Abstract
The aim of the paper is twofold. First, the paper assesses the compatibility of the epistemic foundations of game theory (dubbed “potential omniscience”) and Austrian economics (dubbed “unknowledge”). This assessment is done through the lens of the triptych universe/learning/uncertainty. Despite their deep differences, their epistemics can be seen as the two poles of a “knowledge spectrum”, making them complementary. Second, we determine when to apply which one. We hypothesize that the epistemics of game theory is better suited to analyze what we call structurally stable economic configurations. Extending an under-developed idea of Lachmann (1986), we propose that the easiness of capital redeployment determines the degree of structural stability of an industry. By doing this, we establish an original relationship between knowledge, entrepreneurship and capital.

Keywords: Austrian Economics, Game Theory, Epistemics, Capital, Entrepreneurship

JEL Classification: B25, D8, L26
The topic of knowledge is especially important for the integration of uncertainty into economics since the way we conceive uncertainty directly proceeds from the way we conceive knowledge. Uncertainty is an epistemic obstacle: omniscience and uncertainty are antinomic, while ignorance and uncertainty are tautological.

Austrian economics and neoclassical economics are undoubtedly the research programs that devoted the more effort to precise their respective epistemic foundations and, consequently, their respective conception of uncertainty. The main reason for this quest for epistemic foundations is that it fully participates in the strengthening of methodological individualism on which both rely. The understanding of individual decision-making necessarily involves the clarification of the nature, treatment and use of knowledge by individuals. Consequently, potential gains from intellectual trade between Austrian economics and neoclassical microeconomics may exist only if their respective conceptions of knowledge are compatible.

In the paper, we will only focus on a sub-field of contemporary neoclassical microeconomics, namely game theory, and we will only address the possibility for Austrian economics to benefit from game theory. Two reasons explain our choice. First, contemporary game theory relies on an axiomatic epistemics that makes its exposition practical and understanding straightforward. Second, one of the founders of game theory, Oskar Morgenstern, was assimilated to the Austrian school and published several papers in a purely Austrian vein on time, disequilibrium, and imperfect foresight (1935a, 1935b) before his famous *Theory of Games and Economic Behavior* written in collaboration with John von Neumann in 1944. It is now widely recognized that Morgenstern created the tools of game theory in order to address the core “Austrian” question of the coordination of individual decision-making and expectations (Leonard, 2010, Weintraub, 1992, Young *et al.*, 2004). It is thus legitimate to ask if the tools of contemporary game theory may be of some usefulness for Austrian economics. In other words, is there a double, back-and-forth, movement between Austrian economics and game theory, the former providing the initial question to the latter, the latter providing in exchange new powerful tools.

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1 The title of our paper echoes that of Rosen (1997), *Austrian and neoclassical economics: any gains from trade?*, in which he states that potential gains from intellectual trade between Austrian economics and neoclassical economics would consist in infusing a dose of entrepreneurship, disequilibrium and evolutionary competition, that is, a dose of Austrian economics, into the essentially static framework of neoclassical economics. This is now commonplace for economists, be they Austrian or not (Baumol, 1993).

2 In its evolutionary form, game theory benefited from the insights of Austrian economics, especially for the study of the spontaneous emergence of institutions (Schotter, 1981, Sugden, 1989, Young, 1996, 1998).
to the former? If the first movement is now a well-established fact, the existence of the second movement is not yet clearly established⁴.

Very few papers are devoted to a systematic confrontation of Austrian economics and game theory⁴. Foss (2000) is an exception. Following Foss, there are clear gains from trade for Austrian economics from taking into account the way game theory (especially cooperative game theory and repeated coordination games) analyzes the question of the coordination of knowledge and expectations. This rapprochement would also permit Austrian economics to adopt a formalized exposition more in line with the contemporary way of doing economics: ‘Game theory may be the best existing analytical vehicle to choose to the extent that Austrians want to dress their arguments in more formal garb. Game theory allows the Austrians to come formally to grips with key ideas on subjectivism, coordination, rules and institutions, and the entrepreneurial market process’ (Foss, 2000: p. 53). In other words, there are gains from trade because both focus on similar topics.

Nevertheless, Foss only addresses the question of the desirability of a rapprochement, without addressing the question of its epistemic feasibility. Our paper aims at filling this gap. We will show that the epistemic foundations of game theory (section 1) and Austrian economics (section 2) are largely incompatible but that, despite these incompatibilities, the tools of game theory may nevertheless be of some usefulness to Austrian economics to study routine economic situations that exhibit a certain degree of structural stability (section 3). In the fourth section, we try to provide a more precise definition of structural stability. Our results are thus more nuanced than Foss’s unqualified conclusion.

