new objectives or actions beyond those merely necessary so that the individual dynamics, characterized a priori as has been said, would lead to coordination. Another similar outcome emerges when R operates in such a way that *all* sources of unfeasibility disappear: that is, when (A) implies full revision of individual dynamics for the achievement of the feasibility of all individual action plans at the meso level.

More complex is the second case. In (B) it is necessary to identify what type of R is at work and on which aspects of the plans — formation or selection — operates reflexivity for each agent. After the preliminary completion of the effective state of

the agent, reflexivity incorporates (at the level of interaction, i.e., stages (3) and (4)) the information on the sources of inefficiency in plans. For example:

i. It may happen that *R* deployed by one, several or all agents is such that agents accommodate individual feasibility of their plans (*F*1) with no consideration of *C*1 and *C*2. This type of reflexivity would lead agents to incorporate the fact that the social dynamics is (will be) rationed in their expectations. Under these circumstances, from the agents' subjective point of view, individual action plans after the operation of this type of *R* (adaptation of expectations in a more or less accommodative way with what reality is / will be) would be fully feasible individually considered.[35]
ii. It could also be the case that a type of *R* causes agents to reconsider their plans and not merely adapt the expectations under rationing, as described above. In view of the divergence, in the external domain of action, between the expected and the actually achieved, agents may understand that they have made an inadequate disposition of actions to goals or held inconsistencies *C1* (internal domain or analytical stages (1) and (2)). Reflexivity could trigger *learning* processes to eliminate errors or reduce the lack of knowledge to improve the adequacy of actions. In this case, *R* would lead to improvements or gains of consistency *C1* and therefore allow future states to be more feasible, both at individual and social levels.
iii. Another possibility is a type of *R* that also operates on the reconsideration of the consistency of the plans at the individual level according to property *C*2 —consistency of goals. In this case, agents revise their plans when looking for a qualitative improvement in the content, priority and hierarchy of goals. There could be new hierarchies of goals — of some agents, for example — that give rise in an interaction to eliminate some partial rationings.
iv. Finally, it is also possible that, in view of the divergence between expectations and achievements, a judgement on the inefficiency of action by agents lead them to a complete redefinition of aspirations, the establishment of new goals and actions, etc. In this case, *R* would lead to a complete redefinition of *C*1, *C*2, and *F*1, at the level of the individual — stages (1) and (2) — to eradicate completely the sources of inefficiency in terms of interaction — stages (3) and (4) — instead of accommodating agents' plans to the initial rationed situation. Individual dynamics would lead to the establishment of entirely new expectations about future possible states or completely new representations of future possible states deemed possible. This scenario would result in completely new social dynamics with no or different sources of inefficiency in action.

4 Concluding remarks

The elements to be considered when establishing an evolutionary efficiency criterion in the context of a theory of production of action — such as plans, intentionality, expectations, iteration, feasibility, consistency, reflexivity, etc. — have led us to consider an analytical process whereby we identify and explain possible sources of inefficiency in the production of action. As far as efficiency properties of a system are

[35] Two examples of this are the Keynesian entrepreneur of the *General Theory* (Keynes 1936) and the economics of rationing (Malinvaud 1977; Benassy 1986).

systemic properties, but refer to non-homogeneous elements (e.g. different structures of intentionality), different social dynamics are possible. For example, in the presence of rationed action, agents can "lower" their expectations (review and eventually remove some of their goals), adjust their individual plans for the rationing environment or fully review their plans, both in the content and adequacy of actions and/or hierarchy of goals. Agents can also abandon some of their objectives, changing the institutional framework or introducing creative responses (Schumpeter 1947a, b) to an inefficient environment, which would imply reshaping the entire course of subsequent (planned) events. In any case, the alignment of plans (of goals, ultimately), at least partially (Harper and Endres 2017), is a necessary condition for the efficient functioning of processes of the coordination of action. For example, Nelson (2005) identifies the origin of certain alignments of plans in the emergence of certain organizations and institutions. In our approach, these realignments could overcome, for example, problems related to type *F*2 feasibility, from which efficiency can be analyzed at the level of the interaction of plans.

Agents pursuing their own (individual and collective) goals can fully or only partially achieve them at all. Improvements in the efficiency of a socio-economic system, through the removal of expectations about future states that agents defined from their individual (cognitive, ethical…) dynamics after interaction, are driven to achieve better matches with agents' intentions that are updated or integrated in their goals. The improvement requires the revision of individual intentionality (reflexivity), and in terms of interaction, of collective intentionality of the agents involved in the system. Some underlying evolutionary processes — non-disruptive creative processes, the emergence of radical innovation, etc. — may be illuminated within this analytical framework.

To summarize, the performance of an evolving economic system involves questions such as how and why the agents within the system produce specific goals of action; how and why they articulate, select and unfold specific courses of action to achieve them; how the alignments of goals and the adequacy of connections among actions and goals produce instants of reality through the interactive deployment of action within the general dynamics of a system, etc. The generation and continuous renewal of systems of objectives of the agents (in its content, constitution and hierarchy) is what ultimately makes the system evolutionary, not merely dynamic. Thus, it can be said that the evolution of a system is maintained by the ethical, cognitive and cultural dynamics of the agents who interact within a system. Any substantive evolutionary efficiency criterion should take into account all these elements.

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