1. Potential omniscience: the axiomatic semantic formalism of knowledge

Contemporary game theory relies on the interactive semantic formalism of knowledge (see Aumann, 1999, Battigalli and Bonanno, 1999, Board, 2004, Fudenberg and Tirole, 1991, Kripke, 1963). Our object is not to present all the subtleties of the axiomatic, but only its logical structure and main implications for the treatment of uncertainty.

The semantic formalism of knowledge is a partition structure, where every agent has a partition over a supposedly complete space of states of the world, also called universe, Ω. A state of the

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³ For an application of game theory to the Austrian theory of the business cycle, see Carilli and Dempster, 2001.
world ‘specifies the physical universe, past, present, and future; it describes what every agent
knows, and what every agent knows about what every agent knows, and so on; it specifies what
every agent does, and what every agent thinks about what every agent does, and what every
agent thinks about what every agent thinks about what every agent does, and so on; it specifies
the utility to every agent of every action, not only of those that are taken in that state of nature,
but also those that hypothetically might have been taken, and it specifies what everybody thinks
about the utility to everybody else of every possible action, and so on; it specifies not only what
agents know, but what probability they assign to every event, and what probability they assign
to every other agent assigning some probability to each event, and so on’ (Geanakoplos, 1992:
p. 57). More concisely, a state of the world is ‘a complete description of the world, leaving no
relevant aspect undescribed’ (Savage, 1954: p. 9). Agents are able to completely and univocally
specify the characteristics of each state of the world, so that they can unambiguously distinguish
them. As we can see, the very definition of a state of the world already implies interactive and
recursive dimensions of knowledge, actions, payoffs and probability.

Among the universe exists the “true” state that actually occurs. Agents do not a priori know
this true state, but are nevertheless able to establish which element of a partition P defined on
Ω contains the true state. If the true state is ω, the information set of agent A is represented by
the element PA(ω) of the partition PA: agent A knows that the true state is one of the states
contained in PA(ω). Consequently, all the elements that do not belong to PA(ω) are not
considered as potential “candidates”.

An event is a subset E included in Ω. In a state ω, an agent knows an event when the event is
an element of the agent’s partition containing ω. If KE designates the set of the states ω in
which agents knows an event E, we obtain KE = {ω: PA(ω) ⊂ E}, with K a knowledge operator
(Aumann, 1999). From these definitions, five core axioms can be deduced (Samuelson, 2004).

First, since every state ω satisfies PA(ω) ⊂ Ω, we obtain the “axiom of awareness”

KΩ = Ω,

that means that agents are able to identify in which state of the world they are or, equivalently,
that agents are able to identify the set of possible states by formulating a complete and univocal
descriptions of the states. The axiom of awareness thus merely underlines the main characteristic of the definition of a state of the world.

Second, the “axiom of omniscience” is about an event being itself constituted by two events E and F. The considered event is thus the intersection of E and F. In terms of knowledge, it means that knowing the intersection of two events amounts to knowing both events:

\[ K(E \cap F) = KE \cap KF \]

If we take the particular case where E is included in F, we obtain \( E \subset F \Rightarrow KE \subset KF \). Since \( E \subset F \) can be read as “E implies F”, it means that if the agent knows E, thus he knows F, too. In other words, an agent knows every implication of everything he knows, for example the payoffs attached to any strategy. Samuelson (2004: p. 372) illustrates the axiom of omniscience by giving the example that if we explain all the axioms of mathematics to an agent, thus he knows all the theorems of mathematics, since the former imply the latter. The axiom of omniscience thus implies that agents have unlimited deductive and computational capacities.

Third, the “axiom of knowledge” states that knowing an event means that this event actually occurred and, thus, that it is true

\[ KE \subset E \]

In other words, an agent can only know something if it is true and, contrariwise, cannot know something that is false.

The fourth axiom, the “axiom of transparency”, or “positive introspection”, extends the third axiom to the whole knowledge of an agent:

\[ KKE = KE \]

Each agent is conscious of the knowledge he has and is thus able to completely describe, codify, communicate, and give value to it. Each agent knows with certainty what he knows\(^5\). By virtue of the axiom of knowledge, agents’ knowledge is thus true. To see this, suppose the event KE is a union of elements \( \omega_1 \) and \( \omega_2 \) of the agent’s partition: \( KE = \{\omega_1, \omega_2\} = \{\omega_1\} \cup \{\omega_2\} \). It is a direct consequence of the definition of what it means to know something. The agent can know E at state \( \omega \) only if it is true at every state in \( P_A(\omega) \). The agent knows E at one state in \( P_A(\omega) \) only if he knows it at every state in \( P_A(\omega) \). It ensures that KE is a union of elements of the

\(^5\) There is thus no room for tacit knowledge in the semantic formalism of knowledge.
agent’s partition. Then the states in which the agent knows KE, that can be written KKE, is the set KE (Samuelson, *op.cit.*: p. 373).

The fifth axiom, the “axiom of wisdom”, or “negative introspection”, is complementary to the previous proposition: if the agent does not know E, then he knows that the does not know E. If \( \neg KE \) means ‘does not know’,

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\neg KE = K (\neg KE)
\]

The agent understands and is aware of all possible states, those that actually occurred, but also those that might have occurred.

The partition-structure axiomatic hitherto exposed deals with the characteristics of knowledge hold by a single individual. The framework can nevertheless be extended to address situations of multi-agent interactions. This extension implies the concept of common knowledge, first introduced by the philosopher Lewis (1969), later applied to game theory by Aumann (1976), and developed in an axiomatic form by Milgrom (1981).

Common knowledge is a direct consequence of the definition of a state of the world. Every agent forms his partition on the same universe \( \Omega \) that they all describe in the same manner. Furthermore, every agent knows that the respective partition of the other agents are also defined on the same universe. Thus, agents cannot ignore the partitions of the others, because these partitions are included in \( \Omega \). Consequently, it is tautological that the partitions are common knowledge and that players have no uncertainty about each other’s partition and priors (Aumann, 2005). According to Samuelson (*op.cit.*: p. 375) ‘A state is a complete description of Bob’s partition. If Alice entertains several possibilities for Bob’s partition (or prior) over the state space \( \Omega \), then this uncertainty should itself be captured in the state space. The space \( \Omega \) should be expanded, breaking each of its states into several new states, corresponding to the different partitions over \( \Omega \) that might characterize Bob. Then we have a larger state space \( \Omega' \), over which Bob has a partition. If Alice is uncertain about Bob’s partition or prior over this larger state space, then we should repeat the process, continuing to do so until such uncertainty is banished. The principle behind Aumann’s argument is that any aspect of the environment about which Alice and Bob might be uncertain should be captured in the description of the states of the world’.
In this framework, uncertainty is defined as the agent’s incapacity to precisely define the state of the world that will actually occur, despite their capacity to circumscribe the true state in their partition: ‘Uncertainty means that we do not have a complete information of the world which we fully believe to be true. Instead, we consider the world to be in one or another of a range of states. Each state of the world is a description that is complete for all relevant purposes. Our uncertainty consists in not knowing which state is the true one’ (Arrow, 1974: p. 33). Following Langlois (1983), we can describe this conception of uncertainty as “parametric” (see also Langlois, 2006, 2013).

From this conception of knowledge, we can directly deduce the conception of learning as a conscious acquisition of information that progressively “prune” $P_A(\omega)$, so that the partition ultimately becomes a singleton only composed of the true state of the world. Since uncertainty consists in not knowing a priori which state is the true state, learning reduces uncertainty by putting aside the “false states”. As Fudenberg and Tirole state (1991: p. 543), ‘with this formulation of knowledge, more precise information corresponds with knowing a smaller set: knowledge here is the ability to rule out some of the states that were possible ex ante. In particular, if a player knows that the true state is in $E$, he knows that the true state is in any superset of $E$. A learning model is thus an explicit formal procedure that specifies learning rules adopted by players and their interaction in repeated games (Fudenberg and Levine, 1998).

To accept this “cut off” conception of learning, it is necessary to assume a narrow correspondence between the acquisition of new information and the consequent modification of individuals’ partition. The same bit of information must have the same consequence on every agent’s behavior or, in other words, all agents must interpret and value the same bit of information in the same way. Since agents’ rationality is also common knowledge, this necessary condition is automatically respected. If individuals cannot agree to disagree (Aumann, 1976), they must consider that all the other agents rationally and optimally analyze the information they have: the initial divergence between individuals’ priors must be based on sound information, and all agents know that all other agents analyze information rationally. Consequently, we can assume that if two individuals have the same information, they have identical beliefs. This is what is usually called in game theory the “Harsanyi doctrine” (Aumann, 1974, 1987, Harsanyi, 1967). As Halevy states (1998: pp. 2-3), ‘according to the “Harsanyi doctrine”, two agents who have access to the same information and the same training,
ought to arrive at identical conclusions. In the case of probabilities, differences in the likelihood assessment of a certain event must be explained (according to this doctrine) by different information, since all rational agents use Bayes’ rule’.

We can sum up this description of the semantic formalism of knowledge endorsed by contemporary game theory by underlining the three following points that deal respectively with the universe, learning, and uncertainty:

(1) It is commonly known that the universe is given and that states of the world are interpreted in the same rational, optimal, way. Consequently, individuals are fully aware of their own knowledge and of the knowledge of their opponents;
(2) Learning is a conscious acquisition of information that prune agents’ partition. Following the Harsanyi doctrine, the acquisition of information has commonly known consequences on agents’ partition and probability updating;
(3) Uncertainty is parametric and is defined as agents’ initial incapacity to precise the true state.

2. Unknowledge and uncertainty: the epistemic foundations of Austrian economics

Contrary to the axiomatic epistemics of game theory, there is no systematic exposition of the epistemic foundations of Austrian economics, but only separate elements scattered all over the literature (see Langlois, 1985). Our reading is thus inescapably partial, even if its main characteristics are, we think, commonly shared by Austrian economists. To echo the presentation of game theory, we will expose the epistemic foundations of Austrian economics through the triptych universe, learning, and uncertainty.

Universe. The epistemic core of Austrian economics is the proposition that the universe is neither bounded nor unambiguously (that is, objectively) definable, but open-ended and subjectively understood. Due to agents’ subjectivity of interpretation, the assumption of “cognitive transparency” of the universe endorsed by game theory - and neoclassical economics at large- must be rejected. The universe does not exist a priori and independently of its discovery, interpretation, and creation by individuals. Knowledge is permanently created in an endless, endogenously self-nourished, path dependent, and timely process, so that the universe exhibits a high degree of “plasticity”. This process of knowledge creation deepens the social
division of knowledge which, as the division of labor, increases global factor productivity, capital per head and ultimately promotes growth⁶.

The epistemics endorsed by Austrian economics also assumes that knowledge is dispersed and partly tacit -“individuals can know more than they can tell” (Hayek, 1937)-, while the semantic conception assumes that it is centralized “somewhere” and perfectly codified and exchangeable. This implies that, from an Austrian perspective, the main role of markets is not to optimally allocate scarce resources under fully known (or knowable) constraints, but to efficiently transmit information about the particular circumstances of time and place, a kind of information that is dispersed, asymmetric, practical, local, contextual, largely ephemeral, and unorganized, compared with scientific knowledge.

This “plastic-universe” vision is clearly at odds with the semantic conception of knowledge, for which the universe is given, finite, and commonly known, and where the totality of eventualities, along with their respective probability, are univocally enumerated (or enumerable) from the outset. Here, the conditions that orient decisions predate actions and individuals have no power on their environment of action: they can neither create new states of the world, nor determine by their own actions the true state that will actually occur. Indeed, the true state is selected by Nature (Harsanyi, 1967) that makes the first move at the beginning or at several points of the game and “chooses” a particular state of the world with a given, and commonly known, probability distribution. It is impossible to envisage the appearance of new knowledge in the semantic framework, since it would be impossible to assign them a probability distribution for the obvious reason that innovations and novelty cannot be predicted (Arrow, 1994).

Learning. Learning and the plasticity of the universe belong together. From the Austrian perspective, individuals interpret information through their subjective schemes of interpretation, a structured classification system that is partly genetically inherited and permanently updated via new experiences and errors (Hayek, 1952). Following Schütz’s (1932) theory of action (Koppl, 2001, 2002, Kurrild-Klitgaard, 2001), the subjective perceptions of the environment are ordered by schemes of experience and classification, defined as reference matrices (a reliable diagnosis tool) that are built through a process of sedimentation and

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⁶ This point can already be found in Menger (1994) and has been outlined at numerous occasions by Lachmann (1986).
synthesis of experience. Action and expectations are based on experience depositories of practical, concrete and well-proven (that is, efficient) knowledge. The articulation of these depositories generates the individual’s model of representation thanks to which new experience and information are interpreted, categorized, classified, and ultimately transformed into knowledge. Thanks to these matrices, individuals can re-contextualize the actual situation by reference to those already lived. Individuals are thus (even if imperfectly) able to distinguish the typical and common characteristics of the actual situation from its singular and contingent characteristics. If individuals face routine situations, they will apply ordinary and stereotyped knowledge and solutions that proved efficient and ease the coordination of their expectations7 (Koppl and Whitman, 2004).

On the other hand, when individuals face non-routine situations, they will have to discover new ways of understanding and doing without reusing a well-established model: the passage from routine to non-routine situations can be seen as an “epistemic shock”, where the previous induction-based categorizations suddenly become helpless. The notion of “normality” hitherto adopted, and the expectations based on it, must be recalibrated (Sauce, 2014). The understanding of non-routine situations does not rely anymore on already proved recipes and will necessitate the creation of new procedures of schematization that can be reactivated later, if they prove accurate and efficient. Two points can be underlined:

(a) Even if each individual holds a subjective model of representation that reflects his/her particular “biographical path”, the recurrent confrontation with typical, routine, situations explains the proximity, if not perfect identity, of individuals’ model of representation, genetic inheritance amplifying this proximity. The accumulation and synthesis of experience give rise to matrices of practical and proven knowledge that are well-adapted to typical situations. They have thus a dimension of practical efficiency that allows individuals to form accurate expectations about the behavior of each other in typical situations: routineness eases the coordination of expectations. Thus, the “interactive subjectivism” endorsed by Austrian economics cannot be assimilated to solipsism.

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7 We may object that our reasoning is circular: is coordination of expectations the consequence of routineness, or is routineness the consequence of coordination of expectations? Our position is that coordination of expectations is the consequence of routineness. Section 3 exposes some economic determinants of routineness.
(b) Contrariwise, when facing non-typical, non-routine situations, individuals’ scheme of orientation may become obsolete or, to a lesser extent, insufficient, what prompts the revision or creation of new forms of actions and expectations. Learning is thus an endless enrichment and/or restructuration of existing schemes of interpretation. Contrary to the conception of learning endorsed by the epistemics of game theory, learning is here a dynamic process of enlargement of the individuals’ space of representation, not a pruning of the universe.

These operations of selection, synthesis and abstraction of the external environment are totally absent from the framework of game theory, that considers that there exists a uniform, isomorphic and non-ambiguous relationship between information, knowledge, meaning and learning. Under the assumption of isomorphism, two individuals with different information partitions and experience would nevertheless interpret a given bit of information in a strictly similar manner. From an Austrian perspective, their interpretation would be close, but not necessarily similar, when they are recurrently exposed to similar conditions, but very probably dissimilar when facing non-routine situations. The importance of subjective interpretation clearly appears in disequilibrium and non-routine situations.

Uncertainty. Uncertainty proceeds from the open-endedness of the universe and the subjectivity of interpretation. There is uncertainty because there is an inescapable lack of knowledge, that is, ignorance or “unknowledge” (Frowen, 1990, Shackle, 1983, Witt, 2009). Ignorance is not a strategic variable, but a constraint necessarily (ontologically) imposed on individuals. To use Carillo and Mariotti (2000) terms, ignorance is not a rational or strategic obliteration of information. Uncertainty is here non-probabilistic or “structural” (Langlois, op.cit.).

The conclusion we can draw from what precedes seems to be clear cut and in complete opposition with that of Foss (op.cit.): Austrian economics can in no way benefit from game theory to analyze the coordination problem because their respective epistemics are largely incompatible, the epistemics of game theory neutralizing the coordination problem from the outset by assuming that what must be discovered throughout the coordination process is already commonly known. The axiomatic epistemics of knowledge endorsed by contemporary game theory thus makes the coordination problem, that is, its initial raison d’être, largely trivial. Individuals “navigate” in a universe of “potential omniscience” without shaping it beforehand.
Like the strategy set and the matrix of gains, the set of knowledge is given. Consequently, individuals do not have to construct the maximization problem they have to solve, since they directly face the problem and have all the elements necessary to solve it optimally (Ghirardato, 2001).

3. Toward an epistemic rapprochement

We can either accept this unqualified conclusion, or see it as too hasty. Indeed, instead of opposing their respective epistemics, we can also see them as the two poles of a “knowledge spectrum”, the first pole of the spectrum being assimilated to the “potential omniscience” triptych of game theory, the second to the “unknowledge” triptych of Austrian economics⁸.

If we accept the spectrum hypothesis, a further question appears: how can we know where we are on the knowledge spectrum? Where to put the cursor? Our thesis is that the place of the cursor depends on the degree of structural stability (that is, typicality/routineness) of the market configuration studied, the degree of structural stability being itself determined by the transaction costs of capital reshuffling: when structural stability is high (resp. low), the cursor goes closer to the epistemics of game theory (resp. Austrian economics). This vision in terms of knowledge spectrum constitutes the gains from trade for Austrian economics that would enrich and complete its analysis of the market process.

Extending on Hayek (1937), Lachmann (1976) conceives the market process as the outward manifestation of an unending stream of knowledge. By discovering and creating new profit opportunities, consumers’ preferences and production techniques, entrepreneurs are the “driving force” of the market process⁹ (Kirzner, 1973, 2000). Unknowledge (and consequently learning) and entrepreneurship are clearly interlinked, the former being a necessary condition for the latter. As exposed above, learning is conceived as the updating of agents’ subjective model of interpretation. The updating may be piecemeal or deeper, depending on the degree of

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⁸ Garrison (1982) also uses the term “knowledge spectrum” but in a slightly different way. Contrary to our use, he delimits the spectrum by the perfect-knowledge and perfect-ignorance poles. If our first pole is similar (even if Garrison does not take great care to precise what he means by “perfect-knowledge”), our second pole is different: the unknowledge epistemics of Austrian economics characterized above does not refer to perfect ignorance or total absence of knowledge, but to a particular triptych universe/learning/uncertainty.

⁹ Our assimilation of the ways Kirzner and Lachmann conceive the market process may seem debatable. But the opposition between them is about the relative strength of equilibrating and disequilibrating tendencies of the market process, not about the very nature of the market process.
routineness and predictability of the (social and material) environment in which individuals are embedded.

In structurally stable environments, individuals recurrently face typical situations -such as price volatility, competitors’ strategies or price elasticity of demand. The stability and predictability of the environment ease the identification, understanding and discrimination between the random and permanent forces (the “causal-genetic” process) that are at its origin (Cowan and Rizzo, 1996). The environment becomes “cognitively transparent” in the sense that individuals accurately understand its underlying causal-genetic process. Even if the understanding of the causal-genetic process is not a priori uniformly distributed amongst the population, the recurrence of typical situations and the profit-and-loss selection filter permit individuals (1) to gradually adopt close and sound models of representation, (2) to reuse well-proved ideal-typical knowledge and tools (typical solutions to typical problems), and (3) to devise a commonly shared notion of “normality” (Lachmann, 1943, 1956, Sauce, op.cit.). Predictability and market discipline reduce uncertainty about each other’s behavior, the range of possibilities (that is, the strategy set and corresponding gains/losses), greatly extend the efficiency of the adopted rules of thumb and the predicting capacity of individuals (Hayek, 1952).

The triptych universe/learning/uncertainty of a structurally stable environment share essential characteristics with that of game theory, especially concerning the nature and result of the learning process. In both triptychs, learning can be conceived as a pruning of possible states of the world whose result is the increase of the cognitive transparency of the universe. On the other hand, confrontation with non-routine situations makes outdated the diagnosis and the definition of normality adopted hitherto, causing the dis-coordination of expectations. Here, the triptych universe/learning/uncertainty of Austrian economics (especially its conception of learning as an enlargement/enrichment of the space of representation) is the natural candidate to analyze the process of learning and adjustment of individual plans and expectations. The characteristics and result of the learning process thus depend on the nature of the environment (in terms of routineness and predictability) in which individuals are embedded: the more stable the causal-genetic process of price formation is, the more predictable the environment, and the more homogeneous and coordinated are agents’ models of interpretation.

By establishing a close relationship between the characteristics of the environment of action and the characteristics of the learning process of individuals, one may object that our reasoning
is at odds with the strong focus on subjectivism of Austrian economics. Nevertheless, we can find in the Austrian literature elements that confirm our analysis\textsuperscript{10}. For example, according to Lachmann (1943, 1956), in the absence of structural change, the long-term equilibrating forces have time to “freeze” and fully play their equilibrating role by neutralizing the disequilibrium forces to define a normal price. Experience and market discipline would then progressively homogenize and improve the soundness of the diagnosis of individuals. On the other hand, in a non-routine or “kaleidic” world (Lachmann, 1976), where the structural stability of the causal-genetic process can be jeopardized by entrepreneurial errors and innovations in next to no time, the notion of long-term operating forces loses its significance. In a kaleidic world, the discoordination of expectations forces individuals to update their model of interpretation in depth and the result (the degree of coordination of expectations) of this market-wide learning process cannot be ascertain beforehand. We can thus already find in Lachmann the idea that the end-result of the learning process (that is, the degree of coordination of plans and expectations) closely depends on the characteristics of the environment in which individuals are embedded: “Human action is not determinate, but neither is it arbitrary [...] Human action is free within an area bounded by constraints” (Lachmann, 1971: p. 37).

The concept of “system constraint” developed by Koppl and Langlois (1991) and Koppl and Whitman (2004) is another example. Koppl \textit{et al.} defines a system constraint as a set of constraints and incentives that determine the characteristics (in terms of predictability) of the environment in which individuals are embedded. Depending on the coherence, or “tightness”, of the system constraint, uncertainty of the environment of action is reduced, permitting individuals to increase the prescience and rationality of their expectations. As Koppl and Whitman indicate (2004, p. 32), “In the presence of a tight system constraint, the actions of ordinary people can approximate the “rational” standards of the pure rationalist. No one literally solves the mathematical optimization problem. But the system constraint acts to keep those who come closer and discard the rest. The difficulty with rational-choice theory, however, is that the system constraint is not always tight. When the system constraint is loose, the actor has more liberty to act in ways that are not appropriate to the situation. He may behave in an idiosyncratic, non-optimizing, or non-rational manner”. Stated differently, the learning process and its end-result in terms of homogeneity of models of interpretation and coordination of expectations are context-dependent. The next step of our analysis consists in understanding why some economic

\textsuperscript{10} This paragraph relies on Sauce, 2014 (\textit{op.cit.}).
environments are more structurally stable than others\textsuperscript{11}: why are some markets more “jostled” by entrepreneurs than others? Why is there a diversity of market processes?

Austrians usually (implicitly) suppose that the unknowledge conception of the market process is a universal that can be equally well applied to the study of very different kinds of markets, from derivatives, airplanes, raw materials to cauliflowers (Lachmann, 1986). Differences in price flexibility and volatility, innovation pace, stability of demand, short- and long-term rigidity of the coefficients of production and the like between industries are generally ignored in the canonical Kirznerian framework. Lachmann is a notable exception in his recognition of the existence of several types of market processes. Lachmann (1986: p. 3) indeed remarks that “some inter-market processes involve the mobility of certain types of capital goods, others do not. To ignore such phenomena causing the diversity of market processes, where they matter, for the sake of obtaining a level of abstraction permitting us to speak of the market process would be quite wrong”\textsuperscript{12}. Our reasoning extends that of Lachmann by integrating a knowledge dimension. We hypothesize that the characteristics of the triptych universe/learning/uncertainty (that is, the place of the cursor on the knowledge spectrum) heavily depends on the mobility of the (physical and financial) assets combined by entrepreneurs: when assets are hardly redeployable to other industries, the market exhibits a high degree of structural stability, making the triptych universe/learning/uncertainty of game theory more fruitful to analyze its characteristics.

Lachmann’s noteworthy identification of capital mobility as an \textit{explanans} of the diversity of market processes is completely in line with his conception of the entrepreneur as a creator and destructor of capital combinations\textsuperscript{13}. According to Lachmann, entrepreneurship and capital belong together: “As long as we disregard the heterogeneity of capital, the true function of the entrepreneur must also remain hidden” (1956 [1978]: p. 16). The essential role of the entrepreneur consists in filling the “gaps” in the capital structure by combining functionally

\textsuperscript{11} For sake of simplicity and generality, we neglect the non-economic determinants, such as artificial entry/exit barriers imposed by government regulations, to explain structural stability.

\textsuperscript{12} While Kirzner disconnects the theories of capital and entrepreneurship, Lachmann sees them as complementary. Kirzner’s disconnection between both theories clearly appears in his influential 1997 paper \textit{Entrepreneurial discovery and the competitive market process: An Austrian approach}, where he states that his paper is devoted to the exposition of “the modern Austrian approach to understanding the competitive market process” (p. 61), but does not deal with other major areas of Austrian economics, such as “cycle theory, monetary theory, capital theory” (ibid.). It is thus even unnecessary to mention capital theory in order to understand the “modern Austrian approach” of entrepreneurship.

\textsuperscript{13} For a comprehensive appraisal of Lachmann’s conception of entrepreneurship, see Endres and Harper, 2013.
heterogeneous and specific capital goods to create complementarities, synergies, and value (Foss et al., 2007) in a coherent and forward-looking plan of production. Nevertheless, even if the relationship between entrepreneurship and capital ownership/control is forcefully underlined, Lachmann does not address the question of knowing if the types of capital assets combined by entrepreneurs has an impact on entrepreneurship.

Yet, if entrepreneurs are asset owners whose main economic function consists in reshuffling capital combinations through inflows and outflows of physical and financial capital between markets, it implies that the easiness of such inter-market movements of capital (that can be measured by the level of transaction costs) imposes a constraint on entrepreneurs to enter/exit the market or revise their plans of production. When forward and second-hand markets for assets exhibit a low degree of liquidity (or simply do not exist), transaction costs of asset reshuffling may become prohibitive and even engender sunk costs, hampering the recombination and regrouping of capital. Low liquidity of forward and second-hand markets for assets can thus discourage (or even make impossible) the entrepreneurial function of inter-market capital reshuffling. Remark that we do not conceive transaction costs and sunk costs as a consequence of the physical characteristics of assets, but as a consequence of the liquidity of the forward and second-hand markets for these assets. An asset is not specific sui generis; it is specific only if the forward and second-hand markets for it are illiquid. Stated differently, asset specificity is not a data determined by the physical characteristics of assets, but a variable determined by market phenomena.

On the other hand, if entrepreneurs expect that it will be (more or less) easy to revise in the future their plan of production if it proves incorrect, they are encouraged to enter the market today. What matters here is not the degree of functional specificity or fixity of capital, but the easiness of their reselling; what matters here is the easiness with which plans can be revised.

This is another deep difference between the Kirznerian and Lachmannian conceptions of entrepreneurship, since for Kirzner “pure entrepreneurs” are decision-makers, not asset owners: “Ownership and entrepreneurship are to be viewed as completely separate functions. Once we have adopted the convention of concentrating all elements of entrepreneurship into the hands of pure entrepreneurs, we have automatically excluded the asset owner from an entrepreneurial role. Purely entrepreneurial decisions are by definition reserved to decision-makers who own nothing at all” (1973: p. 47). On the other hand, according to Lachmann (1986, p. 66), “In a production economy it is hard to see how entrepreneurs can exploit profit opportunities without having to invest their capital for at least a few years and thus running the risk of seeing the opportunity vanish before the capital is amortized. Outside the sphere of pure exchange entrepreneurial action is thus always prompted by expectations”.

For example, a house is not a specific asset during a real estate bubble, but becomes more specific as the time and efforts needed to sell it (that is, transaction costs) increases.
once they are implemented. In other words, by constituting economic barriers to exit\textsuperscript{16}, expected transaction costs determine the level of potential entry (and consequently “jostling”) on a market.

When transaction costs on assets are high, the inflow/outflow of physical and financial capital is strongly constrained, stabilizing the number and characteristics of existing incumbents. The recurrence of interactions between competitors helps increasing the understanding of their characteristics and the predictability of their strategies. For example, it becomes easier for incumbents to predict the pricing strategies or the elasticity of supply of their competitors, or to understand their cost structure or human resources management. In other words, transaction costs stabilize the market structure and reduce uncertainty about the strategy set of incumbents. Consequently, when entrepreneurs face high levels of transaction costs (and \textit{a fortiori} sunk costs), the application of the triptych universe/learning/uncertainty of game theory is relevant. On the other hand, the epistemic assumptions of Austrian economics are more relevant when forward and second-hand markets are liquid or when entrepreneurs are acting on perfectly contestable markets where costlessly reversible entry, such as “hit and run” strategies, is not precluded. Both epistemics are thus complementary, once transaction costs are taken into account.

\section*{Conclusion}
Initially, game theory and Austrian economics both dealt with the same topic of the coordination of individual behavior. Now, the progressive precision of the epistemic foundations of game theory made the problem of coordination largely trivial. A possible reading would consist in concluding that their respective epistemic conceptions (in terms of the triptych universe/learning/uncertainty) are irreconcilable and that Austrian economics cannot benefit in any way from the analytical tools of game theory: according to this interpretation, there are no gains from trade for Austrian economics. We adopt another, more qualified, interpretation by seeing the epistemic foundations of game theory and Austrian economics as the two poles of a “knowledge spectrum”.

\textsuperscript{16} Our reasoning is thus close to Baumol and Willig (1981), according to which sunk costs, and not fixed costs, constitute barriers to entry. Our analysis is nevertheless slightly different, because sunk costs are here merely seen as “extreme” transaction costs. We do not draw a conceptual distinction between transaction and sunk costs, but see the latter as an extreme level of the former.
We hypothesize that the place on the knowledge spectrum depends on the degree of structural stability of the industry studied. Extending on Lachmann (1986), we see inter-market capital mobility as the main determinant of structural stability. The paper thus establishes a relationship between knowledge, entrepreneurship and capital, an articulation that was hitherto completely absent in the Austrian literature.

Another interesting result can also be derived from our analysis: the possibility for entrepreneurs to “jostle” a market depends on their ability to reshuffle capital between markets. Since the easiness of these capital movements depends on transaction costs, we can establish the empirically testable “pattern prediction” that the intensity of entrepreneurship is not a data that can merely be observed ex post by economists, but a variable that depends on the level of transaction costs.

References


